
# Generation Challenge Programme
# CGIAR Challenge Programme Annual Report 2007

**Submitted by**
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Generation Challenge Programme
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# Contents

# Acronyms and abbreviations

| | |
|---|---|
| ACGT | African Centre for Gene Technologies, South Africa |
| ARI(s) | advanced research institute(s) |
| BAC | bacterial artificial chromosome |
| BecA | Biosciences Eastern and Central Africa |
| BIOTEC | National Center for Genetic Engineering and Biotechnology, Thailand |
| BMGF | Bill & Melinda Gates Foundation |
| CAAS | Chinese Academy of Agricultural Sciences |
| CG | See 'CGIAR' |
| CGIAR | Consultative Group on International Agricultural Research |
| CHF | Swiss francs |
| CIAT | International Center for Tropical Agriculture |
| CIMMYT | International Maize and Wheat Improvement Center |
| CIP | Centro Internacional de la Papa (International Potato Centre) |
| CIRAD | Centre de coopération internationale en recherche agronomique pour le développement, France |
| DFID | Department for International Development, UK |
| DPKit | Delivery Plan Kit |
| EBI | European Bioinformatics Institute, UK |
| EC | European Commission |
| EMBL | European Molecular Biology Laboratory |
| EMBRAPA | Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation) |
| EPMR | External Programme and Management Review |
| EST | expressed sequence tag |
| EUR | Euros |
| GBP | British pounds |
| GCP | Generation Challenge Programme |
| GFAR | Global Forum for Agricultural Research |
| GSS | Genotyping Support Service |
| IAU | Internal Auditing Unit (of the CGIAR) |
| ICARDA | International Centre for Agricultural Research in the Dry Areas |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IITA | International Institute of Tropical Agriculture |
| iMAS | Integrated Marker-Assisted Selection System |
| INRA | Institut National de la Recherche Agronomique, Morocco |
| IRD | Institut de recherche pour le développment, France |
| IRRI | International Rice Research Institute |
| JIC | John Innes Centre, UK |
| LGDP | Laboratoire génome et développement de plantes |
| LIMS | Laboratory Information Management System |
| MAB | marker-assisted breeding |
| MAS | marker-assisted selection |
| MB | molecular breeding |
| MTP | Medium-Term Plan |

| | |
|---|---|
| NARS | national agricultural research system |
| NIAS | National Institute of Agrobiological Sciences, Japan |
| NILs | near-isogenic lines |
| PAC | Programme Advisory Committee |
| PDG | Project Development Guide |
| PI | Principal Investigator |
| PSC | Programme Steering Committee |
| QTL | quantitative trait loci |
| R&D | research and development |
| RAP | Review and Advisory Panel |
| SCRI | Scottish Crop Research Institute, UK |
| SDC | Swiss Agency for Development and Cooperation |
| SEK | Swedish krona |
| SHC | Stakeholders Committee |
| Sida | Swedish International Development Cooperation Agency |
| SNP | single nucleotide polymorphism |
| SP | Subprogramme |
| SSR | simple sequence repeat |
| UCB | Universidade Católica de Brasilia, Brazil |
| WARDA | Africa Rice Center |

# 1. Executive summary

The Generation Challenge Programme (GCP), launched in July 2003, is a research and capacity-building network that uses plant genetic diversity, advanced genomic science and comparative biology to develop tools and technologies that enable plant breeders in the developing world to produce better crop varieties for resource-poor farmers. Thus GCP helps link 'basic' research with 'applied' science—to help make scientific innovations and new technologies relevant for resource-poor farmers, and to improve access by scientists and researchers in the developing world to technologies that can make plant breeding faster and more efficient. Designed as a two-phase 10-year initiative, GCP is now approaching the end of Phase I, which runs from 2004–2008. Phase II will be 2009–2013.

Activities are organised under five Subprogrammes (SPs):

- SP 1: Genetic diversity of global genetic resources
- SP 2: Genomics towards gene discovery
- SP 3: Trait capture for crop improvement
- SP 4: Bioinformatics and crop information systems
- SP 5: Capacity-building and enabling delivery.

In its fourth year, GCP had a total of 113 projects within the five SPs. Of these, 22 were funded by competitive grants, 90 were commissioned, and one—a new project on tropical legumes—was a special project.

Our strategy has evolved through time, in step with the dynamism in the priorities and needs of our mission. Our overall Strategic Framework,[1] defined in 2006, guided activities and determined priorities in 2007, as well as informing the selection of commissioned projects for 2008. Key features of research in 2007 were: better integration of activities across SPs 1, 2 and 3; more focus on key strategic crops and target regions for SP3 projects; promotion and utilisation of the first GCP products; greater participation of breeders in GCP projects; and an increasing leadership role by scientists from national programmes.

As we implement the strategy, the shape and focus our Subprogrammes is evolving, as outlined in section 2.2 of this report. We now have a clearer and improved focus on improving drought tolerance, as will be demonstrated by the research themes of our 3rd call for competitive research, which go out in early 2008.

In the year under review, we went beyond results at the Subprogramme level, and began to make real impacts on crop improvement. Our pathways to impact included, among others, molecular marker analysis of germplasm diversity for most GCP crops, increasing access to intra-crop genetic diversity, developing new markers to improve breeding efficiency for drought-prone environments, and improving phenotyping approaches and protocols.

In addition, the searchable GCP Central Registry[2] listing all datasets from GCP projects is now online to facilitate information sharing and data management. In 2007, also launched a special project to improve tropical legumes for sub-Saharan Africa. Other accomplishments in 2007 included, among others:

- producing rice introgression materials with high genetic resolution, and making the same accessible for phenotping and trait tagging;

[1] Strategic Framework at: http://www.generationcp.org/comm/gcp_framework_final.pdf
[2] Central Registry at: http://gcpcr.grinfo.net/

- identifying—and transferring to national programmes—gene-based and linked markers diagnostic for rice salt tolerance and phosphorous uptake;
- the release of iMAS (Integrated Marker-Assisted Selection System)—a bioinformatics tool for breeders conducting MAS; and
- establishing a large R&D community to improve legumes for Africa and coordinate initial activities.

GCP strives to develop usable products in the form of knowledge, materials and tools for plant breeders. To achieve this, we develop appropriate and need-based tools. For example, a Delivery Plan (DP) is now required for every new major project (defined as projects with a budget of USD 250,000 or more). To ensure cogent and consistent DPs, in 2007, we developed a Delivery Plan Kit (DPKit)[3] with a dual purpose: the DPKit is simultaneolusly a support tool for researchers, as well as a monitoring and evaluation (M&E) tool for research managers. The DPKit was immediately used starting with the seven projects initiated in 2007. To ensure product delivery and relevance, DPs are a participatory exercise, formulated by researchers leading the projects, in direct consultation with the targeted users of their research products.

Moving from planning to products, the Annual Research Meeting was held in Benoni, South Africa in September, providing a consultative forum for reporting on products now emerging from GCP's research, but also picking up emerging issues in the arena in which GCP operates.

Data generated by the different GCP projects are also considered as a valuable product, and the Programme is committed to sharing these data as international public goods for public access at no cost. With an increasing amount of information generated by GCP's research activities, data quality control and data release are receiving more attention, in the context of product management and product delivery.

For GCP, another crucial aspect for product delivery and uptake is capacity-building for partners. In 2007 we completed sets of learning materials on crop diversity, on genomics and comparative genetics and on bioinformatics; provided training on topical policy issues; launched the 'Capacity-building *à la carte*' programme for teams working on applied research; awarded competitive fellowships and travel awards; developed and implemented project Delivery Plans using the DPKit; tested the Genotyping Support Service; and pioneered a community of practice approach for rice with partners in Asia.

The number of visitors to the GCP website in 2007 averaged about 60,000 hits per month, while *GCP News*, an electronic newsletter, reached about 2,000 subscribers. In 2007 GCP also raised awareness by participating in several international events, including the annual Plant and Animal Genome Conference in San Diego (USA) in January and BioAsia 2007 in Bangkok (Thailand) in November.

