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CGIAR Review 2010 – According to the System Priorities of CGIAR projects funded by the EC in 2009 - to be carried out in the second half of 2010



IFAD – ECART Institutional Contract



Generation Challenge Programme

Hosted at the International Maize and Wheat Improvement Center

CIMMYT

Addressing: CG Systems Priority 2: *Producing more and better food at lower cost through genetic improvements*

CIMMYT (66) Trait Capture for Crop Improvement

DRAFT Report

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Mission conducted November 22 – December 7, 2010



Picture: ICRISAT, Mali Oct 2009. Farmers select sorghum varieties with improved aluminium tolerance and phosphate uptake and other traits by tagging with ribbons. This favoured plant is the local check variety (CSM 335). Developing a preference for reduced height, improved threshability, improved panicle size and plant architecture and less immediately visible traits takes time and farmer education. Practical implementation of the early GCP products is now a GCP priority. (Photo: Drs Rattunde and Weltzien)

CIMMYT 66 – MEXICO AND INDIA

Mission conducted over the period November 22 – Dec 7, 2010

Table of Contents

Table of Contents.....	ii
Acronyms	iii
Acknowledgement	v
Executive Summary.....	vi
1. Introduction	1
1.1 Role and linkages of GCP Sub-programme-3.....	2
2. GCP Sub-Programme 3 “Trait capture for crop improvement” (CIMMYT 66 EC project number) in the overall program of GCP and in the Medium-Term Plan	4
3. Analysis of the project contributions to the Sub-Programme-3 outputs.....	5
OUTPUT 1: CHARACTERISATION OF SEGREGATING POPULATIONS AND IDENTIFICATION OF GENOMIC REGIONS FOR PLANT BREEDING.....	5
OUTPUT 2: DEVELOPMENT AND EVALUATION OF NOVEL BREEDING OR MOLECULAR TECHNOLOGIES TO BETTER SERVE MODERN PLANT BREEDING.....	6
OUTPUT 3: MARKERS/ALLELES VALIDATION IN ADAPTED GERMPLASM UNDER TARGET ENVIRONMENTS	7
OUTPUT 4: APPLICATION OF MOLECULAR MARKERS IN BREEDING PROGRAMMES.....	7
4. Review criteria	9
4.1 Relevance of the project.....	10
4.2 Efficiency - Quality of Research.....	11
4.3 Effectiveness	12
4.4 Practical implementation of SP.....	13
4.5 Synergy and collective action	14
4.6 International or regional public goods character of the research undertaken	14
4.7 Impact, sustainability and visibility of the EC co-financing.....	15
5. Conclusions and recommendations	16
5.1 Conclusions	16
5.2 Recommendations	17
List of Annexes.....	19
Annex 1: Terms of Reference	
Annex 2: The names of the evaluators and their institutions	
Annex 3: Map of mission locations	
Annex 4: Calendar of the visit and list of persons/organizations consulted	
Annex 5: Literature and documentation consulted/available	
Annex 6: Logframe GCP Sub-Programme-3 2009-11	
Annex 7: GCP 2009 Annual Report	
Annex 8: CIMMYT ongoing GCP projects in 2009 – Sub-programme-3	
Annex 9: A list of Highlight Products delivered in GCP Phase 1 (2004-08) - all Sub-programmes	
Annex 10: Annual Workplan and Budget, GCP 2008-10	
Annex 11: Scientific Publications from GCP 2009-10	
Annex 12: Recommendations from the 2007 External Independent Review of GCP	
Annex 13: DAC Summary	

ACRONYMS

AICRP	: All India Co-ordinated Research Project
ARC	: Agricultural Research Corporation (Burkina Faso)
ARI	: Advanced Research Institute
BINA	: Bangladesh Institute of Nuclear Agriculture
BRI	: Bangladesh Rice Research Institute
CAAS	: Chinese Academy of Agricultural Sciences
CG	: Consultative Group
CGIAR	: Consultative Group on International Agricultural Research
CIAT	: Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CIP	: Centro Internacional de la Papa (International Potato Center)
CRP	: Commodity Research Programme (of the CGIAR)
CP	: Challenge Programme
CIMMYT	: Centro Internacional de Mejoramiento de Maíz y Trigo
CIRAD	: Centre de coopération internationale en recherche agronomique pour le développement (Agricultural Research for Developing Countries)
CSU	: Charles Sturt University, Australia
CRURRS	: Central Rainfed Upland Rice Research Station, India
CSIRO	: Commonwealth Scientific and Industrial Research Organisation (Australia)
CULS	: Czech University of Life Sciences Prague
DAC	: Development Assistance Committee
DARTS	: Department of Agricultural Research and Technical Services, Malawi
DDG	: Deputy Director General
DG	: Director General
EIAR	: Ethiopian Institute of Agricultural Research
EIARD	: European Initiative for Agricultural Research for Development
EC	: European Commission
EMBRAPA	: Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research)
EU	: European Union
FAO	: Food and Agriculture Organization of the United Nations
GIBS	: Genomics and Integrated Breeding Service
GCP	: Generation Challenge Programme
GIS	: Geographical Information System
GTZ	: German Agency for Technical Cooperation
IARI	: Indian Agricultural Research Institute
IBP	: Integrated Breeding Platform
ICARDA	: International Center for Agricultural Research in the Dry Areas
ICERI	: International Conference of Education, Research and Innovation
ICRISAT	: International Crop Research Institute for Semi-Arid Tropics
IER	: Institut d'économie rurale, Mali
IFAD	: International Fund for Agricultural Development
IGD	: Integrated Genomic Database
IGD-CU	: Institute for Genomic Diversity, Cornell University, USA
IGKV	: Indira Gandhi Krishi Vishwavidyalaya (Indira Gandhi Agricultural University), India
IITA	: International Institute for Tropical Agriculture
INERA	: Institut de l'Environnement et de Recherches Agricoles (Institute for the agricultural and environmental research) (Burkina Faso)
INIA	: Instituto de Investigação Agrária (National Institute of Agricultural Research)
INIFAP	: Instituto Nacional de Investigaciones Forestales y Agropecuarias (National Institute for

	Investigation in Forestry, Agriculture and Animal Production) (Mexico)
INRA	: Institut National de la Recherche Agronomique (National Institute for Agricultural Research)
INRAN	: Institut National de la Recherche Agronomique du Niger (National Institute for Agricultural Research in Niger)
INTA–Argentina	: Instituto Nacional de Tecnología Agropecuaria, Argentina
INTA–Nicaragua	: Instituto Nicaragüense de Tecnología Agropecuaria, Nicaragua
INIFAP	: Instituto Nacional de Investigaciones Forestales, Agrícola y Pecuarias (National Institute for Investigation in Forestry, Agriculture and Animal Production)
IP	: Intellectual Property
IPG/RPG	: International Public Goods/Regional Public Goods
IRD	: Institut de Recherche pour le Développement (Institute for Research and Development)
IRRI	: International Rice Research Institute
ISRA	: Institut sénégalais de recherches agricoles, Senegal
JIRCAS	: Japan International Research Center for Agricultural Sciences
KARI	: Kenya Agricultural Research Institute
KSL	: Krishidhan Seeds Ltd, India
MDGs	: Millennium Development Goals
MTP	: Medium Term Plan
NagU	: Nagpur University
NARI	: National Agricultural Research Institute
NDUAT	: Narendra Deva University of Agriculture and Technology (India)
NGOs	: Non-Governmental Organizations
NIL	: Near-Isogenic Line
NMRI	: National Maize Research Institute (Vietnam)
NSFCRC	: Nakhon Sawan Field Crops Research Center (Thailand)
PI	: Principal Investigator
QTLs	: Quantitative Trait Loci
R&D	: Research and Development
SABRN	: SADC (Southern Africa Development Community) Bean Research Network
SP	: System Priority
SRF	: Strategic and Results Framework
SUA	: Sokoine University of Agriculture (Tanzania)
TAMU	: Texas Agricultural and Mechanical University (USA)
TNAU	: Tamil Nadu Agricultural University, Coimbatore, India
UAS-B	: University of Agricultural Sciences, Bangalore, India
UK	: United Kingdom
UoAb	: University of Aberdeen
UoAl	: University of Alberta, Canada
UoD	: University of Dhaka, Bangladesh
UoM	: University of Melbourne, Victoria, Australia
UoMi	: University of Missouri, USA
UPLB	: University of the Philippines, Los Banos
USA	: United States of America
USDA	: United States Department of Agriculture
USDA-ARS	: USAD- Agricultural Research Service
USAID CRSPs	: USAID Collaborative Research Support Programs
WB	: World Bank
WHO	: World Health Organization
YAAS	: Yunnan Academy of Agricultural Sciences (China)

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Derek Russell
Vladimir Verner

¹ A list of persons met is given in Annex 4.2.

The Generation Challenge Programme (GCP) 2003-13, with its HQ in CIMMYT, undertakes strategic research into the relief of biotic and abiotic stress (and especially drought) as its target, deliberately addressing very difficult and complex issues in plant breeding, yet these are vital areas of research if the world is to respond positively to the twin challenges of increased staple food production and climate change, with improved and more productive crop plant breeding material.

The Programme contributes to CGIAR System Priority 2 '*Providing more and better food at lower cost through genetic improvement*', with the key indicator being the *Number of pre-breeding products distributed to national breeding programmes*'. The contribution to SP2, through GCP Sub-Programme-3 '*Trait capture for genetic improvement*', co-financed by the EC from 2004 (as CIMMYT-66) is reviewed here. GCP Phase I (2003-8) ended with a re-focusing on more concrete downstream outputs and an integrated service component in Phase II (2009-13) as recommended in a 2007 external review (annex 11) and reflected in the subsequent Medium Term Plans and the Transition Strategy document. Sub-programme-3 has now been combined with Sub-programme 1 under the name '*Integrated Crop Breeding*'. This current review deals with the early stages of Phase II (MTP 2009-10), reviewing the 13 GCP projects most significantly (75%) funded by the EC.

Allowing for the upstream nature of the GCP research, the work has been highly relevant to SP2, underpinning the work of others, esp. in the NARS, now and in the future. 'Products' include a wide range of stress-adapted germplasm in CG mandate crops, genetic constructs containing genes significantly influencing stress traits, molecular breeding methodologies, data sets, international field testing networks and researcher communities of practice. Farmer focused outputs from these partner institutions are expected to grow exponentially as their ability to identify and select valuable stress resistant traits is enhanced by the improved capacity in molecular selection, genotyping and phenotyping and through the use of the key crop trait libraries by the GCP Sub-programme. The work is widely published in high impact journals.

Contributions to the development of a Genomics and Integrated Breeding Service as a common, accessible source of integrated molecular breeding tools and an archive for relevant breeding results in focus crops in partner institutions will be a major, ongoing output from the GCP sub-programmes when it is embedded within the new CG Research-Programme (CRP) structure. Ensuring this is now a major priority.

The GCP outputs are strongly IPG/RPG focused and this is appreciated by partners who feel strong ownership for and commitment to their constituent projects.

GCPs inclusiveness (c. half Phase II projects led by the NARS and effective 'communities of practice' set up), is one of the great, and much appreciated, strengths of the programme.

The GCP goals were ambitious and, in common with the molecular breeding community world-wide, technical progress has not been as rapid as hoped, only partly due to difficulties in trans-boundary movement of genetic material, difficulties in drawing up and approving agreements and staffing changes. Nonetheless, by the end of the GCP in 2013, Sub-programme-3 will have achieved its aim of making very solid progress in providing the underpinning science, tools and pre-breeding material needed by the international breeding community.

It is recommended that financing of the project be continued.

- It is recommended that GCP facilitate the introgression of the *Pup1* phosphorous deficiency tolerance trait from rice, and of Striga tolerance, into sorghum for Africa.
- It is recommended that GCP maintain and enhance its focus on working with the nodal institutions within partner countries which have the national mandate for particular crop-related functions.
- It is recommended that project reporting make it clearer where and when agreed outputs have been achieved.
- It is recommended that GCP expand support for facilitating international germplasm transfer agreements.
- It is recommended that urgent consideration be given to the integration of the GIBS molecular breeding platform in the revised CG structure.
- It is recommended gender be given a stronger focus.
- It is recommended that GCP further support analyses of their most successful projects
- It is recommended that the GCP programme management system should have a period of stability on the basis of the 2011-13 MTP.
- It is recommended that the EC provide a letter of commitment in response to the funding request of the GCP for July 2011 to 2013.

EXECUTIVE SUMMARY

1. THE CG CENTRE: Generation Challenge Programme (GCP) hosted at the International Maize and Wheat Centre, Mexico City, Mexico (CIMMYT)

Mandate: To explore plant genetic diversity and apply advanced genomics and comparative biology to advance the breeding of the main staple crops grown by resource-poor farmers in drought-prone and other harsh environments.

2. PROJECT:

2.1 Number, Title, Overview

Number: CIMMYT 66:

Title: CGIAR Generation Challenge Programme Sub-programme-3: Trait capture for crop improvement

Overview: Aims to guarantee widespread impact of new genes, markers and traits, and to facilitate rapid and effective uptake of molecular breeding for tropical staple crops through a) Facilitating research-development links b) Validating candidate genes in target environments and adapted germplasm c) Expanding and supporting phenotyping capacity d) Strengthening crop breeding communities

2.2 System priority and sub priorities addressed

SP2: Producing more and better food at lower cost through genetic improvements (100%); 35% Asia (including Central Asia) and Pacific Islands; 5% Latin America including Caribbean; 60% sub-Saharan Africa
SP2A: Maintaining and enhancing yields and yield potential of food staples
SP2B: Improving tolerance to selected abiotic stresses

2.3 Outputs

Output 1: Characterisation of segregating populations and identification of genomic regions for plant breeding

Output 2: Development and evaluation of novel breeding or molecular technologies to better serve modern plant breeding

Output 3: Markers/alleles validation in adapted germplasm under target environments

Output 4: Application of molecular markers in breeding programmes

Note: These outputs are Themes 1 to 4 in the MTP 2009-11 logframe (see Annex 6). Several individual Sub-programme-3 projects contribute to each output and some to several simultaneously. See Annex 10 for the specific outputs targets for 2009-10.

3. CONCLUSIONS AND RECOMMENDATIONS:

3.1 Project Design and Implementation

GCP Sub-programme 3 ‘Trait capture for genetic Improvement’

Performance ²	HS	S	LS	HUS	Comments
Relevance	☒				All individual project objectives conform with the CG SP-2 and GCP log frame objectives and are well tailored to the needs of the CG centres, NARS, ARI and company identified beneficiaries. Project underpinning contribution to improved knowledge and techniques will be exemplary.

² HS: Highly Satisfactory, S: Satisfactory, LS: Less than Satisfactory, HUS Highly Unsatisfactory

Efficiency		<input checked="" type="checkbox"/>			Management administrative and financial efficiency has been excellent. Technical outputs are of international standard and highly relevant to the GCP objectives. The numerous timeline issues have been dealt with by no-cost extensions. The pressure to re-focus on more downstream outputs has resulted in some inevitable weakening of support for the more underpinning research which is the GCP's strength.
Effectiveness	<input checked="" type="checkbox"/>				Users of this strategic research are highly appreciative of its value and intend to continue to develop the provided tools and techniques after the closure of GCP, esp. through the GIBS platform. The evidence of practical outputs of pre-breeding materials available internationally will now increase exponentially over time.
Practical implementation of SPs	<input checked="" type="checkbox"/>				The research directly addresses SP2 in a focused manner and advances strongly towards products implementing SP2. More attention needs to be paid to interaction between breeders and soil scientists and the breeders and the developers of the marker libraries in the core germplasm collections, esp. in wheat. There are problems with trans-boundary seed exchange. Extension services and capacity building should take a more prominent role from now on, esp. in sub-Saharan Africa.
Synergy and collective action	<input checked="" type="checkbox"/>				Each project contributes practically to the achievement of SP2 with the centres and institutions working collaboratively and capitalizing on their comparative strengths. The 'communities of practice' initiatives capture these strengths for the future.
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				All developed protocols, genes and traits being worked on are of general applicability across regions and internationally for the benefit of farmers in the 15 identified agro-ecological regions. The programme actively facilitates the spreading of its developed knowledge, experimental protocols, molecular tools and, increasingly, pre-breeding plant material.
Impact, sustainability and visibility of the EC co-financing		<input checked="" type="checkbox"/>			EC core funding support has been vital to the considerable impacts of the programme, EC support is consistently emphasised but the funding sources and attributions are necessarily complex and to an extent opaque. Work supports the first component of the EC's Food Security Thematic Programme. Longer term and sustainability will depend significantly on embedding GIBS in the revised CG and the continuation of the collaborative networks post 2013

3.2 Recommendations

- It is recommended that GCP facilitate the introgression of the *Pup1* phosphorous deficiency tolerance trait from rice, and of Striga, tolerance into sorghum for Africa.
- It is recommended that maintain and enhance its focus on working with the nodal institutions within partner countries which have the national mandate for particular crop-related functions.
- It is recommended that project reporting make it clearer where and when agreed outputs have been achieved.
- It is recommended that GCP expand support for facilitating international germplasm transfer agreements.
- It is recommended that urgent consideration be given to the integration of the GIBS molecular breeding platform in the revised CG structure.
- It is recommended gender be given a stronger focus.
- It is recommended that GCP further support analyses of their most successful projects

- It is recommended that the GCP programme management system should have a period of stability on basis of the 2011-13 MTP.
- It is recommended that the EC provide a letter of commitment in response to the funding request of the GCP for July 2011 to 2013.

3.3 Overall recommendation on future support by the European Commission

	Yes / no	Comment
Suspension	No	
Continuation	Yes	The GCP partnership models are running excellently, with national institutes now leading c. half the projects. Technical progress is very good, with the number and value of outputs now entering the exponential increase phase. See recommendations.

CIMMYT (66): Generation Challenge Programme : Sub-programme-3 – Trait capture for Genetic Improvement

1. Introduction

The Generation Challenge Programme addresses the UN Millennium Development Goal of ‘*halving, by 2015, the number of hungry people and those living on less than a dollar a day*’. The EC support for the project CIMMYT 66 co-funds the GCP’s Sub-Programme 3 ‘*Trait capture for genetic improvement*’ which contributes to the MDG under CGIAR System Priority-2 ‘*Providing more and better food at lower cost through genetic improvement*’ which has the indicator: *Number of pre-breeding products distributed to national breeding programmes*’.

The Generation Challenge Programme (GCP) 2004-13, has its management centre hosted by CIMMYT, through which the EC co-financing funds for this sub-programme are channeled (as CIMMYT 66). GCP Sub-programme-3 is discussed and reviewed according to the main criteria proposed by the EC terms of reference: relevance, efficiency, effectiveness, impact, sustainability and visibility in a systems priority perspective. The review mission visited GCP headquarters at CIMMYT in Mexico and collaborators in India at ICRISAT, Hyderabad, University of Agricultural Sciences, Bangalore, Tamil Nadu Agricultural University, Coimbatore, the Indian Agricultural Research Institute and Indian Council for Agricultural Research in New Delhi. India was selected as the single country with the largest number of CIMMYT 66 projects operating over the period reviewed. Review of projects operational outside India or Mexico was conducted by conference calls from CIMMYT and ICRISAT. The 13 EC co-funded GCP Sub-programme-3 projects most significantly (75%) funded by the EC contribution were reviewed.

Annex 1 has the terms of reference of the review, annex 2 the names of the evaluators and their institutions, annex 3 the map of places visited, annex 4 the calendar of the visits and list of persons/organizations consulted, annex 5 the literature and documentation consulted and available and annex 6 the logframe GCP Sub-programme-3 2009-11.

GCP has 15 staff based at CIMMYT including a management team of 4 Sub-programme leaders, one product delivery leader and one programme Director. Only 5-10% of the overall scientific budget of GCP is spent by CIMMYT (6% in 2009) with projects widely commissioned in the 15 identified ecosystems targeted on the basis of poverty (child malnutrition) and drought – one in Central America, five in Africa and nine in Asia. Consortium partners received 38% of the budget in 2009 and non-consortium partners 56%. CG Centres received approximately half the budget, with a further one quarter going to developed country partners and one quarter to developing country partners. The EC contribution to the total GCP budget was 46% in 2009 and was expected to be 35% in 2010 (GCP 2009 Annual Report, see annex 7).

A full listing of ongoing GCP projects in 2009 under Sub-programme-3 is shown in annex 8. The 2004-2008 achievements summary (by GCP) is in annex 9, annex 10 shows the Annual Workplan and Budget for GCP 2008-10, annex 11 provides the overview of scientific publications from GCP 2009-10 and annex 12 has recommendations from the 2007 External Independent Review of GCP. Finally annex 13 contains the DAC summary.

The total Sub-programme-3 project budget and the EC contribution for the period of review are as follows (in both US\$ and EUR):

Year	Total projected budget US\$ mill	EC contribution		US\$ mill	%
		planned EUR mill	actual EUR mill		

2008	4.717	1.2000	1.2561	1.5965	33
2009	4.657	1.1000	1.0572	1.4520	31
2010	2.318	1.1000	1.0867	1.4843	64
Total	11.692	3.4000	3.4000	4.5337	39

If, for external reasons, the ECs co-funding to the GCP was to decline significantly in the coming years, this would necessarily impact adversely on the output portfolio.

1.1 Role and linkages of GCP Sub-programme-3

The purposes of the GCP projects are:

1. Research-Development linkages
2. Validating candidate genes in target environments
3. Expanding and supporting phenotyping
4. Strengthening breeding communities

GCP has the objective of exploring plant genetic diversity and applying advanced genomics and comparative biology to advance the breeding of the main staple crops grown by resource-poor farmers in drought prone and other harsh environments. As such it commissions (but does not itself undertake) strategic research on biotic and abiotic stresses (and especially drought tolerance), deliberately addressing very challenging issues in plant breeding, acknowledging that these are vital areas of research if the world is to respond positively to the twin challenges of increased staple food production and climate change with improved and more productive crop plant breeding material.

The GCP sub-programmes are:

1. Crop genetic diversity
2. Genomics towards gene discovery
3. Trait capture for crop improvement
4. Bioinformatics and crop information systems
5. Capacity-building and enabling delivery

An early focus on Sub-programme-1 and 2 during Phase I (2004-8), has evolved as planned into a greater focus on Sub-programme-3 to 5 in Phase II. Individual projects normally have a focus in one sub-programme area but frequently address more than one area. There have been 28 projects commissioned under Sub-programme 3 (see Appendix 8). Some were completed before the period of this review. The reviewers examined all projects solidly focused in Sub-programme-3 supported by the EC funding and active during the review period (13 in total), and were appraised of the work under the wider GCP and the connections of Sub-programme 3 with other sub-programmes by the GCP sub-programme leaders.