The Programme Steering Committee (PSC) was GCP's main governing body during 2007. However, this year witnessed the start of a restructuring of GCP's governance. The PSC resolved at its December 2007 meeting to transfer substantive governance to an independent Executive Board, which becomes operational in June 2008. The Board's primary responsibility will be to provide oversight on GCP's strategic direction, as well as to assess finances and risk environment. As part of the reform process, the PSC will define its mode of interaction *vis-à-vis* the new Executive Board, and also redefine its role, internal *modus operandi* and interaction with

[3] DPKit at: http://www.generationcp.org/sp5/?da=08122719#dp_kit

the GCP Management Team. The roles and responsibilities of two advisory committees—the Stakeholders Committee and the Programme Advisory Committee—will also be redefined.

The first GCP External Programme and Management Review was conducted in 2007, and its final report will published in 2008. The review recommendations will feed into GCP's efforts to improve its *modus operandi*, and also to better organise and focus the research portfolio as GCP moves into Phase II.

The EPMR acknowleged GCP's role in forging and nurturing partnerships, and leveraging our collective resources to establish an even broader network of R&D participants to support and help realise GCP objectives. The EPMR Panel noted in its draft report: *"Perhaps the most important value of GCP thus far, is the opportunities it has provided for people of diverse backgrounds to think collectively about solutions to complex problems, and, in the process, to learn from one another."*

Because GCP research is mostly 'upstream', it is critical to collaborate with organisations involved in large-scale plant breeding, seed multiplication and seed distribution, for impact in our target regions.[4] We need, as an example, to further consolidate our links with the Program for African Seed Systems (PASS), jointly funded by the Bill & Melinda Gates Foundation and The Rockefeller Foundation. GCP will enhance collaboration with small- and medium-sized enterprises, including the private sector and any other organisations to ensure product delivery to, and capacity-building for, Africa and South and Southeast Asia. Working with the private sector is critical for GCP, and we take a case-by-case approach to reflect the nature of each partnership.

From a financial perspective, 2007 was a year of mixed fortunes, but overall with a happy ending. The uncertainty was not due to funder doubts but related rather to measures to ensure a good match between receipt of contributions through the year and our calendar for disbursing funds, based on our workplan. Fortunately the payment schedule did not greatly hamper our projected 2007 workplan; we reorganised our disbursements to avoid cash-flow problems, and finished the year with a clean bill of health. In fact, 2007 registered our highest income ever since the inception of the Programme due to several factors as explained in the Financial report. In 2008, we should see a return to our standard situation, with a projected income of about USD 16 million.

[4] A brief on GCP's target regions, and the 12 crops associated with these regions is at: http://www.generationcp.org/gen.php?da=08128238#gcp_target-crops

# 2. Background

## *2.1 Programme objectives and structure*

The Generation Challenge Programme (GCP), launched in July 2003, is a research and capacity-building network that uses plant genetic diversity, advanced genomic science and comparative biology to develop tools and technologies that enable plant breeders in the developing world to produce better crop varieties for resource-poor farmers. Thus GCP helps link 'basic' research with 'applied' science—to help make scientific innovations and new technologies relevant for resource-poor farmers, and to improve access by scientists and researchers in the developing world to technologies that can make plant breeding faster and more efficient. Designed as a two-phase 10-year initiative, GCP is now approaching the end of Phase I, which runs from 2004–2008. Phase II will be 2009–2013.

GCP has four main objectives:

- Provide access to, and promote the use of, genetic diversity in plant improvement programmes.
- Develop a public platform of genetic and genomic resources and tools, and support a global community that can use them.
- Generate and apply knowledge across crops, and demonstrate the potential of comparative genomics to contribute to plant improvement programmes.
- Use genetic diversity and advanced science to develop products for plant breeding programmes to improve the livelihoods of resource-poor farmers in marginal drought-prone environments.

Activities are organised under five Subprogrammes (SPs):

*SP 1: Genetic diversity of global genetic resources.* Characterises the diversity of crop germplasm collections in the custody of the CGIAR and national programmes in terms of genetic structure and associated phenotypic variation.

*SP 2: Genomics towards gene discovery.* Uses or develops genomic tools and technologies and evaluates interdisciplinary approaches to better understand gene function and interaction, in order to improve knowledge of gene systems across crops.

*SP 3: Trait capture for crop improvement.* Validates gene function and refines molecular breeding systems and the resulting enhanced germplasm, so as to increase the efficiency, speed and scope of plant breeding.

*SP 4: Bioinformatics and crop information systems.* Integrates GCP information components and analysis tools into a coherent information gateway and provides support for data analysis to the other GCP SPs.

*SP 5: Capacity-building and enabling delivery.* Empowers scientists in developing country national programmes to use modern breeding approaches. SP5 also coordinates the development and implementation of project Delivery Plans and is responsible for intellectual property issues, and research in policy and impact assessment.

Each SP has up to five themes (see Appendix A).

Research under GCP may be funded by one of three complementary funding mechanisms—competitive grants, commissioned research projects and special projects. This system ensures that GCP's research portfolio is fine-tuned to the latest developments in the research-for-development world in which GCP operates.

## *2.2 Research strategy and priorities*

GCP's research strategy has evolved since the start of the Programme, as priorities and needs have changed. To ensure continued coherence and direction for Programme research, in 2006 we defined a Strategic Framework[5]. This guided activities and determined priorities in 2007, as well as informing the selection of commissioned projects for 2008. The strategy is complemented by 'reference studies' to confirm and consolidate impact targets (farming systems, crops or traits). These reference studies guide GCP's Management Team in priority-setting and resource allocation.

Key features of GCP research in 2007 were: better integration of activities across SPs 1, 2 and 3; more focus on key strategic crops and target regions for SP3 projects; promotion and utilisation of the first GCP products; greater participation of breeders in GCP projects; and an increasing leadership role by scientists from national programmes.

As the new strategy is put into practice, the shape and focus of GCP SPs is evolving:

- SP1's efforts were initially devoted to characterising a broad germplasm set through molecular markers. The next step is to phenotype the reference sets identified in target environments, and to better define the linkage disequilibrium in target crops and identify favourable alleles through association studies.
- New SP2 projects will now focus exclusively on identifying genes and gaining a better understanding of regulatory pathways involved in drought tolerance, exploring new approaches through comparative genomics, and taking advantage of the increasing number of genomic sequences available.
- The number of SP3 projects promoting the use of markers is increasing, commensurate with the knowledge generated in SP1 and SP2, as well as from research outside GCP. Thus, SP3 validates and adds value to the products and information generated by the other SPs. All SP3 projects will be geared towards crop improvement in drought-prone environments, focusing on GCP target crops and regions.[6]
- For SP4, the basic infrastructure for information exchange within GCP has been developed. Consequently, funding for this line of activities is expected to decrease to maintenance level. The development of software, tools and methodology to sustain GCP's science will continue as before, and support to GCP scientists on biological questions and on data handling and analysis will increase.
- The role of SP5 is becoming increasingly critical to ensure marketing and delivery of GCP products, while continuing to support capacity-building for target beneficiaries further down GCP's delivery chain. We recently initiated *ex ante* analysis to evaluate the impact of key GCP products, and to help refine our target traits and regions based on local needs.

[5] http://www.generationcp.org/comm/gcp_framework_final.pdf
[6] http://www.generationcp.org/UserFiles/File/gcp-target-systems_brief.pdf

# 3. Research accomplishments

## *3.1 Overview*

In 2007, GCP had a total of 113 projects within the five SPs. Of these, 22 were funded by competitive grants, 90 were commissioned, and one—the new project on tropical legumes (see below)—was a special project.

In this fourth year of the Programme, we went beyond results at the Subprogramme level, and began to make real impacts on crop improvement. We completed molecular marker analysis of germplasm diversity for all of our target crops[7] except for faba bean and foxtail millet, expanded the seed multiplication ready-reference samples available for the majority of the crops, and extended knowledge frontiers on crop domestication. We also increased access to intra-crop genetic diversity, improved phenotyping approaches and protocols, identified and validated new markers for drought-prone environments, and refined strategies and technologies for marker-assisted selection (MAS) for simple traits and marker-assisted breeding (MAB) for polygenic traits. The searchable GCP Central Registry[8] listing all data sets from GCP projects is now online to facilitate information sharing and data management. The year also saw the launch of a special project to improve tropical legumes, through germplasm characterisation and improvement through molecular markers, for drought-prone environments.