The themes for Sub-programme-3, drawn from the logframe outputs are:

1. Characterisation of the genetic basis of desiccation and drought resistance (e.g. in groundnut).
2. Development and evaluation of new breeding techniques (e.g. QTL and MAS for several crops and the development of protocols for root architecture traits)
3. Validation of alleles and markers (e.g. salinity and low phosphate tolerance in rice)
4. Development of molecular markers in breeding programmes (e.g. salt tolerant rice)

Work within the sub-programme is intended to run from the more basic identification of genomic regions for plant breeding (Theme 1) and the development of molecular breeding and phenotyping

tools and protocols (Theme 2) to the validation of those breeding tools (molecular markers, alleles) in CG mandate crops under target field conditions (Theme 3). Theme 4 projects involved the use of those validated molecular breeding tools in breeding programmes, currently with a focus on utilizing the disease resistance developed under earlier GCP work but beginning to move towards the introgressing of drought tolerance traits.

Phase I (2004-8) ended with a re-focussing on more concrete downstream outputs and an integrated service component in Phase II (2009-13) as recommended in the 2007 External Programme and Management Review (annex 11) and now reflected in the July 2010 Medium term plan for 2011-13 and in the Transition Strategy document (Appendix B of the 2009-11 MTP details GCPs management response to the recommendations)³.

This re-organization allows GCP to respond more directly to the SP2 key indicator – the *Number of pre-breeding products distributed to national breeding programmes*, reorganising GCP into two areas, a service component – the Genomics and Integrated Breeding Service (GIB Service) building on the earlier Integrated Breeding Platform and a Research Component which will comprise eight crop-based projects fitting into (and significantly run through) the Commodity Research Programmes (Theme 3), while the GIB Service will cross cut those CRPs⁴. GCP programme management will be re-organised accordingly. Sub-programme 3 is already merged with Sub-programme 1 and re-named ‘*Integrated crop breeding*’. From 2011-13, Sub-programme-3 will add foci on:

- a) High throughput genotyping (under contract to a few companies – most likely including KBioscience in the UK)
- b) Implementation of marker assisted recurrent selection (MARS) breeding
- c) Full integration of the Molecular Breeding Platform with the other breeding programme.

Most projects will fall under Theme 4 (the most downstream theme) and only a few ‘heritage projects’ from earlier in Phase II will remain. A large scale field infrastructure improvement project (65 sites in the NARS (32 in Africa)) will be undertaken (not under EC funding) which will underpin Sub-programme-3 projects.

However, at the time of this review in December 2010 the older structure was still in place and it is against this structure (in MTP 2009-11) and its intended outputs that this review is undertaken.

Of the 13 reviewed projects two projects had an output focus relevant to Theme 1, five to Theme 2, two to Theme 3 and four to Theme 4. Eight of the projects were largely based in the review locations (Mexico and India) allowing greater direct interactions with project staff.

1) **Disclaimer:** the authors accept sole responsibility for the contents of this report, drawn up on behalf of the Commission of the European Communities. The report does not necessarily reflect the views of the Commission

³ See recommendations in annex 12.

⁴ See recommendations in annex 12.

2. GCP Sub-Programme 3 “Trait capture for crop improvement” (CIMMYT 66 EC project number) in the overall program of GCP and in the Medium-Term Plan

This sub-programme has four outputs⁵:

Output 1: Characterisation of segregating populations and identification of genomic regions for plant breeding

Output 2: Development and evaluation of novel breeding or molecular technologies to better serve modern plant breeding

Output 3: Markers/alleles validation in adapted germplasm under target environments

Output 4: Application of molecular markers in breeding programmes

Overall funding and activities in Sub-programme-3 have increased in 2009-10 despite the slight decline in the EC contribution, capitalising on the outputs of Sub-programmes-1 (*crop genetic diversity*) with work on the evaluation of crop/marker reference sets in new target environments; Sub-programme-2 (*genomics towards gene discovery*) with work on validation of genes/markers by NARS in target regions. Sub-programme-3 both draws on and contributes to Sub-programme-4 (*bioinformatics and crop information systems*) and its successful projects move into the area of Sub-programme-5 (*capacity-building and enabling delivery*) as laid out in the 2009-11 MTP.

Research products delivered which build on the earlier outputs of the other sub-programmes include, validated makers for resistance in maize – downy mildew; in potato – late blight, potato tuber moth, bacterial wilt and potato leaf roll virus; in sorghum; aluminium toxicity; in rice – phosphorus deficiency, salt tolerance and drought; in wheat – drought.

From 2009, the focus of all new projects under Sub-programme-3 has been drought tolerance, with 18 of the total of 28 projects over the life of the sub- programme having this focus.

⁵ See Appendix 10 for detailed project sub-outputs for each output area.

3. Analysis of the project contributions to the Sub-Programme-3 outputs

Overall progress for all projects in the sub-programme was discussed at length with the GCP sub-programme leader Dr Xavier Delanney and progress for each EC supported project active during the review period (2009-10) was discussed in individual meetings or conference calls with specific project leaders as detailed below and in annex 4 (people consulted) and annex 8 (ongoing projects).

OUTPUT 1: CHARACTERISATION OF SEGREGATING POPULATIONS AND IDENTIFICATION OF GENOMIC REGIONS FOR PLANT BREEDING (6 PROJECTS)

Projects reviewed:

G3007.04/CI-7	Tailoring superior alleles for abiotic stress genes for deployment into breeding programmes: a case study based on association analysis of <i>Alt_{SB}</i> , a major aluminium tolerance gene in Sorghum.		
2007-2009	Tot budget: \$ 603,101	PI: Jurandir V. Magalhaes EMBRAPA	IGD-CU, INRAN, USDA-ARS
G4008.15	Developing potato cultivars adapted to Southern African countries.		
2008-2009	Tot budget: \$ 209,868	PI: F. Vilaro INIA-Uruguay	CIP, DARTS, IIAM, INIA-Chile, INTA-Argentina

The output/theme incorporates most of the Sub-programme-3's 'discovery work'. The output is intended to lead to a better understanding of the genetic basis of disease resistance and drought tolerance and to enhance genetic diversity and its contribution to breeding. Association mapping has helped identify useful new markers in sorghum (aluminium tolerance with EMBRAPA involving sub-programme 2) and maize (downy mildew with BIOTEC Thailand). Wheat, barley and groundnut lines with useful resistances to aluminium and drought have been developed and characterized using novel techniques of wide applicability. Testing of improved germplasm goes ahead in Senegal, Malawi, Mozambique and elsewhere. Pre-breeding NILs carrying the Aluminium tolerance gene *Alt_{SB}* are available and are being introgressed into West African (Niger and Mali) sorghum lines following transfer of germplasm to ICRISAT-Mali. This is a good example of CGPs strengths, with gene discovery under Sub-programme 2 in the Americas, then an improved allele identification phase (see under output 3) followed by breeding application of the trait in the Americas and Africa (INRAN, ICRISAT-Mali) under sub-programme-3, prompting a successful re-evaluation of existing African sorghum lines for Al tolerance.

International germplasm transfers and appropriate field site identification have been major difficulties and work with new institutions in Niger, new leadership at ICRISAT-Mali, improved access to soil mapping data and understanding of how to overcome phosphate deficiency will be required to continue to exploit the benefits of this work (inc. though transferring the *Pup1* gene from rice if a suitable marker can be found). It is hoped to add Striga tolerance. The African potato cultivar development project has had severe difficulties with the signing of project agreements and the international transfer of germplasm with the first material reaching Africa (Malawi) only now. It is expected that these issues will be resolved during a two year no-cost extension.

OUTPUT 2: DEVELOPMENT AND EVALUATION OF NOVEL BREEDING OR MOLECULAR TECHNOLOGIES TO BETTER SERVE MODERN PLANT BREEDING (8 PROJECTS)

Projects reviewed:

G4008.13/CI-3	Improving drought tolerance phenotyping in cowpea.		
2008-2010	Tot budget: \$ 450,836	PI: Jeff Ehlers Univ. of Calif. Riverside	IITA, INERA-BF, ISRA, TAMU
G4008.06/CI-4	Targeting drought-avoidance root traits to enhance rice productivity under water-limited environments		
2008-2011	Tot. budget \$ 900,000	PI: Ken McNally IRRI	ARC (BF), CSU(DRC), NagU, SUA, UoAb, TNAU, UoMi
G4008.12/CI-2	Linking genetic diversity with phenotype for drought tolerance traits through molecular and physiological characterization of a diverse reference collection of chickpea		
2008-2009	Tot. budget \$156,215	PI: Krishnamurthy, ICRISAT	JIRCAS, UAS-Bangalore
G3008.07	Basal root architecture and drought tolerance in common beans.		
2008-2011	Tot. budget 900,000	PI: J.P.Lynch PSU-USA	CIAT, IIAM, SABRN
G3008.08/CI-6	Breeder-friendly high-throughput phenotyping tools to select for adaptive traits in drought environments		
2008-2011	Tot. budget	PI: F. Ogonnaya ICARDA	CIMMYT, CSIRO, EIAR, INERA-Morocco

This output covers support technologies for molecular breeding and improved phenotyping (the ability to score plant lines for traits of interest). Phenotyping is a major concern in abiotic stress tolerance selection as field sites reliably and uniformly showing the particular stress (e.g. drought or high aluminium) are difficult to secure and this is a major constraint to progress.

Quantitative Trait Locus (QTL) mapping has been strongly developed to enable the contribution of several genes to a phenotypic trait of interest to be identified. Rapid progress has been made through collaborations of CAAS, CSIRO and CIMMYT in this area, allowing the construction of genetic models which can be used to optimize crossing strategies to pyramid the genes of interest. This system has been profitably deployed in wheat, sorghum, maize and rice under GCP.

In the area of trait scoring (phenotyping) GCP has examined potential direct measurement tools for drought phenotyping (carbon isotope discrimination and thermal imaging) with considerable technical success but to date limited practicality owing to cost and replicability concerns. In relation to drought tolerance GCP has also looked at the relationship of root architecture (spread, depth and volume) and the development of markers for this, with work advancing strongly in cowpea, rice and beans, though correlations are proving more difficult to identify than had been expected. The phenotypic and genotypic characterization of a chickpea reference set using Diversity Array Technology (DArT) markers has allowed promising marker/drought trait associations. Standardised measurement systems, protocols and a network of international field sites has been developed (benchmarking), in particular for wheat. The fully characterized phenotyping field site network is expected to greatly simplify line

and trait testing across many of the GCP projects, increasing the ability to understand gene/environment interactions.

OUTPUT 3: MARKERS/ALLELES VALIDATION IN ADAPTED GERMPLASM UNDER TARGET ENVIRONMENTS (5 PROJECTS)

Projects reviewed:

G4008.10/CI-7	Assessment of the breeding value of superind haplotypes of Alt _{SB} a major Aluminium tolerance gene in sorghum: linking upstream genomics to acid soil breeding in Niger and Mali (ALTFIELD)		
2008-2010	\$205,200	PI: Robert, Schaffert, EMBRAPA	ICRISAT, INRAN

G4008.16	Speeding the development of salt-tolerant rice varieties through marker-assisted selection and their dissemination in salt-affected areas of Bangladesh		
2008-2009	\$223,768	PI: Abdelbagi Ismail, IRRI	BINA, BRRI, UoD

All projects under this output aim to validate and add value to existing GCP products, with outputs intended for wide dissemination in the crop breeding community. Strong progress has been made in introducing drought-tolerance QTL markers into wheat in various Chinese provinces and in Morocco. The very successful sorghum work with aluminium tolerance is discussed under output 1. In rice an important QTL *Saltol* is being introgressed into a number of Bangladeshi varieties using marker assisted backcrossing (MABC) and the phosphorus uptake QTL *Pup1* is being utilised in IRRI and Indonesian varieties. Timelines for many activities in these projects were overambitious but partners are completing work under no-cost extensions or other funding.

OUTPUT 4: APPLICATION OF MOLECULAR MARKERS IN BREEDING PROGRAMMES (9 PROJECTS)

Projects reviewed:

G3007.05/CI-4	Detecting and fine-mapping QTLs with major effects on rice yield under drought stress for deployment via marker-assisted breeding		
2007-2009	\$598,590	PI: Arvind Kumar, IRRI Co PIs at: BAU (BF), CCRI, IGKV, IRRI, JNKVV	CRURS, NDUAT, TNAU, UAS-Ban, UoAI, YAAS

G4008.11	Dry bean improvement and marker assisted breeding for diseases and abiotic stresses in Central American and the Caribbean		
2008-2010	\$382,590	PI: Jorge, Acosta-Gallegos, INIFAP	CIAT, INTA- Nicaragua

G4008.56	Asian maize drought tolerance (AMDROUT)		
2008-2013	\$1,512,200	PI: BS Vivek, CIMMYT (at ICRISAT)	ICERI, KLS, NMRI, NSFCRC, UPLB, YAAS

G4007.08/CI-4	Integration of genomic tools with conventional screening for developing NERICA rice cultivars for West Africa		
2007-2009	\$304,440	PI: M N Ndjioudjop ARC	Agropolis-IRD, IER

This output is the most downstream and is expected to take markers developed and validated under the earlier outputs into breeding programs for commercial release. Its importance is thus increasing over the life of the GCP. Disease breeding (e.g. resistance in African rice to yellow mottle virus and bacterial blight) has been important early in the GCP with accessions and breeding lines now screened for national systems under sub-programme 3 projects. Resistance to the parasitic weed *Striga* has been screened using marker assisted breeding to produce well adapted cowpea lines for farmers in Niger and Burkina Faso. Maize streak virus resistance has been introduced into Moroccan maize and markers developed for sweet potato resistance for resistance to sweet potato virus disease. Screening for virus and root rot diseases of beans has been undertaken in drought tolerant lines in central America and Marker Assisted Breeding- developed lines are now being distributed in Mexico, Haiti and Cuba through farmer and NGO collaborations.

The introgression and eventual release of drought tolerant lines of the major CGIAR target crops is the current objective. The Dry bean work of CIAT is well advanced with most objectives fully achieved. Drought tolerance appears to correlate positively with good irrigation responses and low P tolerance and breeding material is already widely disseminated in Mexico. The rice work led by IRRI was successful in generating a QTL which, when introgressed into rice lines in China and India is stable in different genetic backgrounds and lifted yields under severe drought from 0.5 tonnes/ha to 1.5 tonnes/ha (water uptake related but, surprisingly, not root length related). UAS Bangalore expects to have QTL selected rice lines released before the end of GCP in 2013. The Bill and Melinda Gates programme is supporting wide testing of these rice lines in Nepal and Thailand and in Africa and the Indian Govt All India Co-ordinated Rice Trials have more than 50% of the lines under test from the GCP programme with a number of lines released in the 5 most important rice producing states. The best QTL assisted lines are now giving 2.8 tonnes/ha under drought. India's Dept of Biotechnology is putting US\$5 mill into the broad development of QTL enhanced lines at IRRI and GTZ is supporting with Euro 1.2 mill. This work will feed into the Global Rice Science partnership. Evaluation of the positive factors which have led to this continuing success would be a sound investment by the GCP.

The Asian maize drought tolerance work is led by CIMMYT from ICRISAT. This, largest sub-programme-3 project, aims to move yields from their current 2 tonnes/ha closer to the experimentally demonstrated potential yields of 13 tonnes/ha working in China, Thailand, the Philippines, Vietnam and India, and will feed into the Bill and Melinda Gates project on Drought Tolerant Maize for Africa, the Syngenta Foundation Affordable, Accessible, Asian (AAA) drought tolerant maize project and the CG maize CRP. The developed CML444 is the top white maize drought tolerant donor parent and there are a number of elite Asian yellow maize lines. Genotyping of these lines is commencing now and marker associations with drought tolerance are being developed (40 candidate markers at this stage). The reviewers met collaborators from both Krishidhan Seeds (5th largest Indian seed company) and from the Syngenta Foundation India and visited field sites. Both collaborators were highly appreciative of their GCP collaboration and are actively using CIMMYT parental lines in their production of hybrid maize lines which are producing up to 10 tonnes/ha under modest rainfall conditions of 500-600mm annually (albeit that this maize is largely for chicken feeding rather than direct human consumption). India still grows c.50% of the maize crop in open-pollinated varieties but there looks likely to be dramatic shift to hybrids. By contrast, collaborations with the Indian Council for Agricultural Research's Directorate of Maize Research have not gone well to date, with potential impacts on the uptake of output lines through the Indian national system.

4. Review criteria

The review criteria as specified in the TOR are discussed for the overall GCP Sub-programme-3. An overall assessment of the performance of the 13 EC supported projects in Sub programme-3 in each of the four output areas and overall is assessed against the review criteria as specified in the TOR (table 4-1), followed by an assessment and brief discussion against those criteria for the overall GCP Sub-programme-3.

Table 4-1: Summary performance of GCP Sub-programme-3 (2009-10) against outputs and overall

Performance ⁶	HS	S	LS	HUS	Comments
Output 1:					Characterisation of segregating populations and identification of genomic regions for plant breeding
Projects reviewed:					G3007.04/CI-7: Magalhaes JV, EMBRAPA G4008.15 Vilaro F, INIA-Uruguay
Relevance	<input checked="" type="checkbox"/>				
Efficiency		<input checked="" type="checkbox"/>			
Effectiveness		<input checked="" type="checkbox"/>			
Practical implementation of SP2	<input checked="" type="checkbox"/>				
Synergy and collective action		<input checked="" type="checkbox"/>			Excellent in the AI tolerance project. Limited progress in the potato project.
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				Both projects strongly link internationally.
Impact, sustainability and visibility of the EC co-financing		<input checked="" type="checkbox"/>			High in the sorghum project but as yet unknown in the potato work.
Output 2:					Development and evaluation of novel breeding or molecular technologies to better serve modern plant breeding
Projects reviewed:					G4008.12/CI-2: Krishnamurthy, ICRISAT G4008.13/CL-3: Ehlers J, UoC Riverside G3008.06/CI-4: McNally, IRRI G3008.07: Lynch JP, PSU G3008.08/CI-6: Ogonnaya, ICARDA
Relevance	<input checked="" type="checkbox"/>				
Efficiency		<input checked="" type="checkbox"/>			Some delays in output production.
Effectiveness		<input checked="" type="checkbox"/>			Outputs beginning to feed into direct products for beneficiaries.
Practical implementation of SP2	<input checked="" type="checkbox"/>				
Synergy and collective action	<input checked="" type="checkbox"/>				Significant multi-partner international collaborations with long-term benefits for partners, science and beneficiaries.
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				Global phenotyping networks set up and genotype/ phenotype correlation methodologies developed and widely disseminated.
Impact, sustainability and visibility of the EC co-financing		<input checked="" type="checkbox"/>			
Output 3:					Markers/alleles validation in adapted germplasm under target environments
Projects reviewed:					G4008.10/CI-7: Schaffert, EMBRAPA G4008.16: Ismail AM, IRRI
Relevance	<input checked="" type="checkbox"/>				
Efficiency		<input checked="" type="checkbox"/>			Timelines were overambitious.
Effectiveness	<input checked="" type="checkbox"/>				
Practical implementation of SP2	<input checked="" type="checkbox"/>				

⁶ HS: Highly Satisfactory, S: Satisfactory, LS: Less than Satisfactory, HUS Highly Unsatisfactory.

Synergy and collective action	<input checked="" type="checkbox"/>				
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				
Impact, sustainability and visibility of the EC co-financing		<input checked="" type="checkbox"/>			
Output 4: Projects reviewed:					Application of molecular markers in breeding programmes G4007.08/CL-4: Ndjiondjop, ARC G3007.05/CI-4: Kumar A, IRRI G4008.11: Acosta-Gallegos JA, INIFAP G4008.56: Vivek B, CIMMYT at ICRISAT
Relevance	<input checked="" type="checkbox"/>				
Efficiency	<input checked="" type="checkbox"/>				
Effectiveness	<input checked="" type="checkbox"/>				
Practical implementation of SP2	<input checked="" type="checkbox"/>				
Synergy and collective action	<input checked="" type="checkbox"/>				
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				
Impact, sustainability and visibility of the EC co-financing	<input checked="" type="checkbox"/>				Outputs achieved and an important contribution to breeding in a wide range of CG mandate crops has been made.

Overall Sub-programme-3:					Trait capture for crop improvement
Relevance	<input checked="" type="checkbox"/>				Project designs and management tightly related to agreed outputs.
Efficiency		<input checked="" type="checkbox"/>			Quality, quantity and management good. Molecular breeders globally have been over-optimistic about timelines.
Effectiveness	<input checked="" type="checkbox"/>				Well placed to increase to and beyond the ending of GCP.
Practical implementation of SP2	<input checked="" type="checkbox"/>				Focus and planning very good. Progress has been slower than planned but expected contributions should still eventuate.
Synergy and collective action	<input checked="" type="checkbox"/>				Genuinely global and mutually supportive collaborations.
IGC/PGC of the research undertaken	<input checked="" type="checkbox"/>				Exemplary.
Impact, sustainability and visibility of the EC co-financing		<input checked="" type="checkbox"/>			Longer term and sustainability will depend significantly on embedding GIBS in the revised CG and the continuation of the collaborative networks post 2013.

4.1 Relevance of the project

The CIMMYT 66 cluster of projects are highly relevant to the overall GCP strategy as laid out in the 2009-11 MTP and this in turn contributes strongly to the CG SP2 - 'Providing more and better food at lower cost through genetic improvement'. The wording of the outputs and many of the constituent project titles conceals this, being directed purely at fellow scientists, making it difficult to see the larger picture of how the projects and outputs fit the larger objectives

The CG SP2's indicator is 'number of pre-breeding products distributed to national systems'. Under the GCP Sub-programme-3 a plethora of such products has been and continues to be generated and the re-focussing of the programme will accelerate this further. Some of these products are germplasm, for example from the GCP Sub-programme-3, Output 3 and 4, projects on aluminium tolerant sorghum, drought tolerant maize, characterised salt-tolerant rice lines, drought and low phosphorus tolerant beans for Central America, disease and parasitic plant tolerant rice, cowpea etc which are being tested and introgressed into local germplasm around the developing world now, in some cases

with major support from other donors. No one the reviewers spoke to doubted that the impact of these on the global food crop breeding community will be felt strongly and rapidly in the coming years. Esperanza *et al* (2009) enumerated this for rice work. This sort of economic assessment of impacts would be valuable for the other major programmes.