GCP activities aim at generating usable products in the form of knowledge, materials and tools for plant breeders. To support this aim, in 2007 GCP launched its Delivery Plan Kit (DPKit),[9] which was used by the seven projects initiated in 2007 (six competitive projects and one special project). For every new major project (defined as projects with a budget of USD 250,000 or more), a Delivery Plan[10] is now required. Plans are formulated by researchers leading the projects, in direct consultation with the targeted users of their research products, to ensure product delivery and relevance.

The Annual Research Meeting[11] was held in Benoni, South Africa in September. It was structured around themes defined primarily by the products now emerging from GCP's research, but also picking up emerging issues in the arena in which GCP operates.

The main outputs for GCP in 2007 are given in Section 3.2 below, while a brief summary of status and results for each SP is provided in Section 3.3. Appendix A lists the themes and outputs in GCP's logframe for each of the five SPs.

## *3.2 Technical outputs*

GCP's research accomplishments in 2007 were as follows:

- Completed molecular marker analysis of germplasm diversity for 19 GCP target crops (all except faba bean and foxtail millet)
- Developed reference samples for the majority of GCP mandate crops

[7] List of GCP target crops at: http://www.generationcp.org/gen.php?da=08128238
[8] http://gcpcr.grinfo.net/
[9] Delivery Plan Kit accessible at: http://www.generationcp.org/sp5/?da=08122719#dp_kit
[10] See our rationale for Delivery Plans at: http://www.generationcp.org/gen.php?da=0790433
[11] Deatails on 2007 ARM at: http://www.generationcp.org/arm.php?da=0898900

- Generated novel information on gene flow related to crop domestication and implications for crop diversity distribution
- Produced introgression materials with high genetic resolution for rice, developed first mutant populations for common beans and potato, and made them accessible for phenotypic evaluation and trait tagging;
- Developed large-scale single nucleotide polymorphism markers (SNPs) for rice, drought expressed sequence tags (ESTs) for cowpeas and pearl millet, a novel set of simple sequence repeat markers (SSRs) for chickpeas, bacterial artificial chromosome (BAC) libraries for cowpeas and groundnuts and a functional illumina chip with 1,536 SNPs for cowpea
- Generated a genetic map for *Musa* species with more than 500 marker loci, plus sequenced some A- and B-genome BACs for *Musa* species
- Identified quantitative trait loci (QTLs) for multiple disease resistances and gene-based markers associated with QTLs for blast resistance in maize
- Characterised and validated leaf growth QTLs in maize for genetic determinism of growth maintenance under water stress
- Identified, and transferred to national programmes, gene-based and linked markers diagnostic for salt tolerance (*Saltol*) and phosphorus uptake (*Pup1*) in rice
- Identified gene-based markers for aluminium tolerance in sorghum ($Alt_{SB}$) and validated SNPs/haplotypes for dissemination in Africa and South America
- Developed near-isogenic lines (NILs) for northern/southern leaf blight in maize, and for aluminium tolerance in sorghum
- Transferred new sources of disease resistance and drought tolerance to related species into cultivated germplasm of groundnut and cassava
- Identified recipient material for groundnuts, cowpeas, beans and chickpeas, including farmer- and consumer-preferred varieties in several African countries, forming the basis for MAS for simple traits and molecular breeding (MB) for complex traits for better performance in drought-prone environments
- Developed models to improve MAS and MB strategies and favour their integration into conventional breeding schemes
- Disseminated to breeding programmes low-cost and high-throughput marker technologies developed by GCP
- Tested new markers for crop improvement in local environments and in adapted genetic backgrounds (eg, *Striga* resistance in cowpeas in West Africa)
- Used markers to select for biotic stress resistance and drought tolerance in several breeding programmes (eg, mosaic disease resistance for cassava in Nigeria, drought tolerance for rice in China)
- Established the GCP Central Registry for project datasets
- Released iMAS (Integrated Marker-Assisted Selection System), a bioinformatics tool to help breeding programmes conducting MAS
- Converted the Laboratory Information Management System (LIMS) developed at ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) to open source and installed it at BecA (Biosciences Eastern and Central Africa) and IITA (International Institute of Tropical Agriculture)
- Established a pipeline for gene expression analysis

- Awarded 'Capacity-building *à la carte*' support to six national programmes
- Implemented a fully operational Genotyping Support Service (GSS)
- First meeting to establish, with regional partners, the Rice Platform in Asia to enhance uptake of products from GCP rice research
- Established a large community to improve tropical legumes for Africa and coordinate initial activities
- Launched the DPKit and formulated Delivery Plans for new projects

## *3.3 Subprogrammes: Status and results for 2007*

### 3.3.1 SP1: Genetic diversity of global genetic resources

*Status:* SP1 seeks to provide breeders and other scientists with germplasm samples gathered from various sources, selected for diversity and representativeness, and characterised as thoroughly as possible. It aims to establish standards which will serve as a reference for connecting and integrating future efforts within the global community, thereby mobilising a wide range of expertise and facilities. SP1 manages a massive campaign of germplasm characterisation, with emphasis on the collections held by the CGIAR Centres as part of their mandate.

*Results:* In 2007, SP1's most significant achievements were: completing molecular marker analysis of germplasm diversity for 19 crops, thereby covering all but two GCP crops;[12] generating new knowledge on crop domestication; developing and making available reference samples for most crops; and, for rice, producing high genetic resolution introgression materials. Overall, the background information necessary for taking fuller advantage of the genetic diversity of GCP crops has significantly increased. This information included revised relationships among standard ecotypes derived from molecular marker-based clustering (eg, in chickpea, common bean, rice, sorghum); evidence suggesting a somaclonal origin for several germplasm clusters in vegetatively propagated crops (potato and *Musa*); uncovering of the parental origin of the most important triploid varieties in *Musa*; and reconstitution of crop migration histories (eg, in maize, coconut, common bean, sorghum). Also, SP1 developed reference samples for most crops and made available or prepared for seed distribution.

### 3.3.2 SP2: Genomics towards gene discovery

*Status:* SP2's main objective is to provide a scientific and collaborative environment so that interdisciplinary and integrated approaches can be used for gene discovery to dissect the genetic mechanisms underlying the adaptive processes. The outputs of SP2 cut across crops and ecosystems, and can be used by researchers and breeders within GCP as well as by the global research community interested in applying genomics to improve agriculture.

*Results:* Major achievements in 2007 included: developing the first mutant populations for common bean and potato and identifying rice mutants with improved drought

[12] List of GCP crops at: http://www.generationcp.org/gen.php?da=08128238

tolerance; identifying candidate genes, markers and QTLs for stress and disease resistance, and working with SP3 to validate and deploy these resources for breeding; and developing new genetic material for genome analysis and breeding, including advanced backcross lines in rice for salt tolerance, blast resistance and enhanced yield under drought. Drought-responsive ESTs in cowpea and pearl millet, novel sets of SSR markers in chickpea and groundnut and bacterial artificial chromosome (BAC) libraries in cowpea and groundnut were developed. More than 250,000 non-redundant SNP markers were identified in 20 rice varieties. Genetic maps for *Musa* species with more than 500 marker loci have been developed and 31 A- and B-genome BACs have been sequenced.

### 3.3.3 SP3: Trait capture for crop improvement

*Status:* The principal objective of SP3 is to guarantee widespread impact of new genes, markers and traits in tropical staple crops, and to facilitate rapid and effective uptake of molecular breeding for those crops. SP3 capitalises on the latest advances in genomics, information technology (IT) and biometrics to accelerate genetic progress of simple traits (eg, resistance to biotic stresses), to dissect complex traits (eg, drought tolerance) into component traits, and to develop tools to adopt and adapt the underlying trait genes. In GCP's research–delivery pathway, SP3 is pivotal, positioned to be primarily responsible for applying technical outputs flowing from SP1 and SP2.

*Results:* In 2007, SP3's main achievements included: transferring newly discovered sources of disease resistance and drought tolerance from wild relatives for groundnut and cassava; developing models to improve marker-assisted selection strategies for biotic and abiotic stresses and integrating them into breeding programmes via low-cost high-throughput technologies. SP3 also established phenotyping networks to improve phenotyping capacities within GCP and to address genotype by environment interactions for drought, and tested molecular breeding systems in specific environments and locally adapted backgrounds. In addition, SP3 developed tools and products to document GCP outputs and streamline their transfer to users.