Other ‘products’ are characterized regions of DNA containing genes positively influencing the trait of interest (Quantitative Trait Loci or QTLs). These are being developed and provided to CG centres, ARIs, NARS breeders etc and farmer-ready plant lines are beginning to appear (e.g. Indian utilization of the drought tolerance QTLs). Other ‘products’ again are the data sets, experimental and data collection protocols, molecular methods etc to which breeders, particularly in the developing world, need access. The unified platform under development– the Genomics and Integrated Breeding Service (GIBS) captures and makes available all these advances in a publically accessible and unified way which has never been available globally to date. Sub-programme-3 contributes strongly to those methods, protocols, data sets and publically available genes and constructs. Additional ‘products’ include international networks of stress –characterised field sites for the testing and comparison of candidate germplasm and the formal and informal ‘communities of practice’ which help to strengthen a sense of ownership and commitment by crop breeders globally. The GCP management has identified and targeted its end-users as the global crop breeding community and drawn them into project design and implementation through a mix of commissioned and open-competitive projects, allowing innovation without losing focus. Management’s response to changes in circumstances within and beyond the project has shown great ingenuity and flexibility, though it perhaps now time to stop any further reorganisation of the GCP during its final three years of operation. The work undertaken is very much state of the art, assured by advisory bodies including major breeding company representatives to whom the reviewers spoke. The commercial breeders were clear that GCP was undertaking vital work on crops of relevance to the poor which would not otherwise be undertaken by the commercial sector but which they would be happy to take advantage off once available.

The GCP Logframe has been effectively used to direct and manage the planning and reporting process for the sub-programme and projects with a strong focus (through the new position of Product Manager) on clear delivery and wide dissemination of multiple concrete outputs. The project annual reporting format needs to more clearly summarise the achievement of individual project outputs and the dates of achievement against the logframes. It may be argued that the choice of goals in disease, drought and other abiotic stress alleviation, was overly ambitious within the time and budget frame. However the GCP community has risen strongly to that challenge, engendering strong progress in the novel science required to meet those challenges and creating an infectious air of excitement about progress and its global significance.

Relevance of the project is therefore rated Highly Satisfactory.

4.2 Efficiency - Quality of Research

4.2.1 Choice of approaches

The GCP approach is exceptional in its genuine commitment to fostering ownership and partnerships with the NARS, industry and other partners outside as well as within the CG – a major objective of the programme. The objectives and needs of the diverse partners have inevitably resulted in a wide range of strategies being adopted to achieve programme goals, but strong progress with appropriate methodologies has been made in all areas reviewed, with partners strongly committed to supporting and utilizing the GIBS platform after the end of GCP in 2013.

4.2.2 Evaluation of project

The shifts in objectives and programme management structure made in response to the recommendations of the 2007 external review (Annex 12) and again with the beginning of Phase II with its more concrete output focus, have resulted in a complex and confusing (even for partners) matrix of objectives, outputs, themes, sub-programmes etc, with some projects evaluated under older criteria and some under new. However, the small GCP management team has an exceptionally clear and firm grasp of the priorities and objectives and has ensured that the intended outputs have been achieved and disseminated through the CG and professional networks they have set up. EC project funding has been used strategically as a source of finance and co-finance for a wide range of ongoing GCP activities in the areas of genetic trait capture and exploitation of germplasm collections. This approach is logical but as a consequence, some activities may not entirely fit with the original overall project goal objectives.

The relatively modest (and declining) budget has been used to catalyse a very wide range of collaborative initiatives, generating strong financial support from other partners. Over half Subprogramme-3 projects are running late on their intended outputs. The willingness of all these projects to continue work to complete their ambitious objectives under no-cost extensions is evidence of the commitment engendered.

Although the GCP is restructuring from 2010-11 in order to increase its delivered product focus, this is, in fact already very strong in its commissioned work and this is widely appreciated by the breeding community met by the reviewers.

4.2.3 Quality of research

The quality of the research is of a high international standard and respected by the scientific world. However, it must be appreciated that the programme was originally aimed at broad-based, upstream research underpinning capacity in molecular breeding globally. The individual projects were as much vehicles for the development of new tools and capacities as about directly and rapidly advancing towards the ultimate goals of abiotic stress alleviation. Many projects report major publications in high impact journals (Annex 11⁷). Annex 9 is a list of the major products from GCP's to 2008. It is confidently expected that the scientific exploitation of this basic research will now increase rapidly on the solid platform constructed by the GCP. Research quality is therefore rated Highly Satisfactory.

The Efficiency of Research is rated Satisfactory, with reservations only the area of timeliness of output completion.

4.3 Effectiveness

GCP's partnership network is impressive. The 2009 Annual Report⁸ lists 120 developing country partners and 49 developed country partners in addition to the 18 (soon to be 22) consortium members, private sector partners etc. All reviewed projects have multiple international partners with CG Centres, NARS and ARIs sharing leadership and partnership roles. The flow of information between partners is good and publication rapid and of a high quality⁹. Movement of germplasm and other genetic products is becoming more difficult due to an increasingly challenging regulatory system world-wide and this has slowed the progress in a number of projects. In conjunction with other sub-programmes there is a strong push to formalize research networks under the 'communities of practice' initiative. These depend strongly on the enthusiasm, initiative and technical expertise of their organizers but at present seem to be strong and appreciated. The Sub-programme-3 maize and rice projects work directly with the private sector, providing pre-breeding material and the parents for the

⁷ See Annex 7 (GCP 2009 Annual Report, pp.85-91 for 2009 publications only) or go directly to Annex 11.

⁸ See Annex 7 (GCP 2009 Annual Report, pp.63-67).

⁹ See Annex 11.

development of commercial hybrids, but the public-good nature of the outputs has been scrupulously adhered to. Work with the Syngenta Foundation has been particularly valuable in generating high-yielding maize hybrids which will have an increasing role to play internationally.

Effectiveness is therefore rated as Highly Satisfactory.

4.4 Practical implementation of SP

All research in projects within CIMMYT 66 is classified as 100% SP2 - *Providing more and better food at lower cost through genetic improvement*. The relevant SP2 priorities are:

SP2A: *Maintaining and enhancing yields and yield potential for food staples*

SB2B: *Improving tolerance to selected abiotic stresses*

The breakdown by CGIAR system priority of GCP expenditure (all funding sources in US\$ mill) is:

Year	SP2A	SP2B
2009:	0.9310	3.7260
2010:	0.4640	1.8540
Total:	1.3950	5.5800

By region total expenditure (US\$ mill) was expected as:

Year	SSA	Asia	LAC	CWANA
2009:	2.329	1.863	0.325	0.140
2010:	1.159	0.927	0.162	0.070
% of Total:	50%	40%	7%	3%

This is in line with SP2 priorities. The reviewers do not have figures which would allow this breakdown for GCP Sub-programme-3 separately.

Total budget of the 13 projects under the review of GCP Sub-programme-3 (US\$ thousands):

Year	Output 1	Output 2	Output 3	Output 4
2008:	82.97	582.05	177.83	120.00
2009:	0.00	754.66	72.60	49.07
2010:	10.38	660.77	75.36	248.22
Total	93.35	1,997.47	325.79	417.29
Total EC	93.35 (100%)	1,817.47 (91%)	325.79 (100%)	368.22 (88%)

Little reference is made in the individual project documents to SP2. The focus is on improved breeding tools and eventually germplasm. However the development of improved germplasm which can provide higher yields through the eventual deployment of more biotic and abiotic stress resistant crops, capable of producing well in more extreme environments, is clearly directed to the SP2 priorities and these drove the project formulation and the choice of outputs/products. Sub-programme-3 outputs contribute to Sub-programme-4 and 5 outputs which themselves directly address the SP2 objective.

Practical implementation of SP is therefore rated as Highly Satisfactory.

4.5 Synergy and collective action

This is an area in which the GCP excels. The division of project partners across developed and developing world institutions according to their needs and comparative advantages has been exemplary. Individual projects are sometimes led by scientists based for the period of the project in institutions other than their own, e.g. the Asian Maize drought tolerance project is led by CIMMYT staff based at ICRISAT. The setting of collective objectives and its management across multiple institutions and frequently continents, is a challenge. One of the lessons learnt from GCPs Phase I was the need to take the building of such collaborations slowly and carefully ensuring the understanding and willing involvement of all participants. The reviewers found that, although contractual and financial arrangements were often delayed for reasons out of the hands of GCP management, the senior staff, administrators and project PIs of partner institutions were more than satisfied with their inputs into planning, decision making, reporting and dissemination and valued the collaborative advances towards common goals more highly than the funding itself. The Indian Council of Agricultural Research's Deputy Director General for Crop Science went as far as to make a point to the reviewers that although the GCP financial input to ICAR institutions is relatively small, he believed that the GCP was the only part of the CG system which genuinely operated in close partnership with the NARS and that the GCP was a major reasons for ICAR's continued close involvement with the CG.

Synergy and Collective Action is therefore rated as Highly Satisfactory.

4.6 International or regional public goods character of the research undertaken

All outputs of the GCP are intended as public goods. This is difficult in the area of molecular breeding where many of the materials and processes required for rapid advance are the IP of commercial or other organisations, with the situation differing in different jurisdictions. GCP is careful to ensure contractually that all outputs are freely and publically available, even when this means restricting or changing the direction of some component research to avoid IP issues clouding public availability later. The GCP has specialists in its management team ensuring this. The regional and international character of the outputs can be clearly seen in the more downstream outputs of the GCP Sub-programmes, with the transfer of aluminium tolerance in sorghum from Central America to Africa and of the capacity to breed drought tolerant maize transferred from Mexico to India as examples highlighted earlier. However, the other 'products' of Sub-programme-3 are also RPG/IPG compliant. The methodologies, protocols and underpinning science are all fully published, promoted at national and regional training workshops and distributed internationally as part of the Product Delivery manager's portfolio. The most highly significant initiative in this area is the evolution of the Molecular Breeding Platform to be the Genomics and Integrated Breeding Platform Service. When complete, this will not only allow global access to existing breeding information, data sets, records of core germplasm characterization etc but will also act as a continually updated pipeline allowing the design, data entry and analysis of complex plant molecular plant breeding programmes in a fully integrated fashion even by breeders who before had no access to the methodological tools and analysis programmes. As one collaborator said – *'it will be a kind of Google crossed with Windows for modern crop plant breeding and will have the same kind of capacity raising impact on breeders in the developing world that those systems have had on the ability to access knowledge and handle data in other areas of human endeavour'*. If GIBS can be satisfactorily implanted in the CP MPs as planned, it will capture the strong RPG/IPG character of the GCP outputs for the future.

RPG/IPG character of the research is therefore rated as Highly Satisfactory.

4.7 Impact, sustainability and visibility of the EC co-financing

The GCP as a whole is already strongly delivering its contribution to SP2 – pre breeding products (see Appendix 9 for a list of Highlight Products from Phase I). A number of these are at or close to release for farmer use e.g. drought-tolerant groundnut and common beans (Nicaragua, Columbia, Zimbabwe), virus and drought resistant cassava etc. Newer products involving Sub-programme-3 outputs, such as the rot tolerant beans and drought tolerant maize and rice, will have very important and rapid impacts on farmer livelihoods in Asia and will make an important and sustainable contribution. Many other products are following in the pipeline. As mentioned earlier, the full impact of these relatively upstream developments will not be seen for some years yet and many will be spread across the global breeding community making post-hoc identification of dollar value of specific contributions (for example of molecular tools) difficult to assess.

EC co-financing, is prominently acknowledged in the various documents produced by GCP and is acknowledged in the annual report, plans etc although, with such a matrix of funders, individual donor contributions are frequently opaque to outsiders. The financing is seen as crucial for the implementation the GCP research agenda and any reduction of the expected EC and other European donor funding in the later years of the programme would be very unfortunate.

Given that GCP Sub-programme-3 operates half-way along the research to product continuum, its demonstrable impact on livelihoods is, as yet, modest but its promise is good.

Impact, sustainability and visibility of the EC co-financing is therefore rated as Satisfactory.

5. Conclusions and recommendations

5.1 Conclusions

It would be true to say that the global crop breeding community as found it more difficult than foreseen in 2003 to utilise the outputs of molecular breeding research in its various forms for the rapid development of improved crops for poorer farmers. Even within crop species, genome structure and gene orders have proved to be more variable than foreseen and the prevalence of polygenic traits with strong genetics/environment interactions more marked than was foreseen, making successful expression of the valued trait after intra or inter-specific transfer more elusive than had been hoped. This is slowing (and deepening) research by all organizations (including commercial companies) in this area. Molecular breeding is not proving to be either faster or cheaper than conventional breeding, though its worth has already been amply demonstrated for simple traits. However, unlike conventional breeding the knowledge gained is incremental and will enable much more effective, productive, targeted and rapid crop development over time. In the specific area addressed by GCP Sub-programme-3, biotic and abiotic stress tolerance, the most successful examples of trait identification and subsequent transfer are in the relatively simple traits such as aluminium tolerance and its relation to soil acidity in sorghum which have been successfully undertaken under projects G3007 in central and S.America and transferred to Africa under G4008. Even here, original trait identification was as far back as 1975 with 30 yrs of funding from USDA and the USAID CRSPS programme. In this particular case GCPs valuable role has been in drawing on the sorghum reference collection, using association analysis to speed up breeding and facilitating the researcher networks (some now as formal 'communities of practice'), resulting in a greatly expanded appreciation of the role of aluminium in reduced sorghum yields globally and subsequent germplasm transfer through ICRISAT-Mali to Niger and Kenya for introgression into Sahel-adapted breeding lines. The raising of awareness of the issue has resulted in the discovery of aluminium tolerant lines in the existing Sahelian germplasm. This shows the complex, detailed yet catalytic role which the GCP programme plays. Drought tolerance breeding in rice led by IRRI, the Dry Bean work in Mexico and the drought resistant maize for Asia are examples of other projects whose impacts alone would justify the EC support of GCP Sub-programme -3 to date. The other Sub-programme-3 projects are operating at an earlier stage of the research-application continuum but there is every reason to expect that they will make equally important contributions in time.

GCPs mix of commissioned and openly competed for projects has resulted in a large number of mainly relatively small (in financial terms) projects. Impressively, the limited funding to key partners has clearly catalysed a much larger body of work within the CG centres, the Universities, NARS and even private sector breeding companies and is now attracting significant funding from other donors (see box 1).

This work is of a very high standard, is genuinely collaborative with widely disseminated outputs and is strongly managed to ensure output targets are achieved (if necessary by no-cost project extensions). The sheer number of projects and range of partners involved is impressive with GCP building research capacity and strong networks (now 'communities of practice') to help take these collaborations forward after 2013. The GIBS molecular breeding platform in particular seems likely to be the focus of collaboration across institutes if an operational system can be set up which allows it to interface effectively with the new CG structure.

In common with many international programmes, contractual difficulties and problems with trans-boundary transfer of breeding material has slowed the progress of a significant number of Sub-programme-3 projects and required some refocusing of efforts.

Text box 1 GCP Funding overview from the historical perspective (2003-10)

GCP has been very successful in gaining co-funding for further research activities. However, any failure, or even delay, in cash-flow can be a very significant threat to these activities. Any reduction in EC funding over the final years of the GCP would have adverse impacts on programme outputs.

	US\$	
European Commission	44,653,112	38%
DFID/UK	31,766,911	27%
World Bank	17,756,000	15%
Bill and Melinda Gates Foundation	16,367,566	14%
Rockefeller Foundation	2,224,917	2%
Switzerland/SDC	2,077,635	2%
Sweden/SIDA	874,494	1%
USAID	400,000	
Syngenta Foundation	361,600	
Pioneer Foundation	160,000	
Austria	54,482	
Kirkhouse	15,000	

Source: GCP

Management of the GCP has responded strongly and flexibly to the funding challenges following the GFC and to the recommendations of the external review to more tightly focus its efforts in terms of the crop and product priorities. The structuring and objectives of the GCP have been significantly redrawn several times in its 7 years life to date (see Introduction) at considerable cost in manpower and intellectual energy for all concerned. Even now, three years from its ending, full agreement on the transition strategy has not been reached. GCP would benefit from a period of stability while it carries out the 2001-13 MTP.

The division of CIMMYT-66 into groups of projects contributing predominately to one of the four outputs has not particularly informative or helpful and appears to be driven more by the exigencies of the logframe methodology rather than by any scientific necessity. Many of the individual projects could equally have been placed further forward or backwards in the research-development continuum supposed to be represented by the four Themes/Outputs.

The ECs financial contribution has been used essentially as core funding to the wider programme of 28 projects under Sub-programme-3 although it has currently been drawn on particularly by the 13 projects listed. It might be appropriate to recognise that more formally.

5.2 Recommendations

1. **It is recommended that GCP facilitate the introgression of the *Pup1* phosphate deficiency tolerance trait in rice, and of Striga tolerance, into sorghum for Africa.**
2. **It is recommended that GCP maintain and enhance its focus working with the nodal institutions within partner countries which have the national mandate for particular crop-related functions.** Failure to do this, even if producing more rapid technical advances with 'easier' partners to work with such as ARIs, risks compromising the likelihood of eventual uptake success.

3. **It is recommended that project reporting make it clearer where and when agreed outputs have been achieved.** Given the large number of individual projects, it would facilitate assessment of progress if a) output timeline project reporting in project annual reports makes it clear whether quantifiable outputs and key products have been achieved b) GCP management cluster and report the diverse outcomes of the individual projects against the agreed GCP outputs and CG System Priorities to facilitate assessment of progress.
4. **It is recommended that GCP expand support for facilitating international germplasm transfer agreements.** Regional and international impacts are being hampered by the difficulties of transferring genetic material between countries and particularly into African countries. Globally regulations are becoming stricter making timely movement of material in many cases almost impossible. The virtual lack movement of breeding materials from S.America in the African potato project is a particular case in point but the sorghum aluminium tolerance project has also suffered and many other projects are forced to make unsatisfactory arrangements for germplasm movements. These problems will not be easily resolved but need to be addressed urgently if the GCPs mandate is to be fulfilled.
5. **It is recommended that urgent consideration be given to the integration of the GIBS Breeding platform in the revised CG structure.** It is important that a timely decision be made as to where the physical base and core staff of the GIBS molecular breeding platform is to lie, what responsibilities within this should be owned and managed by the relevant CG Institutions with specific crop responsibilities, and how funding of this on-going facility can best be achieved within the revised CG structure.
6. **It is recommended gender be given a stronger focus.** Molecular breeding is an area of science which lends itself more readily to an appropriate gender balance than most other areas of agricultural research. GCP should give more attention to this in its selection of projects and staffing where scientifically defensible and make explicit the gender impacts at farmer level of the future exploitation of its products.
7. **It is recommended that GCP further support analyses of their most successful projects.** GCP should capture and disseminate the reasons for the success of particular projects, most with a long development history, as has been done for salinity tolerance in rice (Esperanza *et al.* 2009) e.g. QTL assisted breeding for drought tolerance in Asian rice, the dry bean disease resistance project in central America, the aluminium tolerance projects in America and Africa and the development of drought tolerant maize for Africa. A thorough socio-economic as well as scientific analysis is justified by the need to learn lessons for such projects in the future.
8. **It is recommended that the GCP programme management system should have a period of stability on the basis of the 2011-13 MTP.** GCP management have been responsive to earlier recommendations for re-structuring and re-focussing but with most programme agendas now set, intellectual energy would be better spent on implementing the transition process.
9. **It is recommended that the EC provide a letter of commitment in response to the funding request of the GCP for July 2011 to 2013.** Formal uncertainty over the funding agreement is making it difficult for GCP to commission and support projects and approve expenditures in a context of prudent financial management.

CGIAR Review 2010 – According to the System Priorities of CGIAR projects funded by the EC in 2009 to be carried out in the second half of 2010

International Maize and Wheat Improvement Center

CIMMYT

**CGIAR Generation Challenge Program (GCP) (CIMMYT66)
Sub-Programme 3: Trait capture for crop improvement**

LIST OF ANNEXES

Annex 1:	Terms of Reference
Annex 2:	The names of the evaluators and their institutions
Annex 3:	Map of mission locations
Annex 4:	Calendar of the visit and list of persons/organizations consulted
Annex 5:	Literature and documentation consulted/available
Annex 6:	Logframe GCP Sub-Programme-3 2009-11
Annex 7:	GCP 2009 Annual Report
Annex 8:	CIMMYT on-going GCP projects in 2009 – Sub-programme-3
Annex 9:	A list of Highlight Products delivered in GCP Phase 1 (2004-08)all Sub-programmes
Annex 10:	Annual Workplan and Budget, GCP 2008-10
Annex 11:	Scientific Publications from GCP 2009-10
Annex 12:	Recommendations from the 2007 External Independent Review of GCP
Annex 13:	DAC Summary

TERMS OF REFERENCE FOR REVIEW ACCORDING TO THE SYSTEM PRIORITIES OF CGIAR PROJECTS FUNDED BY THE EC IN 2009 TO BE CARRIED OUT IN 2010 - ACTIVITY 1 -

1. Objectives

As indicated in Annex 1 of the Contribution Agreement signed by the EC and IFAD, it is expected that "a sample of EC supported programmes will be monitored in the framework of the present Contribution Agreement. Joint monitoring arrangements will be considered through EIARD. NATURA (Network of European Agricultural Universities Related with Agricultural Development) and ECART (European Consortium for Agricultural Research in the Tropics), the only pan-European tropical agricultural research organisations, will be contracted by for this purpose. The organisation will fully contribute to the new joint monitoring scheme being developed."

Centre projects will be mainly addressed according to the 5 System Priorities (SPs). SPs are in fact 5 broad clusters of objectives, further divided into 5 specific objectives (see Science Council, 2005). The SPs are structured around 5 major groups of strategic research activities aimed at producing common outcomes. In aggregate, the priorities provide a set of specific goals for a portfolio of research activities around which the CGIAR has organized its scientific and related capacities. They encapsulate major areas of science within the CGIAR's comparative advantage in its assistance to developing country agriculture. The CGIAR Centres spend at least 80 % of their budget according to the SPs. The SPs are set so as to have measurable outcomes (indicators). Hereafter follows a brief presentation of the SPs and their indicators.

System Priority N° 1. Sustaining biodiversity for current and future generations (indicator: number and diversity of accessions adapted to local context collected, conserved, documented and distributed to users);

System Priority N° 2. Producing more and better food at lower cost through genetic improvements (indicator: number of pre-breeding products distributed to national breeding programmes);

System Priority N° 3. Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products (indicator: number of income generation technical options, targeting poor and food insecure smallholders farmers, made available to national advisory and extension services);

System Priority N° 4. Promoting poverty alleviation and sustainable management of water, land, and forest resources (indicator: number of innovative technical options including the sustainability dimension, developed with farmers and other stakeholders);

System Priority N° 5. Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger (indicator: number of policy options related to food security, poverty reduction, and sustainable use of natural resources, made available to decision makers; number of new organisational settings created to involve different stakeholders in the joint management of innovation and related key decisions).

Challenge Programmes (CP) and System Wide Programmes (SWPs) will also be addressed according to their contribution to the SPs.

The EC has selected 22 projects plus CPs & SWPs taking into account the relative importance of the above mentioned SPs according to budget considerations given by centres to each project (expressed as a percentage of budget for activities allocated to each priority). The selection of System Priority N° 2 has guided the selection of the sample of associated projects to be reviewed in the present pilot exercise as explained and discussed in the "task B " study carried out in 2008.

In case of co-funded projects with the EU Member States, "load-sharing" arrangements will be considered through EIARD. Possible synergies/integration with EU Member States, Norway and Switzerland, IFAD and other donors should be explored, not simply by adding experts but possibly by agreeing on a division of labour.

Additionally, the review can possibly include other projects funded by EIARD members, which are focused on the same system priority. This would attract additional financial resources from EIARD members, allowing to carry out a more comprehensive review. Possible synergies with the EIARD/FSTP project should also be explored, since its budget has financial resources for joint CGIAR M&E activities (e.g. coordination meetings, communications and stakeholder involvement, monitoring of recommendations up-take, etc.).

More specifically, the experts will assess, according to the criteria to be tested, the relevance, efficiency, effectiveness, synergy and collective action and the IPG/RPG character of the research undertaken of each of the EC supported projects selected for review under the system priority, particularly with regard to the EC support strategy for the CGIAR and to the needs of targeted partners. The exercise has to be regarded as a review rather than a full project evaluation per-se. The consultants need to take a broader look than a single year time frame and a single Centre. In addition, since not all outputs from a particular project are necessarily dependent on EC funding, it might be necessary to examine components of projects that were not directly linked to EC-funding.

During the missions in countries, a visit to some EC rural development projects or projects (co-) funded by Member States or FAO and IFAD and to the local NARS will be included in order to assess the synergies among the results of the research carried out by the Centres and their adoption by the beneficiaries.

2. Selected Theme and Projects

The selected system priority area is :

Priority area 2: Producing more and better food at lower cost through genetic improvements

Priority 2A: Maintaining and enhancing yields and yield potential of food staples

Priority 2B: Tolerance to selected abiotic stresses

Priority 2C: Enhancing nutritional quality and safety

Priority 2D: Genetic enhancement of selected high-values species

The Sample of projects among those co-funded in 2009 by the EC through the "Food Security Thematic Programme for this particular System Priority is the following:

CIAT SBA1: Bean Improvement for the Tropics

CIMMYT (1) CIM13: Conservation, characterization and utilization of maize and wheat genetic resources

CIMMYT CP GCP (66): Trait capture for crop improvement

ICARDA (2) ICA21: ICARDA-CIMMYT Wheat Improvement Program (ICWIP) for Central and West Asia and North Africa

IRRI (1) IRR41: Raising Productivity in Rainfed Environments: Attacking the Roots of Poverty

WorldFish (5) WF59A: Improving the technological foundation for sustainable aquaculture

All the projects selected have at least a 50 % contribution to SP N° 2 (see table 2 on p. 41 of the previous “task B” study carried out in 2008).

3. Methodological aspects

a) Main reference documents to be made available by the Centres:

- ⇒ CGIAR Centres Medium Term Plans 2008-2010
- ⇒ CGIAR Centres external reviews and relevant Cross-Centre and Programme Reviews
- ⇒ CGIAR Centres reports (technical, financial, audit reports, etc.) relating to the projects.

b) Review criteria to be utilised for each selected project of the system priority

- i) **Relevance:** the relevance of a project relates primarily to its design and concerns the extent to which its stated objectives correctly address the identified problems and real needs at two points in time: when the project was designed and at the time of review. This concerns the identification of real (as distinct from perceived) problems or needs and of the correct beneficiaries, and how well the project’s initial design addressed them, as well as other project design features.

Issues:

- ⇒ Whether the intended users and beneficiaries have been appropriately identified, have participated in the project design and their specific and defined needs incorporated
- ⇒ Does the project effectively focus on small-scale farmers’ needs?
- ⇒ Have gender analyses of roles and needs; access and control of resources and access to information relating to the technology/policy research area, been carried out and used to inform project design?
- ⇒ Are dimensions such as social, economic, local and personal producer strategies for food security and the environment taken into account?
- ⇒ Have the policy relevant dimensions and the needs of policy makers been identified and addressed in the project?
- ⇒ Has the project understood the value chain and current market trends for the commodity on which they are researching?
- ⇒ Are the project objectives relevant to current ARD state of the art. Are they complementary and coherent with related activities undertaken elsewhere and do they avoid replicating known research?
- ⇒ Will the project contribute to improving knowledge and techniques, as well as ensuring their adaptation and adoption by the NARS and target groups?
- ⇒ How is the project intended to contribute to the overall objectives of the Centres and to the system priority of the CGIAR as a whole? How does it fit the general policy of the Centre and of the CGIAR?
- ⇒ Overall design strengths and weaknesses including :
 - quality of the Log Frame and how well it has been used as a planning tool.

- clarity and internal consistency of the stated overall objectives, outputs, outcomes and impacts,
- is the impact pathway well specified for the project, and actors and relationships identified at each stage? Assess whether it is plausible.
- whether the outcomes were well-formulated and widely agreed,
- were the assumptions, risks and conditions associated with the project clearly identified at the appropriate levels,
- realism in choice and quantity of inputs,
- overall degree of flexibility and adaptability to facilitate rapid responses to changes in circumstances.

ii) Efficiency: The efficiency criterion concerns how well the various activities transformed the available resources into the intended results (sometimes **referred** to as outputs), in terms of quantity, quality and timeliness. A key question it asks is "were things done right?" and thereby also addresses value-for-money, that is whether similar results could have been achieved more by other means at lower cost in the same time. It includes a focus on the quality of the research from various points of view: scientific, technical, social, environmental, ethical, financial - including possible IPR issues, and policy, etc. It also explores the quality of the day-to day-management.

Issues:

- ⇒ Are women and men involved in technology testing and evaluation
- ⇒ Are the work programme, budget, human resources and timetable, as well as management procedures, adequate to achieve the expected results of the project?
 - management of the budget (including whether resources allocated were utilised as planned in the project descriptions, e.g. geographical areas) ;
 - management of personnel, information, property, etc
 - will the equipment and methods to be employed in the project lead to the expected results?
 - whether management of risk was adequate, i.e. whether flexibility was demonstrated in response to changes in circumstances; e.g. by amending plans.
 - respect for and achievement of deadlines ;
 - do the individual scientists or teams involved have the necessary capabilities to carry out the project and conduct research on the proposed issues?
- ⇒ Are adequate scientific, technical and social partnerships implemented? What are the arrangements for management of partnerships and networks, e.g. agreements, communication and information sharing, funding arrangements and sharing of resources, expectations, developing trust?
- ⇒ Costs and value-for-money : how far the costs of the project were justified by the benefits - whether or not expressed in monetary terms - that they generated, in comparison with similar projects or known alternative approaches, taking account of contextual differences;
- ⇒ Contributions from donors: were they provided as planned, were communications good?
- ⇒ How does the Centre support the projects and ensure the quality control of their activities?
- ⇒ Is the support process provided by the Centre's headquarters and/or local offices of the project, efficient and adapted to its needs?
- ⇒ Are proper monitoring and evaluation systems incorporated, including farmers' perspectives?
- ⇒ Quality of internal CGIAR Centre monitoring; the use of the PMS; internal systems for monitoring outputs, its accuracy and flexibility

iii) Effectiveness: the effectiveness criterion concerns how far the project's results were used or their potential benefits were realised - in other words, whether they achieved the project purpose. The

key question is what difference the project made in practice, as measured by how far the intended beneficiaries really benefited from the products or services it made available.

Issues:

- ⇒ Whether the planned benefits have been delivered and received, as perceived mainly by the key beneficiaries,
- ⇒ The appropriateness of the planned outcomes used in the above assessment to measure achievement of the project purpose; this should include a judgement on how promptly and effectively the Centre management reacted to any changes that occurred following the initial design by amending outcome definitions found no longer to be appropriate ;
- ⇒ Whether behavioural patterns have changed in the beneficiary organisations or groups at various levels; and how far the changed characteristics have produced the planned improvements (e.g. in productivity or ability to generate actions which lead to economic and social development) ;
- ⇒ Extent to which partnerships and networks have integrated and mainstreamed the issues of poverty alleviation, livelihood improvement and end user consultation
- ⇒ What progress has been made in creating and developing multi-stakeholder partnerships and catalysing innovation? Does the research project contribute to an (intended or ongoing) innovation process that is carried forward by private sector firms, farmers, collective organisations in agriculture, NGOs and development agencies?
- ⇒ Is there evidence of joint action among partners? e.g. setting objectives and planning joint activities and methodologies, field collaboration; data sharing, joint publications/presentations; learning events, enterprise development, M&E etc. How are contributions acknowledged?
- ⇒ Whether any shortcomings at this level were due to a failure to take account of cross-cutting or overarching issues such as gender, environment and poverty during implementation ;
- ⇒ Has the project contributed to capacity strengthening among the range of stakeholder organisations and individuals with whom it works? Has this supported the complementarity of NARS and CGIAR centres and strengthened NARS capacities to deliver NPG and RPG?
- ⇒ Is there evidence of sharing results with policy makers? Have policy makers utilised research information to shape decisions?
- ⇒ Whether the research outputs represent added value to existing / new (sub-) regional / national initiatives and are supported by related policies / measures at these levels.
- ⇒ Evidence of sharing knowledge and results with a wide range of audiences at local, regional and international levels. . In this respect, a bibliometric analysis by means of publications lists from the CGIAR Centres is desirable to make the analysis rigorous and transparent for all parties.
- ⇒ Did any unplanned results arise from the activities?

iv) Practical implementation of SPs: a critical review of the 4 subsets of priorities within System Priority N° 2 as described by CGIAR SC secretariat in "System Priorities for CGIAR 2005-2015" in December 2005, should show whether (if and how) they have influenced the project design. A comparison of the relative importance of SP2 to the other 4 SPs should also confirm the meaning of the figures provided by the Centres on their relative allocation of the budget to each one of the 5 SPs. Is it really quantifiable and with what margin of uncertainty? By what mechanism have Centres allocated the % expected contribution of projects to the various SPs? Is this allocation sound and justified?

With the experience gained in the pilot phase of 2009 when SP5 was targeted, this report will also make recommendations addressing not just the centres/projects visited but rather the system's perspective with key general questions such as:

- ⇒ Does the CGIAR system address the research System Priority adequately?

- ⇒ What can be done to improve the performance of the system regarding this particular System Priority?
- ⇒ Does EIARD as a whole, and the EC in particular, fund this System Priority adequately for the impact pathway to be realised satisfactorily?
- ⇒ What changes are needed to improve research output and outcomes regarding this System Priority?
- ⇒ Have the SPs improved project design in the Centres?

v) **Synergy and collective action:** An analysis of synergies and collective action will be conducted to show the links among selected projects with reference to SP2 as a theme both at project level (links with any similar projects even beyond the sampled projects) and globally across the sampled projects and Centres.

This criterion concerns how the system priority is being addressed collectively by the centres in a collaborative and synergistic way, as opposed to in isolation or in competition, or with duplication and overlap. In other words, by the Centres working together, is the whole larger than the sum of the parts? Are the Centres addressing the system priority as a system which adds value, each Centre capitalizing on its comparative advantage and strengths? Is there a genuine partnership between the centres, and with the respective partners? The analysis of this criterion will therefore focus on:

- ⇒ Whether the planned activities are congruent with the system priority, and harmonized between centres so as to avoid overlap or duplication;
- ⇒ Are there collective actions undertaken relating to the system priority according to each Centre's strength and comparative advantages?;
- ⇒ Are there sufficient resources engaged at the Centres to address the system priority adequately in an efficient and effective way?
- ⇒ Are the partnerships in which the Centres are involved relevant, genuine and effective for addressing the particular system priority?
- ⇒ Have results been shared with other project teams working on the same priority – at the same centre/at other centres?
- ⇒ Is there collective learning, adaptation and change of the Centres involved regarding the system priority?;
- ⇒ Are there mechanisms in place to ensure that the system priority is being addressed adequately, including capacity building of partners?
- ⇒ Whether there any gaps left in addressing the system priority;

vi) **International or regional public goods character of the research undertaken:** are the **research** activities that are undertaken in the selected projects resulting in the production of important international or regional public goods, as opposed to national or local public or private goods benefiting only a single country or part of a country? The analysis of this criterion will focus on:

- ⇒ Whether sufficient attention has been given to the IPG/RPG character of the research in its design and implementation, allowing important spillovers across several countries beneficial to both public and private actors;
- ⇒ Are the public (research) goods produced non rival and non excludable?;
- ⇒ Whether the private sector or other private organizations which are active in the countries concerned could as well have performed the research for their own benefit, but did not do so because the Centre(s) undertook the research;

- ⇒ Are the private markets for the technologies produced absent, incomplete or not solvent because of lack of purchasing power of large segments of the farming population?;
- ⇒ Are economies of scale and scope realized in doing the research because individual countries or groups of countries are unable to mobilize sufficient critical mass for lack of funds or a lack of scientists or institutional infrastructure?
- ⇒ Are the Intellectual Property Rights respected and handled in an adequate manner, in line with the existing CGIAR guidelines (see CAS-IP or the Common Advisory Service for Intellectual Property at the CGIAR).
- ⇒ Are there any ethical violations or is a code of ethical conduct not respected (see in this respect the SC guidelines, which are being finalized).

vii) Impact, sustainability and visibility of the EC co-financing: these important **issues** relate to the longer-term effect of the projects on beneficiaries. Though difficult to fully appraise through a short-term mission, some indication should be stated on these issues:

- ⇒ Whether the research has contributed to enhancement of economic opportunities and other benefits for women and men?
- ⇒ Is the research likely to contribute to food security and rural poverty alleviation (MDG-1), other relevant MDGs (for example MDG-7) and sustainable development?

viii) Performance rating: review teams should include in their assessments an overall performance **rating** for each of the above five review criteria, on the basis of the following scale:

- ⇒ highly satisfactory: fully according to plan or better ;
- ⇒ satisfactory: on balance according to plan, positive aspects outweighing negative aspects ;
- ⇒ less than satisfactory: not sufficiently according to plan, taking account of the evolving context; a few positive aspects, but outweighed by negative aspects;
- ⇒ highly unsatisfactory: seriously deficient, very few or no positive aspects.

Each rating should be stated as part of the conclusions for each of the three criteria.

The review exercise requires an examination of project outputs in terms of reports and technical papers. Therefore the review teams should also examine the quality of such reports.

4. Reporting

- a) **Reports and presentations:** for each selected project, and for the system priority, a briefing and a debriefing of the draft report must be presented to the EC, in order to finalise the review report
- b) **Language:** English
- c) **Date of delivery:** draft report within 15 days after the mission, final report within 10 days after reception of the comments from the EC (due 60 days after reception of the draft report)
- d) **Number of copies required:** 3 copies of the draft reports and 3 copies of the final reports
- e) **The main text** of a review report should not exceed 20 pages per project reviewed, plus Annexes, plus an Executive Summary of no more than 2 pages with fully cross-referenced findings and recommendations.
- f) **The main sections** of the review report for **each selected project** will be as follows :

1- Executive Summary: a tightly drafted, to the point and free-standing Executive Summary is an essential component. It should be short, no more than two pages. It should focus mainly on the key purpose or issues of the review, outline the main analytical points, and clearly indicate the main conclusions, lessons learned and specific recommendations. Cross-references should be made to the corresponding page or paragraph numbers in the main text that follows.

2- Main text: the main text should start with an introduction describing, first, the projects to be reviewed pertaining to the system priority and, second, the review objectives. The body or core of the report should follow the six review criteria mentioned above, describing the facts and interpreting or analysing them in accordance with the key questions pertinent to each criterion.

3- Conclusions and recommendations: these should be the subject of a separate final chapter. Wherever possible, for each key conclusion there should be a corresponding recommendation. The key points of the conclusions will vary in nature but will often cover aspects of the key review criteria (including performance ratings - see above), that is:

- ⇒ Relevance : whether the design of the project was originally, and still is, sound as regards targeting the real needs and problems of the right beneficiaries;
- ⇒ Efficiency : whether the same results could have been achieved at lower costs; or whether there might have been different, more appropriate ways of achieving the same results;
- ⇒ Effectiveness : whether the planned benefits were in fact received, whether the beneficiaries' behavioural patterns changed, whether neglect of cross-cutting issues affected the achievement of the project purpose;
- ⇒ Practical implementation of SPs : whether they have influenced project design, is the % allocation of projects to the SP sound and justified, is the SP adequately addressed by the projects and the System;
- ⇒ Synergy and collective action : whether the system priority is adequately addressed by the Centres taken together, with collective action and synergy, avoiding overlap and duplication and gaps in the research;
- ⇒ IPG/RPG character of the research : whether the outputs and outcomes of the research are truly IPG/RPG with important spillover effects and economies of scale and scope.

Recommendations should be as realistic, operational and pragmatic as possible; that is, they should take careful account of the circumstances currently prevailing in the context of the project, and of the resources available to implement them. They could concern policy, organisational and operational aspects. Recommendations should also possibly contribute to the design of the future CGIAR Results Framework and Mega-Programmes.

4- Annexes: the report should include the following annexes:

- ⇒ The Terms of Reference of the review
- ⇒ The names of the evaluators and their companies (CVs should be shown, but summarised and limited to one page per person)
- ⇒ Map of project area implementation,
- ⇒ Calendar of visit and list of persons/organisations consulted
- ⇒ Literature and documentation consulted
- ⇒ Other technical annexes (e.g. statistical analyses)
- ⇒ 1-page DAC summary per project

The draft report will be sent for comments to the relevant Centre by each team of reviewers before the debriefing in Brussels. The reviewers will be responsible for addressing the Centre's comments on the draft report if appropriate. The responses of the Centres should be attached to the reports as an annex. The final reports will be published and posted as appropriate on the EuropeAid Web.

If necessary, an additional confidential report may be submitted to the EC for its consideration.

g) **The main sections** of the specific review report addressing the **selected system priority** issue :

1- Executive Summary: a tightly drafted, to the point and free-standing Executive Summary is an essential component. It should be short, no more than two pages. It should focus mainly on the key purpose or issues of the review, outline the main analytical points, and clearly indicate the main conclusions, lessons learned and specific recommendations. Cross-references should be made to the corresponding page or paragraph numbers in the main text that follows. See format in annex 3.

2- Main text: the main text should start with an introduction describing, first, the projects to be reviewed pertaining to the system priority and, second, the review objectives. The body or core of the report should elaborate on the findings concerning Systems Priorities per project sampled and their link, if any, describing the facts and interpreting or analysing them in accordance with the key questions mentioned above in section iv) Practical implementation of SPs.

3- Conclusions and recommendations: these should be the subject of a separate final chapter. Wherever possible, for each key conclusion there should be a corresponding recommendation. Recommendations should also possibly contribute to the design of the future CGIAR Results Framework and Mega-Programmes.

5. Expertise required and contractor's requirements

ECART will submit to IFAD up to four Curricula Vitae for each required expert per project, ranked by order of preference. The European Commission will be duly informed.

Experts will have debriefing meetings at the European Commission in Brussels, before and after their mission.

The contractor will have to provide, for each selected project, **two high level experts:**

- One specialised in the scientific area of the project
- One specialised in the assessment of economic and social impact of agricultural research projects

In addition, one of the two experts should have knowledge on environmental issues.

In addition, an **overall team leader** for the system priority must be designated among the experts.

Criteria for selecting experts are:

- Strong experience in monitoring and evaluation of ARD projects
- Strong background in the socio-economic approaches for assessing the impacts of ARD projects
- Significant background in management of scientific projects
- Significant experience in environmental issues.
- Good knowledge of the CGIAR system, without any current commitment in Centres management (e.g. Board member) or projects

Criteria for selecting the team leader are:

- Having at least one year of experience as reviewer of EC funded CGIAR projects
- Having proven experience with the CGIAR system and its M&E
- Good leadership capabilities and experience of working in a team
- Being familiar with ARD in Europe and in developing countries

For each project to be reviewed, a short-term mission is foreseen, combining:

- a visit to the CGIAR Centre in charge of its implementation and
- a field visit to a characteristic component of the project on the following basis (location to be proposed by the Contractor):
 - Outside the country of location of the Centre's headquarters,
 - Preferably in one of the priority countries of intervention of the "Food Security / Food aid" budget line, or
 - Possibly in a country where significant EC funded rural development projects, or projects (co-) funded by Member States, FAO or IFAD, related to the CGIAR visited project theme, are implemented.

In each country, a visit to the EC Delegations, to the local NARS and when relevant to the above mentioned development projects will be included during the missions.

The experts who reviewed the projects need to meet together after their field visits, under the direction of the team leader, and/or liaise by email as needed under the direction of the team leader, to address together the questions pertaining to the system priority of the CGIAR under review, discuss together the review criteria as they relate to the system priority, and come to joint conclusions and recommendations. The team leader should make a separate report regarding the exercise: the possible value added, constraints encountered and suggestions for improvement of the review process and TOR.

6. Budget

The contractor is invited to send to IFAD a technical and a financial offer. The indicative amount for the review of the selected projects (Activity 1) is € 400,000. The level of effort required by each selected expert is 25 days, except for the team leader, where 35 days is required.

The contractor will have to complete the work, i.e. to send the final reports to IFAD, within a nine-month period after signature of the contract.