### 3.3.4 SP4: Bioinformatics and crop information systems

*Status:* SP4 addresses the challenge of linking and integrating information components and analytical tools into a coherent information platform. SP4 has, in its fourth year, reached a stage of maturity: the basis of the information infrastructure has been created, at both the technical level (programming tools, software architecture, standards) and at an organisational level (training of staff, implementation of initial web services). Use case-specific applications fitting in the GCP information infrastructure can now be developed much more easily.

*Results:* In 2007, efforts primarily focused on developing an infrastructure to facilitate information flow between researchers, improving information technology and bioinformatics facilities, and providing software tools and data management support. Particular achievements included: creating a searchable registry[13] for GCP data (with SP1 and SP2); enhancing, and converting to open source, the ICRISAT Laboratory

[13] Searchable data registry at: http://gcpcr.grinfo.net

Information Management System (LIMS) and installing it at two locations in Africa; establishing a pipeline for analysis of expression data (with SP2); and developing improved methodology for QTL x environment analysis (with SP2 and SP3).

### 3.3.5 SP5: Capacity-building and enabling delivery

*Status:* SP5 is cross-cutting and mandated to both build capacity and assure delivery of products from the technical SPs. SP5 fulfils its role not only by building technical capacity for the efficient implementation of research activities in the other SPs, but also by facilitating the flow of GCP products through the research–delivery continuum. For smooth product flow, SP5 works on international and national policy questions to facilitate delivery. In addition, the SP conducts *ex ante* impact analysis at the Programme level to inform GCP's research focus in terms of crop, region and trait, for better decision-making and to guide prioritisation and resource allocation. As GCP products increase, SP5 is increasingly processing and/or promoting these products through value-adding, thus assuring delivery and enhancing return on investments. SP5 is now in a concerted consolidation phase, evolving to fewer but more sharply focused activities firmly embedded in GCP's other SPs.

*Results:* The main achievements of SP5 in 2007 were the awarding of the first 'Capacity-building *à la carte*' projects; the conclusion of the first phase of the GSS; launch of the DPKit and drawing up of the first Delivery Plans; and the establishment of the first community of practice, in Southeast Asia. More information on these and other results from SP5 is given below, in Section 4.1.

# 4. Progress on other activities

## *4.1 Capacity-building*

For GCP, capacity-building is crucial for product delivery. SP5, Capacity-building and enabling delivery, is mandated to both build capacity and assure delivery of products from the technical SPs. Collaboration between NARS in the developing world and GCP research partners is essential to ensure long-term sustainability of the GCP research platform and toolbox. In 2007, two sets of training materials were completed on 'Dynamics of diversity of cultivated plants' and 'Basic genomics and comparative genomics'. Other training materials under development included online materials on basic bioinformatics, and sets of learning materials for MAS and phenotyping for drought. On the policy front, an online course was held in April on genetic resources international policy issues[14]; while in September a workshop was convened to bring GCP researchers up to speed on issues related to plant genetic resources in terms of the new rules established by the Multilateral System and the Standard Material Transfer Agreement of the International Treaty on Plant Genetic Resources for Food and Agriculture. Six grants were awarded to teams from national agricultural research systems (NARS) for personalised training, equipment and expert technical backstopping under the new 'Capacity-building *à la carte*' programme. Five fellowships were also awarded, as well as 16 travel grants. The testing phase of the Genotyping Support Service[15] was completed. Finally, a community of practice approach for rice with partners in Asia was pioneered.

## *4.2 Data management*

A key product from GCP is data generated by the different projects, and the Programme is committed to sharing these data as international public goods for public access at no cost. The value of the data largely depends on how those data are captured, stored, managed, analysed and made accessible to GCP Consortium members and the rest of the world as international public goods. SP4 addresses this challenge. Status and results for SP4 in 2007 are given above, in Section 3.3.4.

The online Central Data Registry[16] is GCP's data repository. All datasets created in GCP are listed, naming the Principal Investigator (PI) and giving details on availability, and where datasets can be accessed, mostly in a standardised GCP-defined fully interpretable format.

With an increasing amount of information generated by GCP's research activities, data quality control and data release are receiving more attention, in the context of product management and product delivery. In particular, with the termination of wide-scale systematic genotyping for structure analysis and diversity sampling from the large food crop collections, and the sizeable data this will generate, data quality control and data exploitation will require considerable efforts and human resources. A number of concrete

[14] http://www.generationcp.org/distantpolicies/page42.html
[15] http://www.generationcp.org/capcorner.php?da=0794844
[16] http://gcpcr.grinfo.net/

steps have been taken, as illustrated by an ongoing project for the GCP reference set. In this project, a subsample of the reference set generated in SP1 for the different crops will be re-genotyped by an external facility. This is to validate the quality of the molecular data generated for most crops using specific microsatellite kits, and will give the scientists who generated the data and the GCP Management Team the confidence that reference sets and genotypic data can be distributed broadly for further genetic analysis.

## *4.3 Communications/public awareness*

GCP communications aim to facilitate information flow within GCP as well as to maintain a positive public image of the Programme. The GCP website (www.generationcp.org) is the primary vehicle for both of these objectives. The number of visitors to the web site in 2007 averaged about 60,000 hits per month. Besides maintaining and updating the website, the Communications Unit also publishes and distributes *GCP News*,[17] an electronic newsletter sent to a growing list of subscribers to update them on upcoming GCP activities, as well as on the latest developments and events in the broader community of crop science. In 2007, *GCP News* subscribers numbered about 2,000. We also rely on other global fora to further publicise our messages. In 2007 GCP participated in several events, for example, the annual Plant and Animal Genome Conference in San Diego in January, and BioAsia 2007 in Bangkok in November. A major task in 2007 was tracking and compiling a list of GCP publications since the Programme's inception, and making them available via the GCP website where possible. This effort will continue in 2008. The list of GCP publications tracked to date is available online.[18]

## *4.4 Others*

### 4.4.1 Impact assessment

Two activities were ongoing in 2007 and will continue in 2008. The first is a project led by the International Center for Tropical Agriculture (CIAT) targeting broad-scale but high-resolution global impact assessment for GCP. The project comprehensively assesses priority farming systems, including detailed poverty evaluation in priority areas. It reviews the implications of drought for each GCP crop, with in-depth evaluation of constraints and opportunities related to crop production. The second project, led by the Virginia Polytechnic Institute and State University, uses *ex ante* impact analysis to project early estimates of benefits of GCP investments, and to validate an approach to impact assessment that might be used to document progress.

### 4.4.2 Project support

We reassessed project support in 2007, and followed up with several project management initiatives. We embarked on the Project Development Guide (PDG), an online resource for project design, monitoring, implementation and evaluation, for use by researchers as well as managers and reviewers. Coupled with the DPKit, the PDG will greatly improve the design of new projects with clear milestones and workplans, which will optimise the

[17] http://www.generationcp.org/enewsletter.php
[18] List of GCP publicaqtions at: http://www.generationcp.org/research.php?da=0642451

planning and improve monitoring of our broad and diverse research portfolio. We also revised project reporting procedures to give more emphasis to monitoring and evaluation over reporting *per se*. Finally, we resolved to promote more frequent informal interactions between SP Leaders and PIs or Co-PIs.

# 5. Governance and management

The year 2007 witnessed the start of a restructuring of GCP's governance. This reform was the culmination of a process that began in 2005, when GCP's Programme Steering Committee (PSC) recognised the need for a more independent and more functional governance structure, and established a Task Force to formulate recommendations for reform. The PSC resolved at its December 2007 meeting to transfer substantive governance to an independent Executive Board. The Board's primary responsibility will be to provide oversight on GCP's strategic direction, as well as to assess finances and risk environment. This new Board becomes operational in June 2008.

Below is a brief description of GCP's governance and management as it stood in 2007.

## *5.1. GCP Consortium, Programme Steering Committee and advisory committees*

### 5.1.1 GCP Consortium

The Generation Challenge Programme unites three sets of partners, who together make up the GCP Consortium: these include nine CGIAR centres, six advanced research institutes (ARIs) and seven NARS.[19]

GCP operates under a legal Consortium Agreement[20] that circumscribes the legal and operational rights, as well as obligations of, institutional partners, including the host institution CIMMYT (the International Maize and Wheat Improvement Center). The governance reforms initiated in 2007 could result in substantial revision of the Consortium Agreement.