Annex 2. The names of the evaluators and their institutions

2.1 Curriculum vitae. Prof. Dr. Derek Russell

Personal data

Name: RUSSELL, Derek
Birthday: 26 April 1950
Place of birth: Arbroath, Scotland, United Kingdom
Nationality: British and New Zealand
Position: Principal Scientist, Natural Resources Institute, University of Greenwich, UK
Adjunct Professor, Genetics Dept, University of Melbourne, Australia

Education

Ph.D. Entomology, Auckland University (1986)
M.A. Economics, Aberdeen University (1975)
B.Sc. (Hons) Zoology, Aberdeen University (1974)

Expertise

Management of scientific aid programmes, Insecticide resistance management, Agricultural science programme evaluations

Employment

2002- present Principal Scientist, Sustainable Agriculture Group, Natural Resources Institute, UK working as Adjunct Professor, Genetics Department, Melbourne Univ, Australia
1999-2001 Principal Scientist, Head of Pest Biology and Management Section, Agricultural Resources Management Department, NRI, UK
1996-99 Higher Scientific Officer, Chemical Ecology Group, Pest Management Department, NRI, UK
1992-95 Seconded as Assistant Professor of Biology, American University in Cairo, Egypt
1987-92 Sci. Officer then Higher Sci. Officer, Pheromone Application Section, NRI, UK
1986-87 Post Doc fellow in entomology INRA Avignon, France
1985-86 Junior Lecturer in zoology - Victoria Univ. of Wellington, New Zealand

Experience

Leadership: Project leader in multidisciplinary and multi-country scientific aid projects

- Public Sector Co-ordinator - International PPP Collaboration on Insect Management in Brassicas in Asia and Africa (CIMBAA) USA, UK, Australia, Taiwan, India (2003-present)
- Project leader EU Framework-5 Inco Dev multi country project (UK, Denmark, France, India, China, Pakistan) 'Assessment of the environmental and agronomic appropriateness of Bt transgenic cotton in small producer IPM systems in China' (COTRAN) (2001-2005)
- Project leader for Common Fund for Commodities programme multi-country programme (UK, India, China, Pakistan) in Insecticide Resistance management in cotton (2002-6).
- Programme review, Reviewer of the CIRAD (France) cotton programme (2007).

Technical specialism:

- Insect Resistance management specialist – EU Framework 5 project leader for Bt cotton in China and Indian Insect Resistance Management Principal Investigator (2001-5)
- Crop/pest simulation modeling – 8 years in Egypt as a project leader for UK Dept of International Development and the American University in Cairo.
- Budgeting/ project management – running all budgeting and the project management for the above programmes for the last 20 years.

- Author of simulation models for plant/insect population development (major component of aid projects in cotton and brassicas for which was principal investigator in Egypt and India.

2.2. Curriculum vitae Dr. Vladimir Verner

Personal data

Name: VERNER, Vladimir
Birthday: 1976
Place of birth: Broumov, East Bohemia, (former) Czechoslovakia
Nationality: Czech Republic
Position: Professor Assistant, Institute of Tropics and Subtropics, Czech Univ of Life Sciences, Prague, Czech Republic

Education

Ph.D. Tropical and Subtropical Agriculture (2007)
Czech Univ of Life Sciences Prague, Czech Republic
University of Hohenheim, Germany (S/E)
M.Sc. Economics and Management (2002)
Czech Univ of Life Sciences Prague, Czech Republic

Expertise

Farming and rural systems development, household economy, environmental indicators, project and program management, team leader.

Employment

2005-present Professor Assistant, Institute of Tropics and Subtropics, Czech Univ of Life Sciences Prague, Czech Republic
08-11/2010 UNDP, Technical Assistant. M&E of the Czech Republic Official Development Assistance projects in Dorno Govi province, Mongolia

Experience

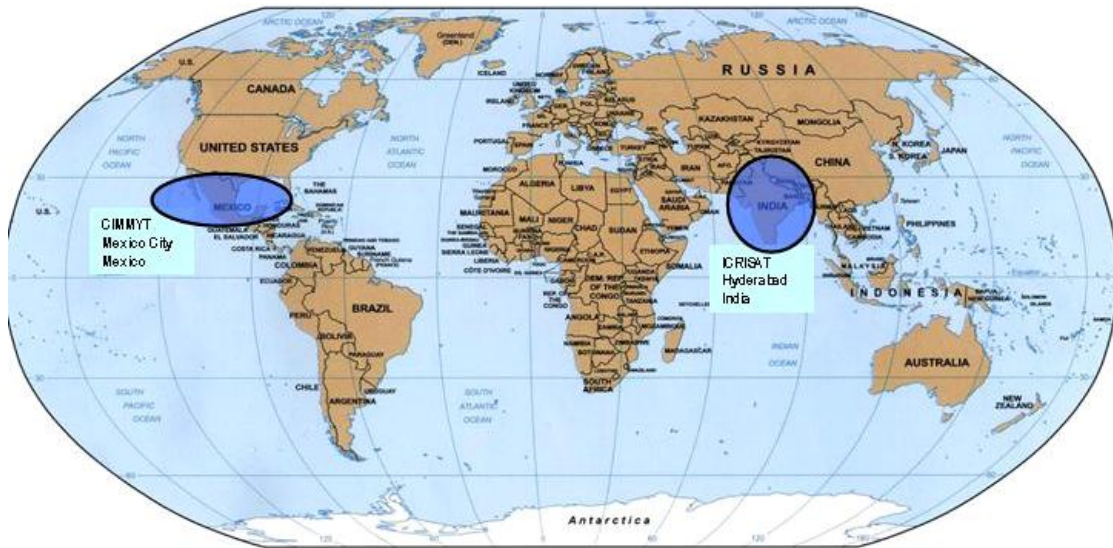
Leadership:

- Project leader within the bilateral Czech ODA: Fruit orchards—Ethnobotany, economic performance and market chain development in semi-arid areas, Southern Kyrgyzstan (2008-10)
- Project member, responsible for farming and rural systems economics, within the bilateral Czech ODA: Natural resource management in the buffer-zone of protected area, Central Vietnam (2006-09)

Technical specialism:

- Farming and rural systems development within the framework of R&D project in tropics and subtropics (2006-2010)

Annex 3. Map of mission locations



Visits were made to CIMMYT headquarter in Mexico City, Mexico, and, within India, to ICRISAT and Syngenta in Hyderabad, University of Agricultural Sciences in Bangalore, Tamil Nadu Agricultural University in Coimbatore, the Genetics Department, Indian Agricultural Research Institute and to the Indian Council for Agricultural Research HQ, New Delhi.

Annex 4. Calendar of the visit and list of persons/organizations consulted

4.1. Calendar of the visits (2010)

- CIMMYT HQ, Mexico City, 22-27 Nov
- ICRISAT HQ, Hyderabad, India, 28 -30 Nov, 3 Dec
- Univ of Agricultural Sciences, Bangalore, India, 1 Dec
- Tamil Nadu Agricultural University, Coimbatore, India, 2 Dec
- Indian Institute for Agricultural Sciences, New Delhi, 4 Dec
- Indian Council for Agricultural Research, 7 Dec

Travel itinerary in details

Arrivals:		
Prof. Dr. Derek Russell	Monday, Nov 22	5.00 am, AS 249 from Los Angeles
Dr. Vladimir Verner	Tuesday, Nov 23	7.45 pm, KL 685 from Amsterdam
Monday, Nov 22		
09:30-10:30	Revision of the agenda with Jean-Marcel Ribaut and discussion about the logistics for the trip to India	Guest house
Tuesday, Nov 23		
08:30-10:00	Introduction to SP1 activities (GCP-64) with Jean-Christophe Glaszmann – CIRAD	ABC seminar room; phone conference
10:00-12:00	General overall presentation of the GCP plus discussion with Jean-Marcel Ribaut	ABC seminar room
12:30-13:30	Lunch	Cafeteria
14:00-15:00	Introduction to the GIS and phenotyping atlas with Glenn Hyman	ABC seminar room; phone conference
15:00-16:00	Visit to the Gene Bank and introduction to the wheat reference set with Tom Payne	GCP offices
16:00-16:30	Genotyping of wheat reference set with Susanne Dreisigacker	ABC seminar room
16:30-17:00	Biometrics and statistical tool development with Jose Crosa	ABC seminar room
19:00-21:00	Dinner	
Wednesday Nov 24		
8:30-9:30	General overall presentation of the GCP plus discussion with Jean-Marcel Ribaut	ABC seminar room
9:30-10:30	Overview of SP3 activities with Xavier Delannay	ABC seminar room
10:30-12:30	Overview of SP3 EC projects (GCP-66) with Xavier Delannay	ABC seminar room
12:30-13:30	Lunch with Jean-Marcel Ribaut and Larry Butler	Cafeteria
14:00-15:30	Introduction to the Integrated Breeding Platform (GCP-67) and presentation of the Integrated Field book with Graham McLaren	ABC seminar room
15:30-16:30	Introduction to the capacity building effort (GCP-68) with Jean-Marcel Ribaut	ABC seminar room
16:30-17:30	Jeffe Ehlers, California River side. Project G4008.13/CI-3: Improving drought tolerance phenotyping in cowpea. Link with the Tropical Legume initiative	CIMMYT video conference room
19:00-21:00	Dinner	
Thursday, Nov 25		
8.00-9.00	Michel Ragot, review and advisory panel member for SP3 projects and chair of the Scientific and Monitoring Advisory committee for the IBP	ABC seminar room; phone conference
9:00-10:30	Matthew Reynolds, CIMMYT Project G3008.08/CI-6: Breeder-friendly high-throughput phenotyping tools to select for adaptive traits in drought environments. Other GCP wheat activities	Matthew Reynolds office at CIMMYT
10:30-12:00	Jorge A Acosta-Gallegos, INIFAP Project G4008.11: Dry bean improvement and marker-assisted selection for diseases and abiotic stresses in Central America and the Caribbean	ABC seminar room

12:30-13:30	Lunch with Jean-Marcel Ribaut, Jorge A Acosta-Gallegos and his team	Cafeteria
14:00-15:30	Product Management with Larry Butler	ABC seminar room
15:30-16:30	Impact assessment and Ex ante analysis with Larry Butler	ABC seminar room
18:00-19:00	Abdelbagi M Ismai, IRRI Project G4008.16 : Speeding the development of salt-tolerant rice varieties through marker-assisted selection and their dissemination in salt-affected areas of Bangladesh	ABC seminar room; phone conference
19:30-21:30	Dinner	
Friday, Nov 26		
09:00-10:00	Delivery Plan Kit with Larry Butler	ABC seminar room
10:00-12:30	PI: Jurandir Vieira Magalhaes, EMBRAPA Project G3007.04/CI-7 : Tailoring superior alleles for abiotic stress genes for deployment into breeding programmes: a case study based on association analysis of Alt _{SB} , a major aluminum tolerance gene in sorghum PI: Robert Schaffert, EMBRAPA Project Assessment of the breeding value of superior haplotypes for Alt _{SB} , a major Al tolerance gene in sorghum: linking upstream genomics to acid soil breeding in Niger and Mali (ALTFIELD) Introduction to the comparative genomics challenge initiative	ABC seminar room; phone conference
12:30-13:30	Lunch	Cafeteria
14:00-14:30	IP and public goods with Fred Okono	ABC seminar room
14:30-15:00	Workflow system with Fred Okono	ABC seminar room
15:00-17:00	Project Management with Jean-Marcel Ribaut	ABC seminar room
17:00-18:00	Wrap-up session	ABC seminar room
Saturday, Nov 27		
8:30-11:00	Report writing, Departure to Juarez International Airport	
14:54 GTM-6	Departure from Juarez International Airport to New York (DL 484)	
23:00 GTM-5	Departure from JFK International Airport to Dubai (EK 202)	
22:00 GTM+4	Departure from Dubai International Airport to Hyderabad (EK 524)	
Monday, Nov 29		
5:00	Arrival of Derek Russell and Vladimir Verner to ICRISAT guesthouse	
11:00-11:20	Meeting with William Dar, ICRISAT Director-General	DG's Office at ICRISAT
11:20-12:00	Meeting with David Hoisington, ICRISAT DDG	DDG's Office at ICRISAT
12:00-13:00	Lunch with ICRISAT representatives	
13:00-14:00	BS Vivek, CIMMYT Project G4008.56 : Maize project	The Great Lakes Conference Hall (307)
15:00-16:00	Field trip and interaction with Syngenta, IS Singh (collaborator from Krishnidhan Seeds, Jalna and small medium size company will join the discussions)	Maize project and Syngenta fields
20:00	Dinner	
Tuesday, Nov 30		
9:00-10:00	ICRISAT video with Rajeev Varshney	SAT Venture
10:00-11:00	Rajeev Varshney, Introduction and updates on theme Comparative and Applied Genomics (CAG) of GCP	The Great Lakes Conference Hall (307)
11:00-11:30	Rajeev Varshney, visit to Centre of Excellence in Genomics (CEG)	CEG
11:30-12:00	Oscar Lizarazu, meeting, GTL-Biotechnology	Oscar Lizarazu office
12:00-13:30	Lunch with ICRISAT representatives	
13:30-14:00	CLL Gowda, meeting, GTL-Crop improvement	C Gowda office
14:00-14:30	Hari Upadhyaya, meeting, visit to Genebank, discussion on Reference set collections, their development and use by NARS partners	
14:30-16:30	Pooran Gaur, Krishna Murthy, Rajeev Varshney, Serah Songok Project G4008.12/CI-2 : Chickpea project	The Great Lakes Conference Hall (307)
16:30-17:00	Vincent Vadez, Krishna Murthy, visit to Rain-out Shelter (ROS)	
19:00	Dinner	

Wednesday, Dec 1		
5:30-6:30	Transportation to airport from ICRISAT campus	
7:50	Departure from Hyderabad to Bangalore	
9:15	Arrival to Bangalore airport	
9:15-10:15	Transportation from Bangalore airport to UAS Bangalore	
11:00-13:00	Drs Sheshashayee (UAS), Pooran Gaur and Rajeev Varshney (ICRISAT), KP Viswanatha (Hiryeu) discussion on chickpea project	Sheshashayee office
13:00-14:00	Lunch with UAS representatives as well as with Prof. Leon Kochian (University of Cornell, USA)	
14:00-14:30	Sheshashayee (UAS), visit to phenotyping facilities	
14:30-17:00	Shailaja Hittalamani (UAS), Arvind Kumar and Amelie Henry (IRRI), discussion on rice project	Department of Agricultural Economics
17:00	Departure to Hyderabad (Rajeev Varshney, Pooran Gaur) Departure to Bangalore Hotel (EC reviewers, IRRI staff)	
18:00-22:00	Report writing, Dinner	
Thursday, Dec 2		
7:00-8:00	Transportation from hotel to airport (EC reviewers, IRRI staff)	
9:25	Departure from Bangalore airport	
10:30	Arrival to Coimbatore (IT 4457)	
10:30-11:30	Transportation from airport to TNAU campus	
11:30-17:00	RC Babu, S Robin, IRRI staff, discussion on rice project, visit to Department of Rice Research	TNAU Campus
17:00-18:00	Departure from TNAU to Coimbatore	
19:40	Departure from Coimbatore airport	
24:00	Arrival to Hyderabad (SG 238)	
Friday, Dec 3		
8:30-9:30	Wrap-up discussions with Jean-Marcel Ribaut	ICRISAT conference hall, phone conference
9:30-11:00	A.Ismail, IRRI Discussion on rice project	ICRISAT conference hall, phone conference
11:00-12:00	Abhishek Rathore Presentation and discussion on iMAS project	ICRISAT conference hall, phone conference
12:00-13:00	Lunch	Cafeteria
13:00-14:00	Trushar Shah Presentation and discussion on IBP project	ICRISAT conference hall, phone conference
14:00-14:30	Wrap-up discussion with Rajeev Varshney	ICRISAT conference hall
14:30-19:00	Preparation of Report	
19:00	Dinner	
Saturday, Dec 4		
6:30-8:00	Transportation from Hyderabad to airport	
9:10	Departure from Hyderabad (KF 828)	
11:20	Arrival to Delhi International airport	
13:00-15:30	IARI Genetics Dept: K.V. Prabu GCP Wheat Challenge Initiative (2008-13) NRCP: N.K.Singh Pigeon Pea genomics (2009-13)	IARI, Pusa Campus IARI, Pusa Campus
16:00-20:00	Wrap-up discussion between consultants	Hotel Bharat Continental
21:00	Dinner	
Sunday, Dec 5		
4:30-5:00	Transport to airport (Vladimir Verner)	
7:20	Departure from Delhi airport to Moscow, SU 536 (Vladimir Verner)	
9:00-17:00	Preparation of Report (Derek Russell)	Hotel Bharat Continental
Monday, Dec 6		
	Non-Review work under other funding (Derek Russell)	
Tuesday, Dec 7		
10:00-11:00	Indian Council for Agricultural Research S.Datta (DDG Crop Science) NARS linkages with GCP in India	TERI Univ. Complex
11:00 – end Day	Non Review work under other funding (Derek Russell)	

Wed, Dec 8	
9.30-11.00	Australian High Commission, New Delhi Sean Starmer, Advisor, Science and Technology Kuhu Chatterjee, Australian Centre for International Agricultural Research – Linkages to GCP in wheat research
11.00 – end of day	Non-review work under other funding (Derek Russell)
Thursday, Dec 9	
All day	Non-Review work under other funding (Derek Russell)
21.00-22.00	Transport to airport (Derek Russell)
23.45	Departure from Delhi Airport to Melbourne (Derek Russell)

4.2 List of persons met

Surname, Given name(s)	Position	Program/Project/Activity	Organization	Meeting in/at/via
Acosta-Gallegos, Jorge A.		G4008.11	INIFAP	Mexico City
Babu, Chandra R.	Professor		TNAU, Centre for Plant Molecular Biology	Coimbatore
Butler, Larry		Impact assessment and ex-ante analysis, Delivery plan kit	CIMMYT, GCP	Mexico City
Crosa, Jose		Biometrics and statistical tool development	CIMMYT, GCP	Mexico City
Chatterjee, Kuhu	Regional Manager – S.Asia	Australian Centre for Interantional Agricultural Research -Research Programmes	AISRF	New Delhi
Dar, William D.	Director General		ICRISAT	Hyderabad
Datta, Swapam	Deputy Director General, Crop Science	Linkages between ICAR and GCP	ICAR	New Delhi
Delannay, Xavier	SP3 Leader		CIMMYT, GCP	Mexico City
Dreisigacker, Susanne		Genotyping of wheat reference set	CIMMYT, GCP	Mexico City
Ehlers, Jeffe	Plant Breeding	G4008.13/CI-3	Univ of California River Side, College of Natural and Agricultural Science	Mexico City (video conference)
Gaur, Pooran M.	Principal Scientist	Chickpea Breeding	ICRISAT	Hyderabad
Glaszmann, Jean-Christophe	SP1 leader		CIRAD	Mexico City (phonecall)
Gowda, Laxmipathi C.L.	Leader	Global Theme	ICRISAT, Crop Improvement and Management	Hyderabad
Henry, Amelia	Postdoctoral Fellow		IRRI, Crop and Environmental Sciences Division	Bangalore, Coimbatore
Hittalmani, Shailaja	Professor, Head	Marker Assisted Selection Lab	UAS, Department of Genetics and Plant Breeding	Bangalore
Hoisington Dave	Deputy Director General Research		ICRISAT	Hyderabad
Hyman, Glenn		GIS and Phenotyping Atlas		Mexico City (phonecall)
Ismail, Abdelbagi M.		G4008.16	IRRI	Mexico City

Ismail, Abdel	Senior Plant Physiologist	Flood-tolerant and salt-tolerant rice	IRRI	(phonecall) Hyderabad
Kochian, Leon V.	Courtesy Professor		Cornell University	(phonecall) Bangalore
Kumar, Arvind	Scientist	Drought Breeding	IRRI, Plant Breeding, Genetics, and Biotechnology Division	Bangalore, Coimbatore
Magalhaes, Jurandir V.		G3007.04/CI-7	EMBRAPA	Mexico City (video conference)
McLaren, Graham	SP4 Leader	Integrated Breeding Platform (GCP-67), Integrated Field Book	CIMMYT, GCP	Mexico City
Murthy, Krishna L.	Scientist	Chickpea project	ICRISAT	Hyderabad
Okono, Fred		IP and public goods, Workflow system	CIMMYT, GCP	Mexico City
Payne, Tom		Genebank and wheat reference set	CIMMYT, GCP	Mexico City
Prabu, K.V.	Professor, Head	GCP Wheat programme	IARI, Genetics Dept	New Delhi
Ragot, Michel		Scientific and Advisory Committee for the IBP		Mexico City (phonecall)
Rathore, Abhishek	Scientist	Global Theme 1- Biotechnology	ICRISAT, Biometrics	Hyderabad
Reynolds, Matthew	Head	G3008.08/CI-6	CIMMYT, Wheat Physiology	Mexico City
Ribaut, Jean-Marcel	Director		CIMMYT, GCP	Mexico City, Hyderabad (phonecall)
Riera-Lizarazu, Oscar	Leader	Global Theme 1- Biotechnology	ICRISAT, Crop Physiology	Hyderabad
Robin, S.	Professor	Rice Molecular Project	TNAU, Department of Rice	Coimbatore
Samiyappan, Ramasamy	Director		TNAU, Centre for Plant Molecular Biology	Coimbatore
Schaffert, Robert		AI Tolerance Gene in Sorghum	EMBRAPA	Mexico City (video conference)
Selvaray, K.N.	Professor, Head		TNAU, Department of Trade and Intellectual Property	Coimbatore
Shah, Trushar	Scientist	Global Theme 1- Biotechnology	ICRISAT, Bioinformatics	Hyderabad
Sheshashayee, Madavalam S.	A.Professor		UAS, Crop Physiology	Bangalore
Singh, N.K..	Leader	Pigeon Pea - Genomics	National Centre for Plant Genetic Resources	New Delhi
Singh, Raghvendra Pratap	Head	Product Development Corn	Syngenta, Seeds Division	Hyderabad
Songok, Serah C.	Fellowship	Genetic diversity in pigeonpea	ICRISAT	Hyderabad
Starmer, Sean	Sen.Advisor	Science and technology	Australian High Commission	New Delhi
Upadhyaya, Hari	Principal Scientist		ICRISAT, Genebank	Hyderabad
Vadez, Vincent	Principal Scientist	Global Theme 1- Biotechnology	ICRISAT, Crop Physiology	Hyderabad
Varshney, Rajeev K.	Principal	SP2 Leader, Genomics	ICRISAT, CEG, Applied	Hyderabad,

Vishwanath, K.P.	Scientist Professor	towards Gene Discovery AICRP on Arid Legumes	Genomics UAS, Plant Breeding	Bangalore Hyderabad
Vivek, Bindiganavile S.	Senior Maize Breeder		CIMMYT (C/o ICRISAT)	Hyderabad

Annex 5. Literature and documentation consulted/available

Documents consulted:

Beversdorf, W., Palenberg, M and Thompson, J. (2008): Report of the First External Review of the Generation Challenge Program. CGIAR Science Council and CGIAR Secretariat (March 2008). 35 pages.

Esperanza, V-I, Alpuerto, B, Norton, G., Alwang, J and Ismail, A. (2009): Economic impact analysis of marker-assisted breeding for tolerance to salinity and phosphorous deficiency in rice. *Review of Agricultural Economics* 31 (4): 779-792 DOI: 10.1111/j.1467-9353.2009.01466.x

Internet address of the CGIAR Generation Challenge Programme: www.generationcp.org

Internet address of project full description (MTP 2008-10):
<http://www.generationcp.org/UserFiles/File/MTP%202008-2010—GenChP2final.pdf>

Medium Term Plans (Phase II): available online at <http://www.generationcp.org/brochure.php#MTPs>
GCP Medium Term Plan 2009-11 (Oct 2008): GCP 120 pages
GCP Medium Term Plan 2010-12 (Dec 2009): GCP 113 pages
GCP Medium Term Plan 2011-13 (July 2010): GCP 79 pages

GCP Transition Strategy: Transition strategy 2011-13 (May 2010). GCP 23 pages.

GCP 2009 Annual Report: 94 pages. Available online at <http://www.generationcp.org>

GCP Sub-Programme-3 Individual project annual reports (most recent – 2009 or 2010). For copies e-mail GCP management at generationcp@cgiar.org

Annex 6. Logframe Sub-Programme-3 ex MTP 2009-11

LOGFRAME Sub-Programme-3 from GCP Medium Term Plan 2009-11

Project 3: Trait capture for crop improvement				
Theme 1: Characterisation of segregating populations and identification of genomic regions for plant breeding				
Output 3.1. Enhancing groundnut (<i>Arachis hypogaea</i> L) genetic diversity and speeding its utilisation in breeding for improving drought tolerance <ul style="list-style-type: none"> • Commissioned: G4008.49 • 2008–2009 • LI/PI: ISRA/O Ndoye 		Groundnut breeders and breeding programmes in Bolivia (PROINPA), Brazil (EMBRAPA) and Senegal (ISRA)	New sources of diversity characterised and used as prebreeding sources of drought tolerance	More diversity and germplasm available for groundnut breeders
Output target 2008	At least 700 Bolivian landraces, two populations of chromosome segment substitution lines and backcross inbred lines available			
Output target 2009	Distribution of new sources of diversity to partners, and drought phenotyping in Senegal			
Output 3.2. Association mapping of downy mildew resistance in elite maize inbred lines in Thailand <ul style="list-style-type: none"> • Commissioned: G4007.04 • 2007–2009 • LI/PI: BIOTEC/C Phumichai 		Maize breeding community in Thailand (KU; NSFCRC)	Backcross populations and new lines available for breeding, and new maize varieties resistant to powdery mildew developed	Maize varieties with improved resistance to downy mildew available to farmers in the Southeast Asia
Output target 2008	Maize inbred lines with resistance to powdery mildew identified; resistant maize inbred lines genotyped			
Output target 2009	Haplotypes for selected candidate genes identified; a set of indicative DNA markers available for allele discrimination and MAS			
Output 3.3. Tailoring superior alleles for abiotic stress genes for deployment in breeding programmes: association analysis of <i>Alt_{SB}</i>, a major aluminium tolerance gene in sorghum <ul style="list-style-type: none"> • Competitive: G3007.04 • 2007–2009 • LI/PI: EMBRAPAJ Magalhaes 		Sorghum breeders and breeding programmes in Niger and other countries facing soil acidity problems	Superior <i>Alt_{SB}</i> haplotypes identified by association mapping, and pre-breeding near-isogenic lines (NILs) carrying different <i>Alt_{SB}</i> haplotypes used in breeding programmes	Improvement of breeding efficiency in sorghum under acid soil conditions
Output target 2008	A diverse sorghum collection phenotyped for Al tolerance and genotyped at <i>Alt_{SB}</i> , superior <i>Alt_{SB}</i> haplotypes identified			
Output target 2009	A set of <i>Alt_{SB}</i> haplotype-specific markers identified and easy-to-use SNP genotyping assays developed			
Output 3.4. Making Latin America potato diversity available for Africa <ul style="list-style-type: none"> • Commissioned: G4008.15 • 2008–2009 • LI/PI: INIA–Uruguay /F Vilaro 		Potato breeders and breeding programmes in the Southern Cone of Latin America, and in Mozambique and Malawi	New breeding tools as DNA-based markers used in NARS in Latin America and Africa to select for key resistance traits, advanced germplasm disseminated to less-developed countries, and capacity-building and expertise of breeding programmes improved	New and more sustainable varieties deployed to resource-poor farmers in Latin America and Africa

Output target 2008	Molecular markers used to monitor the presence of key resistance genes in elite breeding stocks; conversion of short-day adapted germplasm into long-day adapted; and germplasm exchanged			
Output target 2009	Elite germplasm phenotyped for drought tolerance and markers developed for priority resistance traits (eg, late blight, potato tuber moth, <i>Diabrotica</i> , bacterial wilt, potato leaf-roll virus)			
Output 3.5. Field evaluation of wheat-barley introgression lines under different water regimes <ul style="list-style-type: none"> Focus: G4007.23 2008–2009 LI/PI: ARI-HAS/M Molnár-Láng 		Winter wheat breeders facing drought, salt or AI toxicity problems	Wheat-barley translocation lines with drought, salinity and AI toxicity tolerance available to winter wheat breeders	New sources of tolerance to drought, salt and AI tolerance for wheat breeding
Output target 2008	Wheat genetic stocks multiplied and made available to project partners			
Output target 2009	Wheat genetic stock (at least 20 addition, substitution and translocation lines) with chromosomes originating from barley identified using GISH and physically mapped using SSR markers; and effects on drought, salt and AI toxicity tolerance evaluated			
Output 3.6. Seed smoke treatment to favour germination under water-stressed conditions <ul style="list-style-type: none"> Focus: G4007.24 2008–2010 LI/PI: ARI-HAS/E Balazs 		Molecular geneticists and wheat molecular breeders	Genes responsible for the action of smoke compounds on germination identified, mode of action established, and active compound isolated and tested	Effects of smoke compounds on germination better understood and used for the development of molecular-based smoke technologies for crop germination and weed control
Output target 2009	Differentially expressed genes responsible for smoke action identified; pattern of smoke-induced genes expressed in maize described			
Output target 2010	Genes involved in smoke action, amino acid sequence of the clones, domain organisation of the candidate proteins, and promoter sequences and organisation of the genes described			
Theme 2: Development and evaluation of novel breeding or molecular technologies to better serve modern plant breeding				
Output 3.7. Application of simulation models to pyramid multiple genes via MAS <ul style="list-style-type: none"> Commissioned: G4007.06 2008–2009 LI(PI): CIMMYT/CAAS (J Wang) 		MAS programmes in Asia and Africa	MAS models and software used in several breeding programmes in Asia and Africa	More efficient MAS strategies and protocols available for breeding programmes in Asia and Africa
Output target 2008	Simulation models developed and applied to several MAS projects in Asia and Africa			
Output target 2009	Simulation software developed			
Output 3.8. Linking genetic diversity with phenotype for drought tolerance traits through molecular and physiological characterisation of a diverse reference collection of chickpea <ul style="list-style-type: none"> Commissioned: G4008.12 2008–2009 LI/PI: ICRISAT/J Kashiwagi 		Chickpea breeding programmes in India	QTLs used for chickpea marker-assisted breeding in India	More efficient MAS strategies and protocols available for chickpea breeding programmes in Asia
Output target 2008	Chickpea reference collection phenotyped for carbon isotope discrimination and other drought tolerance traits and genotyped (using			

	DArT markers)			
Output target 2009	QTLs identified for at least three drought tolerance traits in chickpea			
Output 3.9. Improving drought-tolerance phenotyping in cowpea <ul style="list-style-type: none"> Commissioned: G4008.13 2008–2010 L/PI: UC–Davis/J Ehlers 		Cowpea breeding programmes in West Africa	Innovative phenotyping tools and protocols developed; phenotyping capacity and expertise for cowpea strengthened; drought-tolerant germplasm and efficient tools for drought tolerance screening identified in cowpea	Large-scale phenotyping facilitated for cowpea in Africa
Output target 2008	Innovative phenotyping methodologies implemented and phenotyping traits used in West Africa partner countries			
Output target 2009	Relationship established between canopy temperature depression, thermal imaging, speed of rooting and performance in field conditions			
Output target 2010	Genotype by environment interaction analysed for drought-tolerance related traits			
Output 3.10. Development of a GCP phenotyping network (complements Output 3.11) <ul style="list-style-type: none"> Commissioned: G4007.25 2009 (renewable) L/PIs: GCP & Consultants (A Blum; G Edmeades; J O'Toole 		GCP projects and breeders of target crops in Africa, Asia and Latin America	At least 10 'hubs' used for high-quality and high-throughput drought phenotyping	Efficiency of drought phenotyping and germplasm deployment improved in GCP projects
Output target 2009	At least 10 suitable field phenotyping platform (FPP) 'hubs' drought phenotyping sites (and their candidate linked local phenotyping platform [LPP] sites) identified, along with recommended steps needed for FPP sites to attain the required GCP standards for uniformity, throughput and expertise			
Output 3.11. Environmental assessment for phenotyping network (complementary to Output 3.10) <ul style="list-style-type: none"> Commissioned: G4008.34 2009–2010 L/PI: CIAT/G Hyman 		Phenotypers and plant breeders of GCP target crops	At least 10 'hubs' used for high-quality and high-throughput drought phenotyping	Efficiency of drought phenotyping and germplasm deployment improved in GCP projects
Output target 2009	Reference FPP sites selected and characterised, relationships between testing sites described and map models of soil–water relationships delivered			
Output target 2010	Database of environmental and climate data, homologue maps, and drought stress indicators (soil–water balance modelling) available for GCP phenotyping locations			
Output 3.12. Targeting drought-avoidance root traits to enhance rice productivity under water-limited environments <ul style="list-style-type: none"> Competitive: G3008.06 2009–2011 L/PI: IRRI/R Serraj 		Lowland rice phenotypers and breeders in India and Africa	Screening tools and high-throughput phenotyping protocols for drought-avoidance in lowland rice	A high-throughput phenotyping platform available for lowland rice
Output target 2009	Phenotyping protocols for root morphology and water uptake refined and root kinematics analysed			
Output target 2010	A collection of 300 accessions as well as NILs with and without major QTLs for yield under drought phenotyped for root morphology and water uptake, and under			

	field conditions, for validation			
Output target 2011	New donors of dehydration-avoidance root traits identified, QTLs controlling root phenotypic plasticity validated, NILs with putative root QTLs evaluated, and at least 10 advanced breeding lines with improved dehydration avoidance evaluated by NARS			
Output 3.13. Basal root architecture and drought tolerance in common bean <ul style="list-style-type: none"> Competitive: G3008.07 2009–2011 LI/PI: PSU/J Lynch 		Common bean phenotypers and breeders in Latin America and Southern Africa	New phenotyping traits and protocols and markers available for tolerance to drought and low phosphorus availability in bean	Breeding efficiency improved for tolerance to drought and low phosphorus availability in bean
Output target 2009	288 accessions of the reference collection, 120 accessions of <i>Phaseolus coccineus</i> and <i>P. dumosus</i> evaluated for basal root whorl number			
Output target 2010	100 RILs from the cross DOR364xG19833 evaluated for basal root whorl number and basal root growth angle and QTLs identified			
Output target 2011	150 RILs genotyped in key genomic regions for basal root whorl number and basal root growth angle, 6 segregating populations used for marker-assisted selection, and 4 QTLs for basal root growth angle validated in backcross or recurrent selection populations			
Output 3.14. Breeder-friendly high-throughput phenotyping tools to select for adaptive traits in drought environments <ul style="list-style-type: none"> Competitive: G3008.08 2009–2011 LI/PI: ICARDA/F Ogonnaya 		Wheat breeders in drought-prone areas	Robust, field-based and non-invasive drought phenotyping tools and protocols available in wheat	Breeding efficiency improved for drought tolerance in wheat
Output target 2009	Eight phenotyping locations characterised and phenotyping protocols refined			
Output target 2010	Relative value of drought adaptive traits evaluated in the eight phenotyping locations			
Output target 2011	Development and validation of algorithms for season-long phenotypic signature describing growth and water use; assessment of the relative impact of putative key traits on drought adaptation in different mega-environments, and characterisation of ICARDA's elite drought germplasm to identify adaptive traits behind enhanced performance under drought			
Theme 3: Markers/alleles validation in adapted germplasm under target environments				
Output 3.15. Integrating marker-assisted selection into the conventional breeding procedure for improvement of wheat (<i>Triticum aestivum</i> L) in the drought-prone areas of Northern China <ul style="list-style-type: none"> Commissioned: G4007.06 2007–2009 LI/PI: CAAS/R Jing 		Wheat breeders from Northern China (Ningxia, Shanxi, Henan and Hebei Provinces)	Drought-tolerant wheat germplasm disseminated and used in Northern China breeding programmes	Wheat breeding efficiency improved in several provinces of Northern China
Output target 2008	At least 8 major drought-tolerant QTLs validated and transferred into elite Chinese wheat backgrounds			

Output target 2009	At least 50 lines carrying target QTLs selected			
Output 3.16. Bridging genomics, genetic resources and breeding to improve wheat and barley production in Morocco <ul style="list-style-type: none"> Commissioned: G4007.05 2007–2009 LI/PI: INRA–Morocco/AA Fouad 		Plant breeders, wheat and barley breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems of North Africa	Novel genes and alleles conferring tolerance to stresses and improving end-use quality mined from the germplasm collections and used through MAS in breeding	More efficient MAS strategies available for wheat and barley improvement programmes under drought-prone environments
Output target 2008	Local and exotic germplasm evaluated under semi-arid conditions and contrasting accessions identified			
Output target 2009	Segregating populations developed for tagging loci involved in stress tolerance and new markers generated, including candidate gene/allele-based molecular markers			
Output 3.17. Validation of <i>Alt_{SB}</i>, a major aluminium-tolerance gene in sorghum <ul style="list-style-type: none"> Commissioned: G4008.10 2008–2010 LI/PI: EMBRAPA/R Schaffert 		Sorghum breeding programmes facing soil acidity constraints	Local germplasm carrying <i>Alt_{SB}</i> evaluated on acid soils, and available to West African scientists and breeders	Al toxicity genes/markers available for MAS in sorghum, and improved sorghum germplasm for acid soil conditions
Output target 2009	Comparison of performance, under acid soil conditions, of a set of prebreeding NILs carrying different <i>Alt_{SB}</i> haplotypes			
Output target 2010	<i>Alt_{SB}</i> transferred in sorghum African landraces			
Output 3.18. Validation of <i>Salto1</i>, a major salinity-tolerance gene in rice <ul style="list-style-type: none"> Commissioned: G4008.16 2008–2009 LI/PI: IRRI/AM Ismail 		Rice breeding programmes facing salinity constraints	<i>Salto1</i> validated in salinity conditions in Bangladesh and available to breeders	Yield of rice varieties increased under saline conditions
Output target 2008	<i>Salto1</i> gene from Pokkali, FL378 and FL478 introgressed into wet and dry season rice varieties			
Output target 2009	Comparison of performance, under salinity conditions, of prebreeding NILs			
Output 3.19. Application and validation of the major QTL phosphate uptake 1 (<i>Pup1</i>) <ul style="list-style-type: none"> Commissioned: G4008.41 2008–2009 LI/PI: IRRI/S Heuer 		Asian rice breeding programmes facing phosphorus deficiency problems	<i>Pup1</i> in rice validated in acid soil conditions in Indonesia and available to breeders	Yield of rice varieties increased under phosphorus-deficient and acid soil conditions
Output target 2008	<i>Pup1</i> introgressed into upland and irrigated rice varieties			
Output target 2009	Seeds of the best <i>Pup1</i> lines disseminated for field screening in Laos and India within ongoing IRRI activities and made available to NARS partners within the GCP platform 'Rice in Asia' for further testing			
Theme 4: Application of molecular markers in breeding programmes				
Output 3.20. Integration of genomic tools with conventional screening for developing NERICA rice cultivars for West Africa <ul style="list-style-type: none"> Commissioned: G4007.08 2007–2009 LI/PI: WARDA/MN Ndjondjop 		Plant breeders, breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems	New improved germplasm combining African (<i>Oryza glaberima</i>) and Asian (<i>O sativa</i>) sources developed and available to West African rice breeding programmes	Improved rice germplasm for Africa
Output target 2008	New segregating germplasm evaluated under abiotic stress			
Output target 2009	MAS for target traits conducted, germplasm developed and links established with farmer communities			

Output 3.21. Marker-assisted selection for sweet potato virus disease (SPVD) resistance in sweet potato germplasm and breeding populations <ul style="list-style-type: none"> Commissioned: G4007.07 2007–2009 LI/PI: CIP/W Grüneberg 		Plant breeders, breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems	Improved drought-tolerant and virus-resistant sweet potato lines available to users	Improved sweet potato germplasm for Africa
Output target 2008	Backcross populations developed, shared with NAARI Uganda and screened for virus resistance			
Output target 2009	Markers closely linked to SPVD resistance genes identified and MAS developed in two breeding populations			
Output 3.22. Detecting and fine-mapping QTLs with major effects on rice yield under drought stress for deployment via marker-assisted breeding <ul style="list-style-type: none"> Competitive: G3007.05 2007–2009 LI/PI: IRR/I/A Kumar 		Plant breeders in India and China	Large-effect QTLs for yield under drought stress available for drought tolerance MAB in rice in India and China	Rice germplasm with improved drought tolerance disseminated in Asia; improved capacity to map and deploy drought yield QTLs developed in Asian NARS
Output target 2008	QTLs with consistent effects on drought yield across genetic backgrounds verified or disproved; effects of drought tolerance QTLs in other backgrounds evaluated			
Output target 2009	Low-cost system for detecting alleles with effects on drought tolerance across a range of backgrounds developed based on BSA; dissemination of advanced breeding lines			
Output 3.23. Local germplasm enhanced via molecular breeding for target traits in tropical legumes (groundnut, bean, cowpea, and chickpea) <ul style="list-style-type: none"> Focus: G6007.05 2008–2010 LI/sPIs: <ul style="list-style-type: none"> ICRISAT/ V Vadez ICRISAT/GCP (R Varshney) CIAT/M Blair UC–Riverside/J Ehlers 		Breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems	New germplasm and improved breeding programmes for tropical legumes in Africa	Germplasm available for drought-prone areas, increased yields in farmers' fields and increased incomes due to improved local varieties
Output target 2009	New backcross populations developed incorporating farmer/market preferences and disease resistance			
Output target 2010	Diversified breeding populations developed with resistance to diseases and tolerance to drought and heat			
Output 3.24. Marker-assisted selection for resistance to <i>Striga gesnerioides</i> in cowpea <ul style="list-style-type: none"> Commissioned; G4008.17 2008–2009 LI/PI: INERA/J-B Tignegre 		Cowpea breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems in West Africa	MAS for resistance to <i>Striga gesnerioides</i> in cowpea implemented and <i>Striga</i> -resistant cowpea available to farmers in Burkina Faso and Niger	New cowpea germplasm (with improved <i>Striga</i> resistance) widely available in West Africa
Output target 2008	<i>Striga</i> resistance markers used by INERA (Burkina Faso) to select <i>Striga</i> resistant cowpea germplasm			
Output target 2009	<i>Striga</i> resistance markers deployed in West African cowpea breeding programmes			
Output 3.25. Marker-assisted selection for resistance to streak virus in maize <ul style="list-style-type: none"> Commissioned; G4008.19 2008–2009 LI/PI: UKZNM Laing 		Maize breeding programmes and, ultimately, small-scale farmers in resource-poor cropping systems in Southeast Africa	MAS for maize streak virus developed in Southeast Africa; hybrids and OPVs with streak virus resistance disseminated in Mozambique	New maize germplasm (with improved resistance to streak virus) for Southeast Africa
Output target 2009	Resistant lines identified in the IIAM maize breeding programme			

Output target 2010	OPVs and hybrids with resistance to streak virus resistance developed using streak virus resistance markers deployed by UKZN			
Output 3.26. Dry bean improvement and marker-assisted selection for diseases and abiotic stresses in Central America and the Caribbean <ul style="list-style-type: none"> Commissioned: G4008.11 2008–2010 PI: INIFAP/JA Acosta-Gallegos 				
Output target 2008	SCAR markers developed for BGYMV and root-rot resistance traits	Bean breeders and farmers in Mexico, Nicaragua, Cuba and Haiti	Bean germplasm with improved BGYMV and root-rot resistance and drought tolerance available to farmers in Central America and the Caribbean	Enhanced bean yield in Central America and the Caribbean
Output target 2009	40 root-rot-resistant and drought-tolerant accessions from worldwide collection identified			
Output target 2010	20 best advanced lines distributed in partner countries			
Output 3.27. Yield improvement of sorghum in Africa through marker-assisted recurrent selection (MARS) and a public-private partnership <ul style="list-style-type: none"> Commissioned: G4008.48 2009–2013 LI/PI: CIRAD/J-F Rami 		Sorghum breeding programmes in West Africa	Improved sorghum genotypes developed for marginal environments in Sahelian West African countries, and MARS protocols adapted to drought-prone environments	Sorghum yields enhanced in West Africa through a marker-assisted breeding approach developed by the private sector in the North and applied in the South
Output target 2009	Two populations of 400 individuals developed from well-adapted varieties			
Output target 2010	400 F3 individual of each population genotyped with 150 SSR markers and 400 F4 families of each population phenotyped in 4 different locations in Mali			
Output target 2011	QTLs involved in target traits and environments detected, F4 families genotyped for flanking markers of selected QTLs and improved lines from the material selected by MARS phenotyped in different locations			
Output 3.28. Yield improvement of maize in Asia through marker-assisted recurrent selection (MARS) and a public-private partnership <ul style="list-style-type: none"> Commissioned: Project No. TBA 2009–2013 LI/PI: CIMMYT/M Bänziger 		Maize breeding programmes in China, India, Indonesia, Pakistan, Philippines, Nepal, Thailand and Vietnam	Drought-tolerant lines and hybrids identified and available to farmers	Maize yields enhanced in Asia through a marker-assisted breeding approach
Output target 2009	Top-crosses of BC1F2 and BC2F1 (derived from crosses between Asian inbred lines recipients and drought-tolerant donor) generated			
Output target 2010	Top-crosses of BC1F2 and BC2F2 phenotyped and genotyped			
Output target 2011	Double haploids extracted from BC1C2 and BC2C2			

Annex 7. GCP 2009 Annual Report

Annex 8. CIMMYT operational GCP Sub-programme-3 projects in 2009-10

NB.