In addition to the Consortium Agreement, there is also a framework of contractual agreements covering the obligations of all Consortium and non-Consortium research partners for work funded, in whole or in part, by GCP.

### 5.1.2 Programme Steering Committee

In 2005, the Programme Steering Committee (PSC)[21] set up a task force to review GCP's governance. The Task Force on Governance Structure developed a set of options and recommendations for reform of the Consortium Agreement, which were presented during the 2006 PSC meeting. The PSC did not endorse the proposed recommendations at that time since further clarity was needed on some fundamental issues relating to GCP's identity. The Task Force's Terms of Reference were revised accordingly. The Task Force deliberated for a further year and then suggested delegating most PSC responsibilities to a new governance body. During its 2007 annual meeting in Beijing, China, the PSC approved the resolution[22] to create an Executive Board (EB) to ensure that GCP is

[19] Full list of Consortium members available at: http://www.generationcp.org/gen.php?da=0781248
[20] Consortium Agreement at: http://www.generationcp.org/UserFiles/File/Consortium_agreement_signed.pdf
[21] Full list of PSC members at: http://www.generationcp.org/gen.php?da=0781307
[22] PSC resolution on the Executive Board at: http://www.generationcp.org/UserFiles/File/final-resolution_executive-board-15Dec07_final.pdf

governed by a panel of independent experts who must be from outside the GCP Consortium. PSC members are drawn from the GCP Consortium.

Prior to this transition to an Executive Board, the PSC has been responsible for overall management and governance. Major responsibilities included approving the Annual Report and upcoming yearly workplan/operating plan, the Medium-Term Plan (MTP), and approving the admission of new Consortium members as well as amendments to the Consortium Agreement. In addition, the PSC has been responsible for policy, the Director's workplan and evaluation, finances and resources, intellectual property and other general issues.The PSC will transfer substantive governance responsibilities to the Executive Board, as stipulated in the resolution

By the end of 2007 however, PSC remained the ultimate governance body since PSC has the right to veto, by a unanimous vote, any decisions taken by the EB. Given this scenario, there is a general feeling that GCP governance needs to be further simplified and it is anticipated that the future role of the PSC will be redefined once the Executive Board is in place.

### 5.1.3 Advisory committees and relationship with host Centre

*(a) Stakeholders Committee*

The Stakeholders Committee (SHC) is a diverse group representing those who will benefit or be affected by the Programme's outputs. Thus members are drawn from within and outside the current scope of GCP's research arena, as well as private sector companies, civil society organisations, regional agriculture fora, and farmers themselves. The mandate of the SHC is to facilitate the articulation, promotion and presentation of the views of the various stakeholders to the GCP management and governance structures in order to contribute to GCP's policies, strategies, research priorities and activities. The SHC is convened by the Global Forum on Agricultural Research (GFAR) and financially supported by the European Commission.

Given the changes in governance and management, it is imperative that the role and responsibilities of the SHC also be revisited. But independent of the governance changes at PSC–EB level, SHC reforms were already underway and dialogue initiated with GFAR, as was reported last year. The GCP Management Team is working with the recently appointed GFAR Executive Secretary on revising the terms of reference for the SHC, and GCP expects to have a rejuvenated SHC in the course of 2008.

*(b) Review and Advisory Panel*

The Review and Advisory Panel (RAP)[23] has a dual function. On the one hand, it provides scientific advice on SP-specific issues directly to SP Leaders and evaluated the progress of ongoing projects. On the other hand, the RAP plays an active advisory and legitimisation function in the selection of commissioned grants. In light of these functions, and considering the fact that RAP members are chosen by GCP management, and also that no reporting relationship subsists between PSC and RAP, RAP is more an

[23] More on RAP at http://www.generationcp.org/rap.php?da=0781418

extension of management than a governance body. RAP consists of five scientists, with one scientist assigned to each GCP SP. It has virtual and in-person meetings and consults frequently with the GCP management.

*(c) Programme Advisory Committee*
The Programme Advisory Committee (PAC) was set up to provide independent scientific review of research themes and projects, and select competitive projects. The PAC Chair However, for various reasons, this committee has not functioned as envisaged. Nevertheless, the SPC receives some external feedback on GCP's scientific direction through the PAC Chair, Dr Wayne Powell. Dr Powell is an internationally recognised expert on plant genetics, who also attends ARM and provides vital feedback to the MT and GCP community as a whole. The PAC Chair is also an observer in the selection of competitive projects (see Section (d) below).

The role and relevance of the PAC are under review as part of the governance and management reform. The new Executive Board will have discretion on whether to revitalise PAC or seek alternatives.

*(d) External Review Panel*
This independent panel screens proposals for competitive grants. The panel comprises prominent scientists in the thematic target areas. Panel members are identified by the GCP Director, with feedback from the MT. The Panel's operational guidelines are developed by the MT and implemented by the Director. The chair of the PAC has access to all the information related to the selection process of the competitive grants, thus ensuring transparency and fairness of the entire process. It is expected the Panel will meet in 2008 to evaluate proposals for GCP's 3rd competitive call.

*(e) Relationship with host Centre*
In 2007, in follow-up to the 2006 audit conducted by the CGIAR Internal Auditing Unit, GCP and CIMMYT jointly signed a Host Agent Agreement on the GCP–CIMMYT hosting relationship, clarifying the roles, rights and responsibilities of each party.

## *5.2 Programme Management Team*

The GCP Management Team is accountable for the scientific management of the Programme, as well as the implementation of—and delivery of products from—research projects. The Team is composed of the Director and the five SP Leaders. The Director and support staff jointly oversee the administration and financial management of the Programme, thus facilitating SP Leaders to concentrate on the content of their respective SPs. In GCP's early years all the SP Leaders were on a half-time split between GCP and the research institutions where they were based. As GCP grows and evolves, and if we are to deliver on our new strategy, this approach is no longer viable. Consequently, consistent with our view on the importance of product management and delivery, SP3 and SP5 Leader positions were adjusted from half-time to full-time positions. The SP3 Leader function now also includes product management to ensure the flow of products along the research–delivery chain, while the SP5 Leader, in addition to

managing capacity-building, will continue to be responsible for product marketing and delivery outside GCP.

## *5.3 Operational issues and challenges*

Operating as it does as a virtual and worldwide network, GCP does face several operational challenges, including:

- *Communication with researchers and IP issues:* Working with geographically distributed partners. Apart from the challenge of effective communication, our partners are drawn from different institutions, which each have their own policies on intellectual property (IP) and germplasm exchange, which has in some cases hampered or delayed the distribution of outputs from GCP-funded research. To overcome the challenge, the Subprogramme Leaders are now making a concerted effort to communicate more frequenquent with project PIs and C-PIs in their respective SPLs. A policy has also been formulated to clarify IP rights and obligations of researchers funded by GCP. See Section 7 on 'Lessons learnt' for more details.
- *Data quality and release:* Because GCP operates as a large network and has multiple projects implemented by partners in multiple institutions, this diversity in projects and partners has also led to different formats of data. The challenge then is homogenising these data, as well as arriving at common criteria on data quality. The MT is already working on these criteria. We also use our Annual Research Meetings to sensitise PIs on the latest standards and tools on the area of data quality and data management. For instance, the 2008 ARM includes a session to familiarise PIs with new data templates[24] to be released by SP4 to assist PIs in uploading data to the GCP Central Registry. The SP4 team will also provide a customised helpdesk at the ARM.
- *Smooth cash flow:* In 2007, fund disbursement through the year from our key funders resulted in a cash flow issue, as outlined in Section 6.1. Consequently, the disbursement of funds to support research activities was adjusted accordingly. This financial situation generates some additional transaction costs as new contracts are drafted in the course of the fiscal year. This diversity in payment schedules will continue into 2008, but we are also optimistic that the situation will improve once our funders shift disbursement to early on in the fiscal year, as has already been indicated by EC representatives.
- *High governance costs:* As indicated in section 5.1.2 above on governance, following the December 2007 PSC resolution to create an Executive Board, GCP will have two governance bodies for the better part of 2008. Naturally, having two bodies will translate into high transaction costs, both in terms of funds as well as staff time. However, we expect this to be time-bound challenge, limited to the transition phase in GCP's governance.

Besides the challenges outlined above, GCP also undertook a systematic and comprehensive risk assessment exercise, facilitated but the CGIAR Internal Audit Unit. The output of this exercise is summarised in Section 5.4.3 below.

[24] Details on the new templates and helpdesk at: http://www.generationcp.org/latestnews.php?i=1332

## *5.4 Reviews*

### 5.4.1 EPMR

The first GCP External Programme and Management Review (EPMR) was conducted in 2007, and its report is to be published in 2008. We expect that implementing the review recommendations will see GCP improve its *modus operandi*. This will be critical in helping us to better organise and focus our research portfolio as GCP moves into Phase II.

### 5.4.2 EC evaluation

In May, the European Commission (EC), which is GCP's largest funder, assessed EC-supported activities across the CGIAR, including GCP projects. Overall, the review was positive. The reviewers identified areas where GCP had made considerable progress, for example, in creating an improved understanding of the structure of the diversity of major world food crops. They also identified areas where progress was slower than had been expected, such as in comparative genomics. The reviewers acknowledged the pioneer role played by GCP within the CGIAR system in formulating and implementing a delivery strategy.

### 5.4.3 Risk assessment

GCP underwent a risk assessment exercise in June 2007, facilitated by the Internal Auditing Unit (IAU) of the CGIAR. The exercise assessed GCP processes and procedures in the context of internal efficiencies and associated internal and external risks. The IAU provided sound recommendations on how to mitigate and minimise the risks identified. In addition, a risk matrix was developed to serve as a self-monitoring tool for GCP to assess risk. The risk matrix will be revised and updated on a yearly basis, at a minimum.

# 6. Finance

The 2007 summary financial report (statement of income and expenses plus statement of changes in net assets and resource allocation) is in Appendix B. Financial information presented for 2007 is based on actual year-end financial reports.

## *6.1 Financial objectives and outcomes*

The overall picture for the year was positive. The 2007 income (USD 23.6 million) represented by far the largest income ever received by the GCP for a fiscal year, and is almost double the projection presented in our 2006 Annual Report (USD 12.8 million).

The large increase of actual income over expected income for 2007 was due mainly to a confluence of three factors:

- a very large contribution from the EC for 2007 (about USD 13 million, with 10 percent to be paid in 2008) to compensate for non-payment of the 2006 contribution;
- a new three-year project (2007–2009) on tropical legume improvement for sub-Saharan Africa funded by the Bill & Melinda Gates Foundation, for which the Foundation disbursed USD 3.5 million for 2007; and,
- very favourable currency exchange rates; about 75 percent of our donor contributions are in European currencies whereas our income and expenses are reported in US dollars.

Our 2007 projection was, in fact, very conservative due to several financial uncertainties at the close of 2006. By the end of 2006, only part of our projected 2007 funding had been secured. This, along with non-payment of the 2006 EC contribution, created a potential cash-flow problem requiring an adjustment in the schedule of payments for our research activities. Accordingly, we adopted a contingency plan prioritising financial support to ongoing research activities. GCP scaled down its operational budget to a minimum and put new competitive and commissioned projects on hold in order to be able to guarantee funding for all ongoing research projects for a minimum of eight months into 2007.

With the confirmation of DFID support (USD 5.1 million) in June, we were able to revert to the original workplan for 2007. This meant that we were in a position to support all ongoing projects for the entire year and to initiate the new 2007 projects that had been placed on hold. The new 2007 projects were initiated in August–September, after a six-month delay.

Confirmation in September of the EC contribution for 2007 finally brought us back on track. This large contribution (received early January 2008) gave us the flexibility to reallocate our expenses across our different accounts and to generate a substantial carryover to support commitments in 2008.

So, 2007 was a year of mixed fortunes but had a happy ending. It is emphasised that the uncertainty experienced was not because of funder doubts but rather the necessity to

synchronise disbursement to projects based on our workplan with the receipt of funds during the year.

The Programme should be in a position to achieve all of its objectives and deliver expected outputs over the coming years with an annual income of about USD 15 million. The evolution of the exchange rate between the US dollar and the European currencies will also play a critical role in the budget balance of GCP in the future.

## *6.2 Schedule of contributions received (by CP donor and amount)*

See Appendix B

## *6.3 Schedule of disbursements to partners (CGIAR and outside)*

See Appendix B

## *6.4 Resource allocation/expenditure (by SP, priority area, object of expenditure)*

See Appendix B of this report, and Appendix C of the 2009–2011 MTP[25] for real resource allocation/expenditure by SP and priority area.

## *6.5 Other issues on financial management*

### 6.5.1 Resource allocation

Resources allocated to research in 2007 stood at about USD 14.7 million out of a total expenditure of about USD 17 million (ie, USD 19 million, less USD 2 million which went into our reserve). In terms of direct and indirect costs, about 85 percent of our funds went directly to supporting research and capacity-building for GCP and its partners, with indirect costs accounting for about 15 percent of expenditures.

### 6.5.2 Carryover into 2008–2009

The USD 2 million temporarily allocated to our reserve, as approved by the Programme Steering Committee, will be used to support commissioned activities in 2009. A total surplus for 2007 of USD 4.9 million added to the USD 7.3 million carryover from 2006, plus our reserve of USD 3 million, boosted total net assets at the end of 2007 to around USD 15.3 million. This figure is higher than original projections, reflecting—in part—inclusion of withheld project funds: GCP requires that the final 20 percent of project funds only be paid after the project delivers on all the obligations in the original project proposal. Thus, the carryover into 2008 includes approximately USD 2.4 million committed for research activities conducted before 2008.

It is critical to underline that this high carryover is required to support 2008 activities until such time as we receive the 2008 contributions from our donors. In December 2007, our financial balance was at the level of our reserve, and we consumed the USD 7.3

[25] MTPs accessible at: http://www.generationcp.org/brochure.php#MTPs

million carried over from 2006. Considering the USD 2.4 million already committed, as indicated above, the 2007 carryover roughly corresponds to the 2007 EC contribution received in January 2008, plus the committed funds for 2008. Accordingly, GCP is committed to reduce its carryover if donors do indeed shift disbursement to early in the fiscal year, as has been indicated by EC representatives.

# 7. Lessons learnt

## 7.1 Reforming governance

Objective and efficient governance is vital to GCP's success. The PSC, established at the outset of the GCP, exhibited various shortcomings in both of these areas which the Executive Board is intended to overcome.

*Analysis*

In the current dispensation, the Executive Board is only an advisory group to whose decisions the PSC has agreed to defer. This structure was adopted because amendments to the Consortium Agreement require the unanimous agreement of the signatories, and it was believed unlikely that sweeping reforms on governance would muster the unanimous vote required to make the reforms permanent. However, we are aware that this new governance structure is still less than ideal, and that GCP will incur high transaction costs with two governance bodies.

*Lessons*

- Given the provisions of the Consortium Agreements, it would be unrealistic to undertake sweeping governance reforms instantaneously, and the reforms have to be approached step by step.
- Therefore, the high transaction costs above are inevitable for a consultative, inclusive and smooth reform process.

*Conclusion:* We believe that we are still drawing lessons on governance reform as it is early days yet, and governance reform is still evolving.

## 7.2 Intellectual property: gap between policy and practice

GCP's mission and mandate both require that the Programme generate international public goods, to be disseminated as widely as possible. In order to realise this mission and mandate, the Consortium Agreement and project contracts include provisions on IP.

*Analysis*

As GCP now begins to generate concrete products from research, in some particular cases, we have encountered problems in expecting that products from GCP-funded research would automatically be available to other partners in the GCP network. Practice does not always follow policy: not all partners will comply with the provisions in the contracts they signed.

*Lessons*

- The provisions on IP in GCP's contractual documents need to be revisited with a view to removing any ambiguities in interpretation, and to sealing gaps that could lead to research partners failing to make germplasm or other IP material available to other researchers in the GCP network.
- GCP needs to explore ways to compel compliance to the contractual documents signed by partners, including ultimately requiring reimbursement of funds from partners who fail to live up to their obligations.