1. Project duration and budgets extracted from project proposals and grant agreements
2. Projects are presented by order of project code number (GXXXX.XX)
3. For more information, see Project briefs and Project updates 2009 at http://www.generationcp.org/UserFiles2/File/Comms-docs/Project-briefs/ProjectBrief2009_Final.pdf and <http://www.generationcp.org/UserFiles2/File/Research/Prog-level-publications/2009/2009-GCP-Project-updates-For-web.pdf>
4. Output numbers, e.g. 'Output 4', correspond to GCP's Medium-Term Plan (MTP) 2009-11
5. Previous output numbers, e.g. 'previously 3.9', correspond to MTP 2008–2010

Project Number, Title, PI				
Duration	Total budget (USD)	Collaborating institutes in 2008	Crop(s), trait(s), region(s)	Output numbers
G3007.04/CI-7: Tailoring superior alleles for abiotic stress genes for deployment into breeding programmes: a case study based on association analysis of Alt _{SB} , a major aluminium tolerance gene in sorghum (PI: Jurandir Vieira Magalhaes, EMBRAPA)				
August 2007– July 2009	603,101	IGD–CU, INRAN, USDA–ARS	sorghum aluminium tolerance Africa and other developing regions	Output 1 (previously 3.3)
G3007.05/CI-4: Detecting and fine-mapping QTLs with major effects on rice yield under drought stress for deployment via marker-aided breeding (PI: Arvind Kumar, IRRI)				
August 2007– July 2009	598,590	BAU, BF, CRRI, CRURRS, IGKV, JNKVV, NDUAT, TNAU, UAS (Bangalore), UoAI, YAAS	rice drought tolerance Asia	Output 20 (previously 3.22)
G3008.06/CI-4: Targeting drought-avoidance root traits to enhance rice productivity under water-limited environments (PI: Rachid Serraj, IRRI)				
November 2008– October	900,000	ARC, BF, CSU, Drought Breeding Network (CRRI, CRURRS, IGKV, NagU, NDUAT, UAS–Bangalore), SUA, TNAU, UoAb, UoMi	rice drought tolerance Asia	Output 8 (previously 3.12)

2011				
G3008.07: Basal root architecture and drought tolerance in common beans (PI: JP Lynch, PSU)				
November 2008–October 2011	900,000	CIAT, IIAM, SABRN	beans drought tolerance Africa	Output 9 (previously 3.13)
G3008.08/CI-6: Breeder-friendly high-throughput phenotyping tools to select for adaptive traits in drought environments (PI: Francis Ogonnaya, ICARDA)				
November 2008–October 2011	897,073	CIMMYT, CSIRO, EIAR, INRA–Morocco	wheat drought tolerance Africa, Asia	Output 10 (previously 3.14)
G4007.04: Association mapping of downy mildew resistance in elite maize inbred lines in Thailand (PI: Chalermopol Phumichai, and Julapark Chunwongse, BIOTEC)				
August 2007–July 2009	60,464	NCSRC–KU, IICRD–KU, NSFCRC	maize mildew resistance Asia	
G4007.05/CI-6: Bridging genomics, genetic resources and breeding to improve wheat and barley production in Morocco (PI: Abbad Andaloussi Fouad, INRA–Morocco)				
January 2007–December 2009	200,000	CIMMYT, CU, ICARDA, UdB, UoMi	wheat, barley various traits Africa	
G4007.06/CI-6: Integrating marker-assisted selection into the conventional breeding procedure for improvement of wheat (<i>Triticum aestivum</i> L) in the drought-prone areas of Northern China (PI: Ruilian Jing, CAAS)				
August 2007–July 2010	150,590	IDF–HAAS, LAAS, NU, NWSUAF, SAAS	wheat drought tolerance Asia	
G4007.07: Marker-assisted selection for sweet potato virus disease (SPVD) resistance in sweet potato germplasm and breeding populations (PI: Wolfgang Grüneberg, CIP)				

August 2007–July 2010	379,800	NaCRRI	sweet potatoes SPVD resistance various regions	
G4007.08/CI-4: Integration of genomic tools with conventional screening for developing NERICA rice cultivars for West Africa (PI: Marie Noelle Ndjiondjop, ARC)				
August 2007–July 2009	304,440	Agropolis–IRD, IER	rice drought tolerance Africa	Output 3.20, completed 2009.
G4007.23/CI-6: Field evaluation of wheat–barley introgression lines under different water regimes (PI: Márta Molnár-Láng, ARI–HAS)				
December 2007– November 2010	144,000	CAAS, CIMMYT, DPSPP–EKC	Wheat, barley drought, salt and aluminium tolerance various regions	
G4007.24: Seed smoke treatment to favour germination under water-stressed conditions (PI: Ervin Balazs, ARI–HAS)				
December 2007– November 2009	24,000	UKZN	Various	
G4008.10/CI-7: Assessment of the breeding value of superior haplotypes for Alt _{SB} , a major Al tolerance gene in sorghum: linking upstream genomics to acid soil breeding in Niger and Mali (ALTFIELD) (PI: Robert Schaffert, EMBRAPA)				
January 2008– December 2010	205,200	ICRISAT, INRAN	sorghum aluminium tolerance Africa	Output 13 (previously 3.17) Title changed to: Assessment of the breeding value of superior haplotypes for Alt _{SB} , a major Al tolerance gene in sorghum: linking upstream genomics to acid soil breeding in Niger and Mali

				(ALTFIELD)
G4008.11: Dry bean improvement and marker-assisted selection for diseases and abiotic stresses in Central America and the Caribbean (PI: Jorge A Acosta-Gallegos, INIFAP)				
January 2008–December 2010	382,590	CIAT, INTA–Nicaragua	beans drought and disease resistance Latin America and the Caribbean	
G4008.12/CI–2: Linking genetic diversity with phenotype for drought tolerance traits through molecular and physiological characterisation of a diverse reference collection of chickpea (PI: Lakshmanan Krishnamurthy, effective March 2009; Previous PI: Junichi Kashiwagi, ICRISAT)				
January 2008–December 2009	156,215	JIRCAS, UAS (Bangalore)	chickpeas drought tolerance various regions	Output 4 (previously 3.8)
G4008.13/CI–3: Improving drought tolerance phenotyping in cowpea (PI: Jeff Ehlers, UoC–Riverside)				
January 2008–December 2010	450,836	IITA, INERA–BF, ISRA, TAMU	cowpea drought tolerance Africa	Output 5 (previously 3.9)
G4008.14: Breeding for drought tolerance with known gene information (PI: Jiankang Wang, CIMMYT)				
January 2008–December 2009	300,000	Agropolis–INRA, CAAS, CSIRO, ICRISAT, IRRI, UQ	Various	
G4008.15: Developing potato cultivars adapted to Southern Africa countries (PI: F Vilaró, INIA–Uruguay)				
January 2008–December 2009	209,868	CIP, DARTS, EMBRAPA, IIAM, INIA–Chile, INTA–Argentina	potato various traits	Output 2 (previously 3.4)
G4008.16: Speeding the development of salt-tolerant rice varieties through marker-assisted selection and their dissemination in salt-affected areas of				

Bangladesh (PI: Abdelbagi M Ismail, IRRI)				
January 2008–December 2009	223,768	BINA, BRRI, UoD	rice salt tolerance Asia	Output 3.18, completed in 2009. Title changed to: Validation of Saltol, a major salinity tolerance gene in rice
G4008.17: Application of marker-assisted selection for Striga resistance in cowpea (PI: Jean-Baptiste Tignegre, INERA–BF)				
January 2008–December 2009	199,986	IITA	cowpea Striga resistance Africa	
G4008.19: Incorporation of an MSV resistance gene in Mozambican maize varieties, mediated by use of MAS (PI: Mark Laing, UKZN)				
January 2008–December 2010	240,000	IIAM	maize MSV resistance Africa	
G4008.30: Development of a GCP phenotyping network (PIs: Abraham Blum and Greg Edmeades, Consultants)				
February 2008–February 2009	117,000	CIAT, KUL	various	
G4008.34: Environmental assessment for phenotyping network (PI: Glenn Hyman, CIAT)				
January 2008–December 2009	279,403	EMBRAPA, KUL, WA	▪ various	
G4008.41/CI–7: Application and validation of the major QTL phosphate uptake 1 (Pup1) (PI: Sigrid Heuer, IRRI)				
January 2008–	166,550	ICABIOGRAD, JIRCAS	rice salt tolerance	

December 2009			Asia	
G4008.48/CI-5: Improve sorghum productivity in semi-arid environments of Mali through integrated MARS (PI: Jean-François Rami, Agropolis-CIRAD)				
August 2008–July 2013	882,600	IER, Syngenta	sorghum drought tolerance Africa	
G4008.49: Enhancing groundnut (<i>Arachis hypogaea</i> L) genetic diversity and speeding its utilisation in breeding for improving drought tolerance (PI: Ousmane Ndoye, ISRA)				
August 2008–July 2009	81,600	Agropolis-CIRAD, EMBRAPA, ICRISAT, PROINPA, UCB, USDA-ARS	groundnuts drought tolerance Africa, Latin America	
G4008.56: Asian Maize Drought Tolerance (AMDROUT) project (PI: Bindiganavile S Vivek, CIMMYT, effective May 2009; Previous PI: PH Zaidi, CIMMYT)				
November 2008–October 2013	1,512,200	ICERI, KSL, NMRI, NSFCRC, UPLB, YAAS	maize drought tolerance Asia	Output 25 (previously 3.28) title changed to: Drought-tolerant maize for Asia

Programme-level projects

Tropical Legumes I project

G6007 Tropical Legumes I (TLI): Improving tropical legume productivity for marginal environments in sub-Saharan Africa (Project Manager: Carmen de Vicente, GCP)				
G6007.01: Improve groundnut (<i>Arachis hypogaea</i> L.) productivity for marginal environments in sub-Saharan Africa (PI: Vincent Vadez)				
May 2007–April 2010	3,037,512	Agropolis-CIRAD, ARI-Naliendele, CRS, EMBRAPA, INRAN, ISRA, UCB, UGA	groundnuts drought and disease resistance	SP1 SP2 SP3
G6007.02: Improve cowpea (<i>Vigna unguiculata</i> L.) productivity for marginal environments in sub-Saharan Africa (PI: Jeff Ehlers, UoC-Riverside)				

May 2007–April 2010	1,952,008	IITA, INERA–BF, IRAD, ISRA	cowpeas drought and disease resistance Africa	SP1 SP2 SP3
G6007.03: Improve common bean (<i>Phaseolus vulgaris</i> L) productivity for marginal environments in sub-Saharan Africa (PI: Matthew Blair, CIAT)				
May 2007–April 2010	1,867,327	CBI, ECABREN/UoN, RIKEN, SABRN, SARI–Ethiopia	beans drought and disease resistance sub-Saharan Africa	SP1 SP2 SP3
G6007.04: Improve chickpea (<i>Cicer arietinum</i> L) productivity for marginal environments in sub-Saharan Africa (PI: Rajeev Varshney, GCP/ICRISAT)				
May 2007–April 2010	1,074,126	DArT P/L, EIAR, EgU, IIPR, LZARDI, UoC–Davis	chickpeas drought and disease resistance Africa	SP1 SP2 SP3
G7009.09/CI–1: Start-up for cassava Challenge Initiative, project 4: Implement MARS project for drought tolerance (PI: Emmanuel Okogbenin, NRCRI)				
December 2009– February 2010	2,124	CRI	○ cassava ○ drought tolerance ○ Africa	SP3

Annex 9. A list of GCP Highlight Products developed in Phase 1 (2004-8) – all Sub-programmes (ex GCP Product Delivery Manager)

Genetic Resources

- Germplasm Reference Sets for 18 crops
 - Core set of accessions representing the genetic diversity of the germplasm bank collection
 - Allows efficient study for adaptive traits, discovery of favourable new alleles and new parental lines for pre-breeding within the context of genetic diversity
 - Crops: maize, wheat, rice, sorghum, potato, barley, cowpea, chickpea, groundnut, common bean, cassava, millets, pigeon pea, lentil, sweet potato, yam, Musa, coconut
- Substitution lines (groundnuts, rice)
- Mutant collections (rice, potato, bean)
- Synthetics (groundnuts and wheat)

Genomic Resources

- BAC libraries and EST sequences (legumes, cassava)
- Microsatellite Kits
 - Simple Sequence Repeat (SSR) marker information for each of the Reference Sets
 - Facilitates routine monitoring and efficient assessment of diversity and fingerprinting of entries in breeder collections
 - Potential association of markers with traits of interest
- DArT Markers for 8 crops
 - Alternative low-cost technology for diversity assessment of crops
 - Using thousands of DNA fragments, genotyping is high density and independent of sequence information
 - More appropriate than SSRs for genomes of certain crops
 - Crops: Musa, coconut, groundnut, potato, chickpea, pigeonpea, yam, pearl millet
- Genetic Map for Groundnut
 - First genetic map of cultivated Groundnut
- Physical Genetic Map of Cowpea
 - First high-density, high throughput SNP (single nucleotide polymorphism) map of cowpea

Informative Markers

- Validated Markers for PUP₁
 - Major QTL for phosphorus uptake efficiency in rice
- Validated Markers for ALT_{sb}
 - Major gene for tolerance to aluminum toxicity in sorghum

- Validated Markers for Saltol
 - Major QTL for tolerance to salt in rice
- Markers for drought tolerance in chickpea
 - Major QTL for several root-related traits for drought tolerance
- QTLs for resistance to root-knot nematodes and *Macrophomina phaseolina* in cowpea
- Markers for *Striga* resistance in cowpea
- Marker for *Fusarium* Resistance in cowpea (resistance to Race 3)
- Markers for Cassava Mosaic Disease
- Markers for Cassava Brown Streak Disease
- Molecular Marker Toolkit
 - Repository of informative markers for abiotic and biotic traits (disease resistance, etc) of major crops

Germplasm

- Drought-tolerant groundnut synthetics
 - (*A. batizocoi* K9484 x *A. stenosperma* V10309)4x and (*A. gregoryii* V6389 x *A. stenosperma* V10309)4x
- Drought-tolerant common bean variety
 - cultivar “INTA Sequia” released in Nicaragua
- Drought-tolerant common bean lines
 - selected for release in Colombia and Zimbabwe
- Drought resistant cassava germplasm
 - 109 accessions Certified virus free
- Cassava lines resistant to Cassava Mosaic Disease + Brown Streak Disease
 - Incorporating farmer preferred traits

Informatics Tools

- iMAS
 - Integrated marker-assisted selection system
 - Only complete software of its kind allowing all required analysis for marker assisted breeding without the help of any external tool or software
- RiceGene
 - Interface to find stress-responsive genes and their location
- GenDiversity
 - Combines decentralized genotyping data for diversity analysis
- GreenPhylDB + Gost (combination of two applications to make a gene search tool)
 - Phlogenomic database for plant comparative genomics + GreenPhylorthologs search tool

- RiCES
 - Searcher for cis-elements in rice genome
- MicroArray Tools
 - Tools for assembling and developing microarrays for genotyping by software developers
- A Laboratory Information Management System (LIMS)
 - Platform independent, multi-user, high-throughput LIMS
 - In routine use at ICRISAT, India and BecA, Kenya
- QU-GENEUI
 - User Interface genetic simulation software providing tools for simulation of breeding programs from simple back-crossing strategies to complex marker-assisted breeding scenarios.
- QuLine
 - Software for optimizing marker assisted breeding systems for drought tolerance in cereals

Learning Materials

- Genomics and Comparative Genomics Learning Module
 - On-line learning module for use by scientists and advanced students with a strong background in biology and genetics as basic class material or self-tutorial.
- Marker Assisted Breeding Learning Module
 - On-line learning module for scientists or upper-level students with a good background of biology, genetics and plant breeding
- McClintock Crop Bioinformatics Course
 - On-line learning module demonstrating how basic bioinformatics tools, techniques and resources can help molecular biologists, geneticists and other scientists to effectively manage sequencing projects

Capacity Building

- 21 fellowships for advanced degrees
 - awarded to molecular scientists from developing countries for advanced degrees
- 9 fellowships for Capacity-building à la carte Programme
 - capacity-building tailored to national research teams in developing countries working on GCP research projects

Annex 10. Annual workplan and budget programme for Sub-programme-3 for the year 2008-10

NB: Document is also referred to as GCP66 (SP3) Proposal 2008-10

CGIAR Generation Challenge Programme (GCP), hosted by CIMMYT

Project 3—Sub-programme-3: Trait capture for crop improvement

Goal:

The Generation Challenge Programme (GCP) is at the heart of a research and capacity building network that uses plant genetic diversity, advanced genomic science and comparative biology to develop tools and technologies that help plant breeders in the developing world produce better crop varieties for resource-poor farmers living in drought-prone environments.

As one of the five GCP Subprogrammes, SP3 focuses on the validation and refinement of molecular breeding systems and the resulting enhanced germplasm, fine-tuning the technology needed to deliver more efficient approaches and tools (eg, validated markers) to breeders, and enhanced germplasm to farmers. SP3 aims to create product-driven teams that span the innovation-to-impact continuum and bridge the gap between the development of research outputs and their actual use in breeding programmes (research for development).

SP3 capitalises on the latest advances in germplasm characterisation, genomics results, information technology and bioinformatics to accelerate genetic progress of simple traits (eg, resistance to biotic stresses), and develop, validate and use markers to improve complex traits that impact crop productivity under drought-prone environments.

Purpose:

Most developing countries—with the exception of a few large and advanced national plant breeding programmes—have little access to the new technologies and skills that have sharpened the effectiveness of plant breeding in wealthy nations. The principal purpose of SP3 is to guarantee widespread impact of new genes, markers and traits, and to facilitate rapid and effective uptake of molecular breeding for tropical staple crops. SP3 strives to achieve this purpose through several interrelated pathways, as outlined below.

Research–development links: Generally speaking, the public sector is characterised by weak research and development links—a major impediment to realising the full value of investments in upstream research. SP3 plays a vital role in creating community linkages with plant breeders, who are also deeply involved in the evaluation, validation and refinement of molecular markers and molecular breeding technologies generated through more upstream activities.

Validating candidate genes in target environments and adapted germplasm: Tremendous progress has been made in understanding the genetic basis of key regulatory pathways in plants in terms of gene function and allele value. But before any molecular breeding application can be considered, there is still a need to extrapolate and validate many of these discoveries in a suitable biological context. The quantification of favourable genetic effects at loci of interest in adapted germplasm under target field conditions is a major purpose of SP3. This quantification is essential for the development of markers for use in breeding programmes. Validation is one of the most severe bottlenecks limiting the extensive deployment of molecular markers in the South.

Expanding and supporting phenotyping: Phenotyping is recognised as a major bottleneck, and drought tolerance phenotyping remains difficult because of limited capacity, inadequate protocols, extensive phenotypic diversity and problems in the design of controlled stress experiments. Consequently, establishing, supporting and strengthening phenotyping networks, as well as the definition of robust protocols, are major priorities for GCP in general, and SP3 in particular.

Strengthening breeding communities: SP3 is committed (in conjunction with SP5) to providing appropriate technical assistance to breeding programmes, to enable them take advantage of molecular breeding in tropical staple crops. The aim is to develop communities of practice (CoPs), supported by regional centres of excellence and state-of-the-art technologies. These CoPs will facilitate a system of centralised validation and the refinement of new technologies delivering protocols for routine application in NARS institutes. Special attention is paid to generating protocols for low-cost trait diagnosis and high-throughput and low cost array-based genotyping.

Outputs:

- Output 1: Characterisation of segregating populations and identification of genomic regions for plant breeding (*Theme 1 in the MTP logframe*)
- Output 2: Development and evaluation of novel breeding or molecular technologies to better serve modern plant breeding (*Theme 2 in the MTP logframe*)
- Output 3: Markers/alleles validation in adapted germplasm under target environments (*Theme 3 in the MTP logframe*)
- Output 4: Application of molecular markers in breeding programmes (*Theme 4 in the MTP logframe*)

Notes:

1. Due to the structure of our logframe, several GCP activities (projects) are grouped under each output. The output targets reported below correspond to the activities supported by EC, and the MTP code number for each activity is indicated in brackets.
 2. Although we have a clear workplan within each output, because of the rolling nature of our activity portfolio conducted through grants of between one and three years, target outputs might not yet be identified for all the three years (ie, 2008–2010) in the current MTP.
 3. The output targets will be continually updated on an annual basis when we develop our rolling three-year MTP each year.
-

Output targets 2008:

- Output 1: Drought-tolerant contrasting cassava varieties identified and micropropagated, identification of drought tolerance related traits, crossing blocks of drought contrasting cassava varieties established (3.1); A diverse sorghum collection phenotyped for aluminum tolerance and genotyped at *AltSB*, superior *AltSB* haplotypes identified (3.4); Molecular markers used to monitor the presence of key resistance genes in programme's elite breeding stocks, conversion of short-days adapted germplasm into long days adapted, and germplasm resistant for known resistance genes exchanged (3.5)
- Output 2: Crosses between virus resistant and farmers' varieties, lines with virus resistance selected through MAS (3.6); Relationship between grain yield and carbonisotope discrimination under different drought scenarios (3.8)
- Output 3: *Saltol* gene from Pokkali, FL378 and FL478 introgressed into wet and dry season rice varieties (3.14)
- Output 4: New segregating germplasm evaluated under abiotic stress conducted, segregating material evaluated under abiotic stress (3.15); QTLs with consistent effects on drought yield across genetic backgrounds verified or disproved and effects of drought tolerance QTLs in other backgrounds evaluated (3.18).