*Conclusion:* Respect for IPR must be balanced with furthering the overall humanitarian mission of GCP. Thus, while GCP partners who develop useful research outputs through GCP activities are entitled to claim IPR

over those outputs, the rights are qualified and subject to a clear policy to share outputs from GCP-funded research, as spelt out in the GCP Consortium Agreement, including the amended humanitarian licence agreement. For partners who have not been forthcoming as had been expected in sharing outputs from GCP-funded work with other GCP researchers, this matter is of concern to GCP Management, and prescriptive and preventive measures will be high on the 2008 agenda.

## *7.3 Data quality and product distribution*

GCP works with a wide array of partners. Given this diversity in our network, the data generated by the various partners is of uneven quality.

*Analysis*

This spread in quality is primarily because of the diversity and geographic dispersal of partners, who, in addition, have varying capacity in generating data, and assuring data quality.

*Lessons*

- Better follow-up would be a good preventive and facilitative measure. Project contracts have accordingly been revised to include a specific clause requiring that data be provided at the end of the project before the last fund disbursement (20 percent of project funds) is released. The requirement prior to this amendment was limited to researchers providing a final technical report.
- It is important to accurately assess the capacity of partners in product delivery, to avoid over-estimating or under-estimating partner capacity.
- It is not enough to generate a product, and by so doing assume that it will be relevant and therefore used and/or adopted. Relevance and users need to be determined at proposal stage, and active dissemination is also necessary.

*Conclusion:* Besides the amendments to project contracts to provide for data release *a priori* project Delivery Plans (see Section 3.1), and capacity-building for GCP researchers, GCP is exploring but also establishing with partners various platforms to assure and widely promote product use as well sustainability. It is still early days yet, but we believe in learning as we go along. As mentioned in Section 5.3, we use the ARM to sensitise and retool our scientists to assure data quality, and we organise workshops and other learning for a on this aspect, eg, a joint SP1–SP5 workshop [26]is slated for November 2008, on reference sets.

[26] Details on reference set workshop at: http://www.generationcp.org/latestnews.php?i=1307

# 8. Appendices

## *8.1 Appendix A: Summary of outputs by Subprogramme*

| Subprogramme (project) | Theme | Output |
|---|---|---|
| **1. Genetic diversity of global genetic resources** | 1: Creation of an improved understanding of the structure of the diversity for the major world food crops | 1.1 Structure of genetic resources for the most advanced (tier-1) crops accurately described (including tools) and summarised in a reference sample<br>1.2 Structure of genetic resources for the less advanced (tiers 2 and 3) crops accurately described (including tools) and summarised in a reference sample<br>1.3 Seed of reference germplasm readily available for all tier-1 crops<br>1.4 Detailed analysis conducted of maize diversity after migration out of America<br>1.5 Methodology developed for resampling genetic diversity in large germplasm collections |
| | 2: Development of a range of flexible HTP genotyping techniques accessible in reference laboratories | 1.6 DArTs validated as a genome-wide molecular characterisation technology<br>1.7 EcoTILLing gene-targeted assessed as a molecular characterisation technique<br>1.8 Methodology developed to assess SNPs with effect on allele expression (Non Coding SNPs)<br>1.9 Database on allele diversity at candidate genes across species developed |
| | 3: Establishment and implementation of a scientific and organisational framework to describe tolerance to drought | 1.10 Set of phenotyping facilities in Brazil made accessible for GCP germplasm evaluation<br>1.11 A crop and whole-plant modelling framework developed to support assessment of tolerance to drought<br>1.12 Phenotyping capacity accessible to the GCP is inventoried<br>1.13 Support service for drought-related phenotyping of specific populations with high quality molecular information implemented |
| | 4: Identification of favourable genetic factors (i.e., potential genes or genome segments) and superior alleles (or haplotypes) through association studies | 1.14 Favourable genetic factors for drought tolerance in maize identified<br>1.15 Improved methodology developed for validating the genetic basis of marker-phenotype associations<br>1.16 Favourable genetic factors for stress tolerance in four legume species identified |

| **Subprogramme (project)** | **Theme** | **Output** |
|---|---|---|
| | 5: Development of novel populational approaches for relating genotypes to phenotypes | 1.17 Favourable genes mapped in the course of breeding<br>1.18 Local assessment of linkage disequilibrium in the genome of rice conducted<br>1.19 Global assessment of linkage disequilibrium in the genome of rice conducted<br>1.20 Linkage disequilibrium in the genome of sorghum used for mapping useful genes<br>1.21 Base broadened of current crop diversity in rice using related species<br>1.22 New alleles introgressed from wide crosses using crop wild relatives |
| **2: Genomics towards gene discovery** | 1: Assembly of genomics and germplasm resources through consolidating and developing specialised genetic stocks | 2.1 Wheat genetic stock assembled and utilised<br>2.2 Systematic evaluation of rice mutant collections conducted for conditional phenotypes with emphasis on stress tolerance<br>2.3 Legume mutant resources developed<br>2.4 Tuber genetic stocks and gene function validation tools developed<br>2.5 Stress-response-enriched EST resources for cowpea created<br>2.6 Stress-response-enriched EST resources for pearl millet created<br>2.7 Multiple rice genotypes sequenced<br>2.8 (pending) Bean genetic and genomic resources developed<br>2.9 (pending) Chickpea genetic and genomic resources developed<br>2.10 (pending) Cowpea genetic and genomic resources developed<br>2.11 (pending) Groundnut genetic and genomic resources developed |
| | 2: Development of comparative maps within and across species and framework genetic markers for target crops | 2.12 Validation of conserved orthologous markers conducted<br>2.13 Comparative QTL mapping for drought tolerance in bean conducted<br>2.14 Comparative QTL mapping for drought tolerance in rice conducted<br>2.15 Targeted *Musa* genome sequencing conducted and frame map constructed<br>2.16 (pending) Cross-species resources for comparative biology in tropical crop legumes developed |
| | 3: Assignment of genes and pathways | 2.17 Targeted discovery of superior disease QTL, alleles in the maize and rice |

| Subprogramme (project) | Theme | Output |
|---|---|---|
| | to phenotypes through the convergence evidence of genome variation, expression patterns, and phenotypic data | genomes conducted<br>2.18 Functional genomics of cross-species resistance to fungal diseases in rice and wheat conducted<br>2.19 Common genetic basis for tissue growth rate under water-limited conditions across plant organs and genomes investigated and determined<br>2.20 Crop gene expression profiles and stress-gene arrays created |
| | 4: Validation of genes and pathways via evaluation of under- or over-expression constructs or variants (induced or natural) of target genes | 2.21 Genes responsible for failure of grain formation in rice and wheat under drought identified<br>2.22 Genes for tolerance of saline and phosphorus-deficient soils to enhance and sustain productivity in rice identified<br>2.23 Aluminium tolerance genes in the cereals identified and characterised |
| **3: Trait capture for crop improvement** | 1: Characterisation of segregating populations, identification and/or validation of molecular markers for target traits to increase plant breeding efficiency | 3.1 Physiological and genetic traits that make cassava one of the most drought-tolerant crops identified<br>3.2 Genetic diversity of peanut's wild relatives unlocked with genomic and genetic tools<br>3.3 Markers developed and marker-assisted selection conducted for Striga resistance in cowpea<br>3.4 Evaluation and characterisation of segregating populations of tropical legumes for biotic stresses (groundnut, bean, cowpea, and chickpea) conducted<br>3.5 Evaluation and characterisation of segregating populations of tropical legumes for abiotic stresses (groundnut, bean, cowpea, and chickpea) conducted<br>3.6 Traits for drought tolerance improvement (crops) identified and/or refined |
| | 2: Development and evaluation of novel of novel breeding or molecular technologies to better serve modern plant breeding | 3.7 Low-cost technologies developed for pyramiding useful genes from wild relatives of cassava into elite progenitors<br>3.8 Low-cost, gene-based trait assay technologies developed for cereals<br>3.9 Transgenic drought-tolerant varieties evaluated and deployed<br>3.10 Marker-assisted breeding systems for drought tolerance in cereals optimised through linkage of physiological and genetic models |
| | 3: Application of | 3.11 Drought-tolerant rice cultivars developed |