Output targets 2009:

- Output 1: A set of *Alt_{SB}* haplotype-specific markers identified and easy to use SNP genotyping assays developed (3.3)
- Output 2: Relationship between CTD, thermal imaging speed of rooting and performance in field conditions (3.9) Phenotyping protocols for root morphology and water uptake refined and root kinematics analyzed (3.12); 288 accessions of the reference collection, 120 accessions of *Phaseolus coccineus* and *P. dumosus* evaluated for basal root whorl number (3.13); Eight phenotyping locations characterized and phenotyping protocols refined (3.14)
- Output 3: comparison of performance, under acid soil conditions, of a set of prebreeding NILs carrying different *Alt_{SB}* haplotypes (3.17); Comparison of performance, under salinity conditions, of prebreeding near-isogenic lines (NILs) (3.18)
- Output 4: Low-cost system for detecting alleles with effects on drought tolerance across a range of backgrounds developed based on bulk segregant analysis (BSA) and dissemination of advanced breeding lines (3.22); Top crosses of BC1F2 and BC2F1 generated for drought tolerance improvement in Asia (3.28)

Output targets 2010:

- Output 2: Genotype by environment interaction analysed for drought tolerance related traits (3.9); A collection of 300 accessions as well as NILs with and without major QTLs for yield under drought phenotyped for root morphology and water uptake, and under field conditions, for validation (3.12); 100 RILs from the cross DOR364xG19833 evaluated for basal root whorl number and basal root growth angle and QTLs identified (3.13); Relative value of drought adaptive traits evaluated in the eight phenotyping locations (3.14)
- Output 3: *Alt_{SB}* transferred in sorghum African landraces (3.17)
- Output 4: 20 best advanced lines distributed in partner countries (3.26); Top crosses of BC1F2 and BC2F1 phenotyped and genotyped (3.28)

Intended Users:

Primary recipients

- *breeders*
- *crop physiologists*
- *crop geneticists*

Target beneficiaries

- *resource-poor farmers in drought-prone environments*

Primary users of output targets generated by SP3 activities are clearly plant breeders in less developed countries, while farmers living in drought-prone environments are the target beneficiaries. SP3 projects establish and cultivate links with plant breeders, as they are the cornerstone in the validation and integration of new markers for crop breeding in target farming systems.

GCP products aim to enable plant breeding programmes to more efficiently develop crop varieties with the characteristics that resource-poor farmers in drought-prone environments need. As our entry point to reaching farmers, and as the interface between farmers and geneticists, NARS breeders are an important link in the feedback loop, by bringing the dynamic of farmer preferences, knowledge and challenges into the research agenda. The breeding community served by GCP is a very important

player that encompasses many national agricultural research systems operating across a wide range of locations and diverse environments.

NARS partners:

Institutions of the National Agricultural Research System (NARS) at large (public and private research institutions, universities, and regional research centers and seed companies) are integral to achieving our goals, and in the current SP3 portfolio, about two-thirds of the commissioned projects are now led by NARS breeders. We anticipate that their participation in GCP—and in SP3 in particular—will be even further enhanced in the coming years now that products are streaming from GCP's upstream science that will have impact on plant breeding in less developed countries.

NARS represent the GCP breeding community and bring to the table specific understanding of phenotypic components of adaptation and capacities for evaluation with regard to local constraints. As GCP projects increasingly evolve from exploration to validation and application, NARS have a leading role to play in the Programme, testing the genes and markers identified through research activities under local conditions for adapted germplasm. NARS play a particularly a central role in SP3 validation activities, and are also the brokers for the use and dissemination of SP3 products.

Because of its mandate, GCP relies heavily on NARS partnerships in research, and, very importantly, as main actors for delivery of research products.

NARS partners will include:

Asia (including Central Asia) and Pacific Islands: Bangladesh Rice Research Institute (BRRI, Bangladesh); Bangladesh Institute of Nuclear Agriculture (BINA, Bangladesh); Central Rainfed Upland Rice Research Station (CRURRS, India); Tamil Nadu Agricultural University (TNAU, India); University of Agricultural Sciences (UAS, India); University of Dhaka (Bangladesh); Yunnan Academy of Agricultural Sciences (YAAS, China)

Latin America (including Caribbean): Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical (CNPMP, Brazil), EMBRAPA; Instituto Nacional de Investigación Agropecuaria (INIA, Chile); Instituto Nacional de Investigación Agropecuaria (INIA, Uruguay); Instituto Nacional de Tecnología Agropecuaria (INTA, Argentina)

Sub-Saharan Africa: Agricultural Research Institute–Naliendele Research Station, (ARI, Tanzania); Crop Research Institute (CRI, Ghana); Institut d'Economie Rurale (IER, Mali); Institut National de la Recherche Agronomique du Niger (INRAN, Niger); Namulonge Agricultural and Animal Production Research Institute (NAARI, Uganda); National Root and Tuber Crop Research Institute (NRCRI, Nigeria); Savannah Agricultural Research Institute (SARI, Ghana)

Note: NARS listed above can be involved in more than one GCP activity, and some NARS partners might change over the three years of the project.

Targeted Eco-regions:

Most SP3 activities aim to have an impact on crop breeding in one of the 15 priority farming systems identified by GCP. These systems are characterised by poverty (with number of stunted children as the indicator) and were selected because of the coincidence of poverty and drought (indicated by high risk of crop failure owing to water scarcity). The distribution of these 15 farming system is as follows: one in Central America, five in Africa and nine in Asia.

Breeders in national agricultural research programmes serve as a critical entry point in reaching our ultimate beneficiaries—resource-poor farmers. In addition to breeders in national programmes, we will work with national, sub-regional and regional initiatives in Asia and sub-Saharan Africa (eg,

NEPAD, CORAF, FARA, ASARECA), the two major targeted Eco-regions of this project. We stand ready to respond when our assistance is called upon.

We also catalyse, initiate and support communities of practice (CoPs) relevant to GCP science and help establish ‘crop by region’ platforms for breeders and other scientists.

We hope to further extend our reach in Africa and Asia by partnering with ongoing initiatives such as the Programme for African Seed Systems (PASS) and the Global Crop Diversity Trust.

Expected impacts:

The proposed activities in this project aim to deliver marker technologies as international public goods. SP3 proposes to pioneer several new approaches for molecular breeding such as development of low-cost high-throughput markers; modelling for better monitoring of marker-assisted breeding strategies; and development of innovative phenotyping protocols. These pioneer approaches will serve both well-studied and under-studied crops, and they will increase the efficiency of plant breeding, thus generating improved germplasm for drought-prone environments.

This project will speed access to wider crop diversity and the adoption of marker technologies in the South by linking activities along the GCP research pathway and establishing regional molecular breeding communities that share common facilities (eg, Mekong countries for rice, North China provinces for wheat, East Africa for sorghum and West Africa for cassava). This approach represents excellent opportunities for assembling and stimulating interactions between breeder teams from different NARS who work on a set of target crops.

Applying advances in plant breeding could literally transform the landscape in developing countries by addressing threats to agriculture, such as drought. This project promotes and demonstrates the added value of using marker technologies in combination with accurate phenotypic approaches to improve crop productivity of major staple crop food in drought-prone environments. Through this focus on genetic gain under water-limited conditions, the project will directly contribute to adaptation to climate change, with concomitant implications for enhanced food security under severe conditions.

GCP’s fundamental efforts to develop new knowledge and products to improve plant breeding—and this project in particular—support the first United Nations Millennium Development Goal and to a certain extent goals 4, 5, 7 and 8. When GCP’s fundamental efforts result in the development of superior varieties that are used by farmers, they offer potential for poor farm households to improve their food and nutritional security, as well as boost their income.

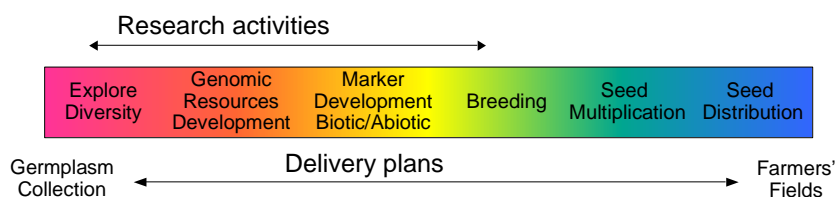
Delivery strategy:

GCP’s revised Strategic Framework (2007) lays particular emphasis on product management and delivery, cognisant of two key factors:

- the importance of ensuring impacts for target beneficiaries (breeders and resource-poor farmers in GCP’s case), and
- the fact that GCP is a time-bound Programme, terminating in 2013, and therefore the sustainability of the research and GCP products must be considered in the delivery plan right from the beginning of the projects.

Given our increased focus on research products and users, we formulated a specific Delivery Strategy. The strategy clearly defines, among other aspects, what we mean by the terms ‘users’ and ‘products’ in the context of the Generation Challenge Programme, and as our contribution to research-for-development (R4D) in the form of international public goods.

As illustrated in our research–delivery pathway below, direct GCP activities end at pre-breeding stage, which is why our partners are so crucial to our work if we are to have impact on our main target beneficiaries—crop breeders and resource-poor farmers in drought-prone environments.



GCP research is entirely demand-driven—we do not conduct basic research in a vacuum. As such, and as a safeguard to ensure delivery, GCP requires that all new projects identify clearly quantifiable outputs, as well as intended users. These intended users must be involved in the development and implementation of the project workplan. Above a certain threshold of financial support, a structured project delivery plan is requested before the project begins; the GCP Delivery Plan Kit (DPKit) is filled in close consultation with the intended users of the research conducted in the project. Delivery plans ensure that researchers clearly define, from the outset: i) the products of their research, and ii) who the users of their research will be.

We launched the DPKit in 2007 and we will continue to develop and refine the DPKit based on user feedback. One of these auxiliary modifications is to provide a rationale on why we require delivery plans.

Visibility:

As in the past, we will continue to acknowledge the European Union’s financial support to GCP. But we want to go further and be more specific about the activities and outputs that will be generated through activities supported by these funds, underscoring how those outputs fit within the EC’s strategy for poverty alleviation through research and development in international agriculture, especially with the first component of the EC’s Food Security Thematic Programme. Therefore, we will produce special publications and flyers on GCP’s EC-supported activities, and corresponding impact, or outstanding achievement.

In the ‘Partners and funders’ section of our website, we acknowledge the generous and consistent financial contribution of the EC to our work. As more tangible products begin to flow from GCP’s research, we will highlight particular products on our website, in addition to print media, in which we will acknowledge EC support consistent with EC’s visibility guidelines. The focus of these communications will be products that are international public goods, and products that ultimately benefit resource-poor farmers in drought-prone environments. This also includes progress in capacity-building and networking at national, subregional, regional and global level.

Linkages to CGIAR system priorities:

Sustaining biodiversity for current and future generations	%
Producing more and better food at lower cost through genetic improvements	100 %
Reducing rural poverty through agricultural diversification and emerging opportunities for high- value commodities and products	%
Promoting poverty alleviation and sustainable management of water, land and forest resources	%
Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger	%

Target regions:

Asia (including Central Asia) and Pacific Islands	35%
Latin America (including Caribbean)	5%
Middle East and North Africa	%
Sub Saharan Africa	60%

Duration:

2008 – 2010

Budget (‘ 000 €)

2008: 1,200.0

2009: 1,100.0

2010: 1,100.0

Internet address of the Project full description (MTP 2008-2010):

The project is reported in the 2008–2010 MTP under ‘Subprogramme 3’ in the narrative sections (pp 11; 17–18; 28–31), and as ‘Project 3’ in the logframe (pp 56–60) at:

<http://www.generationcp.org/UserFiles/File/MTP%202008-2010--GenChP2final.pdf>

Internet address of the Centre:

The CGIAR Generation Challenge Programme website is at: www.generationcp.org

Annex 11. Scientific Publications 2009-10

Project publications 2009 – all Sub-programmes (from GCP annual report)

Books

Open access

None

Not open access

Serraj R, Bennett J and Hardy B, eds (2009). *Drought frontiers in rice: Crop improvement for increased rainfed production*. World Scientific Publishing Co, Singapore, Singapore. ISBN: 978-981-4280-00-6. 408 pp. <http://www.worldscibooks.com/lifesci/7368.html>

Book chapters

Open access

None

Not open access

Hervé P and Serraj R (2009). GM technology for drought resistance. In: *Drought frontiers in rice: Crop improvement for increased rainfed production* (Serraj R, Bennett J and Hardy B, eds). World Scientific Publishing Co, Singapore, Singapore, pp 333-350. ISBN: 978-981-4280-00-6 (DOI: 10.1142/9789814280013_0019).

Hijmans RJ and Serraj R (2009). Modeling spatial and temporal variation of drought in rice production. In: *Drought frontiers in rice: Crop improvement for increased rainfed production* (Serraj R, Bennett J and Hardy B, eds). World Scientific Publishing Co, Singapore, Singapore, pp 19-31. ISBN: 978-981-4280-00-6 (DOI: 10.1142/9789814280013_0002).

Jayashree B and Hoisington DA (2009). Bioinformatics tools for crop research and breeding. In: *Molecular techniques in crop improvement*, Volume II (Jain SM and Brar DS, eds). Springer, Dordrecht, The Netherlands, pp 97-116. ISBN: 978-90-481-2966-9 (DOI: 10.1007/978-90-481-2967-6_4).

Kikuchi S (2009). Massive collection of full-length complementary DNA clones and microarray analyses: Keys to rice transcriptome analysis. In: *QP-PQ: Quantum probability and white noise analysis, Volume XXIV: Quantum Bio-Informatics II-From quantum information to bio-Informatics* (Accardi L, Freudenberg W and Ohya M, eds). Part of series *QP-PQ: Quantum probability and white noise Analysis*, Volume XXIV. World Scientific Publishing Co, Singapore, Singapore, pp 265-289. ISBN: 978-981-4273-74-9. http://www.generationcp.org/UserFiles2/File/Research/PI-Publications/2009/Kikuchi-bk-chap-09_Abstract.pdf

Kochian LV, Hoekenga OA, Magalhaes JV and Pineros MA (2009). Maize aluminum tolerance. In: *Handbook of maize: Its biology* (Bennetsen J and Hake S, eds). Springer-Verlag, New York, USA, pp 367-380. ISBN: 978-0-387-79417-4. <http://www.springer.com/life+sciences/plant+sciences/book/978-0-387-79417-4>

McNally KL, Naredo ME and Cairns J (2009). SNP discovery at candidate genes for drought responsiveness in rice. In: *Drought frontiers in rice: Crop improvement for increased rainfed production* (Serraj R, Bennett J and Hardy B, eds). World Scientific Publishing Co, Singapore, Singapore, pp 311-324. ISBN: 978-981-4280-00-6 (DOI: 10.1142/9789814280013_0017).

Romagosa I, van Eeuwijk FA and Thomas WTB (2009). Statistical analyses of genotype by environment data. In: *Cereals* (Carena MJ, ed). Part of series *Handbook of plant breeding, Volume 3*. Springer, New York, USA, pp 291-331. ISBN: 978-0-387-72294-8 (DOI: 10.1007/978-0-387-72297-9_10).

Serraj R, Dimayuga G, Gowda V, Guan Y, He H, Impa S, Liu DC, Mabesa RC, Sellamuthu R and Torres R (2009). Drought-resistant rice: physiological framework for an integrated research strategy. In: *Drought frontiers in rice: Crop improvement for increased rainfed production* (Serraj R, Bennett J and Hardy B, eds). World Scientific Publishing Co, Singapore, Singapore, pp 139-170. ISBN: 978-981-4280-00-6 (DOI: 10.1142/9789814280013_0009).

Serraj R and Atlin G (2009). Drought-resistant rice for increased rainfed production and poverty alleviation: a concept note. In: *Drought frontiers in rice: Crop improvement for increased rainfed production* (Serraj R, Bennett J and Hardy B, eds). World Scientific Publishing Co, Singapore, Singapore, pp 385-400. ISBN: 978-981-4280-00-6 (DOI: 10.1142/9789814280013_0022).

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Varshney RK (2009). Gene-based marker systems in plants: high-throughput approaches for marker discovery and genotyping. In: *Molecular techniques in crop improvement*, Volume II (Jain SM and Brar DS, eds). Springer, Dordrecht, The Netherlands, pp 119–142. ISBN: 978–90–481–2966–9 (DOI: 10.1007/978-90-481-2967-6_5).

Journal articles

Open access

Bertioli D, Moretzsohn M, Madsen LH, Sandal N, Leal-Bertioli S, Guimarães P, Hougaard BK, Fredslund J, Schauer L, Nielsen AM, Sato S, Tabata S, Cannon S and Stougaard J (2009). An analysis of synteny of *Arachis* with *Lotus* and *Medicago* sheds new light on the structure, stability and evolution of legume genomes. *BMC Genomics* 10:45 (DOI: 10.1186/1471-2164-10-45). <http://s2.generationcp.org/UserFiles/File/Arachis-Lotus-Medicago-Bertioli--2009.pdf>

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Bruce M, Hess A, Bai J, Mauleon R, Diaz MG, Sugiyama N, Bordeos A, Wang G-L, Leung H and Leach JE (2009). Detection of genomic deletions in rice using oligonucleotide microarrays. *BMC Genomics* 10:129 (DOI: 10.1186/1471-2164-10-129). http://www.generationcp.org/UserFiles2/File/Research/PI-Publications/2009/Bruce-et-al_Detection-genomic-deltions_BMC-Genomics_2009.pdf

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Annex 12. Recommendations from the 2007 External review of GCP

1. The review panel recommends that GCP establish simple Programme-level success criteria to provide GCP Management Team the means to focus, measure and monitor GCP programme effectiveness.
2. The review panel recommends that GCP management establish and apply a prioritisation process to identify the highest impact opportunities that GCP (Programme-level) can actually achieve and deliver to appropriate impact channels during its remaining six years.
3. The review panel recommends that GCP deploy the majority (at least 50 percent) of its resources in pursuit of the seven highest impact Programme-level trait-in-crop products that it can achieve over the next five years.
4. The review panel recommends that GCP management in consultation with the curators of the source collections establish the protocols by which each GCP reference set will be maintained and distributed; and the means by which the current genotypic data and passport (catalogued) information on these reference sets will be maintained and augmented by current and future (non-GCP) discovery efforts that employ these collections.
5. The Review Panel recommends that GCP management revisit the skills training aspect of SP5 and focus skills training on the specific needs of the case studies and highest priority trait improvement projects.
6. The review panel recommends that during setup of the Executive Board, a strong emphasis is placed on creating sufficient capacity and expertise for the Board to fulfill its duties, especially in: <ul style="list-style-type: none"> • setting strategic direction for GCP; and, • overseeing GCP finances and managing risks, also those relating to the host centre.
7. The review panel recommends that an attempt is made to further simplify and clarify GCP governance by adapting the Consortium Agreement to the de facto status quo, and to clearly define the role and responsibilities of additional GCP governance bodies (the PSC, the PAC, the Stakeholder Committee).
8. The review panel recommends that GCP upgrade all Subprogramme Leader positions to fulltime positions for the next three years. Since SP3 and SP5 Leaders already have fulltime positions, this implies to move the leadership of SP1, SP2 and SP4 from halftime to fulltime positions (in order to provide the necessary management capacity for Programme-level management and the fulfillment of management duties in their respective SPs; and to avoid split responsibilities between the GCP and the SP Leaders' home institutions).
9. The review panel recommends GCP management adopt an end-product orientation for GCP activities, ie, the integration, alignment and prioritisation of product-oriented projects across Subprogrammes in line with high-priority programme-level product objectives. To support this, the Review Panel recommends that GCP management acquire or develop a product project portfolio management system to help it plan, monitor and manage its best opportunities (achievable high-priority Programme-level objectives).

GCP management accepted all recommendations. Particularly relevant to Sub-programme 3 are:

Recommendation 1. Fully implemented by 2010 (note need for individual project annual reports to clearly state achievement of planned outputs)

Recommendation 2: Fully implemented – project portfolio re-focussed to the highest priority output areas. Molecular Breeding Platform created and re-focussed to GIBS

Recommendation 9: Fully implemented - re-formulated on a crop basis to fit with CG MPs and Product Manager appointed and ensuring wide dissemination of products.

THE STANDARD DAC FORMAT FOR EVALUATION REPORT SUMMARIES¹

Evaluation title

Monitoring mission of the 2009 EC Support to Strategic Agricultural Research through the CGIAR Centres for Food insecure Countries in Sub-Saharan Africa, Asia, Latin America and West Asia/North Africa Regions.

Subject of the evaluation

Review progress under CG SP2 made in 2009-10 by Generational Challenge Programme Sub-Programme 3 (CIMMYT 66).

Evaluation description

Purpose: Review progress made and achievements in 2009 and 2010 and earlier against a set of milestones and detailed outputs and gains made by the project, considering the views of the collaborators and users (primary recipients) of the Generation Challenge Programme, Sub-Programme 3 and its contribution to the CGIAR SP2. Review outputs, evaluate accordingly, suggest improvements/reorientation, provide information and make recommendations with regard to the EC support strategy for the CGIAR in the future, and in particular for GCP.

Methodology: evaluation on the basis of reference documents made available by GCP (hosted at CIMMYT), presentations by GCP staff and collaborating institutions representatives met in Mexico and during a field visit to India (ICRISAT, UAS, TNAU, IRRI, Syngenta, IARI, ICAR). Assessment of the relevance, efficiency, effectiveness, practical implementation of SP2, synergy and collective action, international or regional public goods character, impact, sustainability, visibility of EC co-financing and overall performance rating of GCP research, particularly within the GCCP Sub-Programme-3.

Main findings

Relevance, efficiency, effectiveness, practical implementation of the SP, synergy and collective action, international or regional public goods character, impact, sustainability, visibility of EC contribution and overall performance are all rated highly satisfactory or satisfactory. Active, synergistic, well managed and successful collaborations between the NARS, ARIs and the CG centres have been the hallmark of the programme. Technical progress has been rather slower than expected with restrictions to international movement of germplasm a particular problem, but outputs will be achieved within budget and exploitation now enters an exponential phase of capitalisation on earlier solid foundations. The proposed GIBS molecular breeding platform based within the CG Mega Programmes is the best way to encapsulate results so far and to ensure their wide and sustained application.

Recommendations

Financing to be continued.

- It is recommended that GCP facilitate the introgression of the *Pup1* phosphorous deficiency tolerance trait from rice and of Striga tolerance into sorghum for Africa.
- It is recommended that more attention be paid to working with the nodal institutions within partner countries which have the national mandate for particular crop-related functions.
- It is recommended that project reporting make it clear where and when agreed outputs have been achieved.

- It is recommended that GCP expand support for facilitating international germplasm transfer agreements.
- It is recommended that urgent consideration be given to the integration of the GIBS Breeding platform in the revised CG structure.
- It is recommended gender be given a stronger focus.
- It is recommended that GCP further support analyses of their most successful projects
- It is recommended that the GCP programme management system should have a period of stability on basis of the 2011-13 MTP.
- It is recommended that the EC urgently provide a letter of commitment in response to the funding request of the GCP for July 2011 to 2013.

Feedback

To be completed by AIDCO/H/6

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