| Subprogramme (project) | Theme | Output |
|---|---|---|
| | molecular markers in breeding programs | for North China and South/Southeast Asia by highly efficient pyramiding of QTL from diverse origins<br>3.12 Plans for effective product development, delivery, and use developed<br>3.13 Communities of practice for molecular breeding of target crops formed and supported by the GCP to access new tools, technologies, and markers<br>3.14 Molecular breeding for abiotic stress conducted |
| | 4: Multidisciplinary approaches towards specific crop improvement under target environments | 3.15 NERICA rice improved for abiotic stress tolerance<br>3.16 Drought tolerance and virus resistance enhanced in sweet potato through exploration of heterosis<br>3.17 Germplasm enhanced via molecular breeding for target traits for tropical legumes (groundnut, bean, cowpea, and chickpea) |
| **4: Bioinformatics and crop information systems** | 1: Facilitation of information flow of ongoing research, both in terms of data and in terms of communication between the researchers | 4.1 GCP domain models developed<br>4.2 Web services<br>4.3 GCP Repository created and maintained<br>4.4 Web services technology further developed and applied in reference GCP applications<br>4.5 Templates for GCP data capture, storage, and use created, made available to the research community, and maintained<br>4.6 GCP software engineering and collaboration platform established and maintained |
| | 2: Creation of facilities to support IT and bioinformatics applications in the GCP Consortium | 4.7 Integrated GCP Information Platform created<br>4.8 Data quality within the GCP further improved<br>4.9 High Performance Computing (HPC) facilities integrated in the GCP toolbox<br>4.10 ICRISAT LIMS installed and implemented at the Biosciences Eastern and Central Africa (BecA) facility and IITA-Ibadan |
| | 3: Support to other GCP Projects in terms of software tools and data management | 4.11 Ortholog-function display tools developed (in support of Project 2)<br>4.12 Crop gene expression database and data mining tools developed (in support of Project 2)<br>4.13 Decision support tools for MAS and MAB developed (in support of Project 3) |

| Subprogramme (project) | Theme | Output |
|---|---|---|
| | | 4.14 An eco-physiological statistical framework for GxE and QTLxE analysis developed (in support of Project 3)<br>4.15 Data analysis support available for Project 1 activities with emphasis on sampling germplasm<br>4.16 Data analysis support available for Project 2 with emphasis on microarray and mapping experiments<br>4.17 Methodology and software developed for LD-based phenotype analysis (in support of Projects 1 and 2) |
| **5. Capacity-building and enabling delivery** | 1: Creation of a platform of training resources and a cadre of trained scientists to apply advanced technologies and products | 5.1 Annual training courses in genomics/molecular breeding, bioinformatics, and phenotyping conducted<br>5.2 Course and training materials on intellectual property, freedom-to-operate, and genetic resources policies developed<br>5.3 Training materials for association studies/linkage disequilibrium mapping developed<br>5.4 GCP training materials translated into Spanish, French, Chinese, and Arabic |
| | 2: Cultivation of research and learning opportunities for GCP collaborators and NARS scientists to further GCP mission and progress | 5.6 Mini-grants program implemented<br>5.7 GCP Fellowship Program continued (initiated in 2005)<br>5.8 GCP Travel Grant program continued (initiated in 2005)<br>5.9 Contributions to special conferences<br>5.10 Academic position in molecular breeding established and supported<br>5.11 Capacity-building mechanisms and product pipelines established for tropical legume improvement in Africa |
| | 3: Construction of systems for ensuring product delivery | 5.12 Partnership and delivery options for the GCP surveyed and assessed<br>5.13 Comprehensive support provided to competitive projects to define and implement delivery and capacity building plans<br>5.14 Strategy developed for product distribution |
| | 4: Development and implementation of support services | 5.15 Helpdesk for intellectual property and access and benefit-sharing issues established<br>5.16 Asset inventory system for the GCP developed |

| **Subprogramme (project)** | **Theme** | **Output** |
|---|---|---|
| | | 5.17 Interactive Resource Center established and maintained<br>5.18 Genotyping support service established (Phase 1, genotyping, Phase 2, identification of markers) -- phases rolling every year<br>5.19 Technical backstopping provided |
| | 5: *Ex ante* impact analysis and impact assessment | 5.20 Potential impact of GCP research assessed |

## *8.2 Appendix B: Generation Challenge Programme—Revenue and expenditure for the year ended 31 December 2007*

| | | USD |
|---|---|---|
| **Contributions received** | | |
| **Funders** | | |
| Bill & Melinda Gates Foundation | | 3,540,404 |
| DFID [1/] | | 5,058,750 |
| European Commission [2/] | | 12,121,979 |
| Pioneer Hi-Bred International, Inc. | | 20,000 |
| Rockefeller Foundation | | 342,840 |
| Sweden / Sida [3/] | | 132,651 |
| Switzerland / SDC [4/] | | 398,300 |
| Syngenta Foundation for Sustainable Agriculture | | 25,000 |
| World Bank | | 2,000,000 |
| **Earned income** | | |
| Interest income [5/] | | 336,984 |
| **Total revenue [6/]** | | **23,976,907** |
| **Expenditure** | | |
| **Partners** | | |
| **CGIAR Centres** | | |
| Bioversity | | 365,782 |
| CIAT | | 1,235,642 |
| CIMMYT | | 1,835,551 |
| CIP | | 313,214 |
| ICARDA | | 269,761 |
| ICRISAT | | 1,292,325 |
| IITA | | 493,717 |
| IRRI | | 1,775,191 |
| WARDA | | 156,350 |
| **Total: CGIAR Centres** | | **7,737,533** |
| **Advanced research institutes (ARIs)** | | |
| Agropolis/CIRAD | | 718,137 |
| Agricultural Research Institute of the Hungarian Academy of Sciences | | 110,700 |
| Cornell University | | 500,662 |
| European Molecular Biology Laboratory/European Bioinformatics Institute | | 87,331 |
| John Innes Centre | | 12,720 |
| Laboratoire génome et developpement des plantes (LGDP/IRD) | | 602,100 |
| Scottish Crop Research Institute | | 510,844 |
| University of Georgia | | 184,063 |
| University of California–Davis | | 229,177 |
| University of California–Riverside | | 852,871 |
| Virginia Polytechnic Institute | | 134,126 |
| Wageningen University and Research Centre | | 490,022 |
| **Total: ARIs** | | **4,432,753** |
| **National agricultural research systems (NARS)** | | |
| ACGT | | 21,448 |
| BIOTEC | | 99,775 |
| CAAS | | 526,703 |
| EMBRAPA | | 1,157,834 |
| INRA–Morocco | | 100,000 |
| NIAS | | 95,610 |
| Universidade Catolica de Brasilia | | 176,775 |
| GCP-HQ [7/] | | 532,221 |
| **Total: NARS** | | **2,710,366** |
| **Sub-total [8/]** | | **14,880,652** |
| **Programme management** | | |
| Personnel | | 633,370 |
| Supplies and services | | 1,438,254 |
| Travel | | 78,142 |
| **Sub-total** | | **2,149,766** |
| **Transfer to contingency reserve** | | **2,000,000** |
| **Total expenditure and transfer to contigency reserve** | | **19,030,418** |
| **Excess of revenue over expenditure (surplus)** | | **4,946,489** |
| **Balance brought forward from 2006 and previous years** | | |
| Designated—Opening balance | 7,341,035 | |
| Undesignated—Contingency reserve | 3,000,000 | **10,341,035** |
| **Cummulative balance** | | **15,287,524** |

[1/] Equivalent to GBP 2.5m

[2/] Contribution expected in 2008 equivalent EUR 9.212 in two instalments: Early in January 2008; 1st instalment (90%) EUR 8.290m; and 2nd instalment retention (10%) EUR 0.922 receivable in June 2008

[3/] Equivalent to SEK 0.850m

[4/] Equivalent to CHF 0.450m

[5/] Includes interest credit for DFID $40K; and BMGF $28K

[6/] Commitment for matching funds in the amount of $150K; $100K Morocco contribution and $50K Hungary contribution

[7/] Fellowships and travel grants, consultants, services, workshops and special projects

[8/] The figures reflected in the total CG/ARIs/NARS disbursements do not reflect subcontracts to other institutions. The actual breakdown of GCP funds for research is approximately 34/26/33 percent for the CG/ARIs/NARS respectively, and 6 percent for Contracted Services

Note: GCP financial figures are based on Schedule (Exhibit 5 and 6) included in CIMMYT's Audited Financial Statements (2007)