

**Operations Manual of the International Cocoa Quarantine Centre, Reading
(ICQC,R).
Version: May 2021**



1. Management of ICQC,R

1.1. The title of the Centre (International Cocoa Quarantine Centre, Reading) signifies that this Centre is located at The University of Reading, but the material there is held in trust for the international cocoa community. It is managed by The University of Reading in line with their procedures for the management of externally funded projects with the day-to-day management responsibility devolved by the University of Reading to Prof Paul Hadley and his team in the School of Agriculture, Policy and Development.

1.2. In its management of ICQC,R, the University of Reading team is guided by an Advisory Board (QAB) comprising designated representatives of substantial long-term sponsors of ICQC,R, the project managers and staff of ICQC,R, together with appointed experienced external advisors on entomology, plant pathology and virology of the cocoa crop.

1.3. The members of the Advisory Board will nominate a Chairman and will meet approximately twice per annum at the University of Reading. These meetings will follow an inspection of the cocoa plants in the Centre by each of the externally appointed advisors who will provide a verbal report at the following meeting of the Quarantine Advisory Board followed by a written report. This written report will become part of the minutes of the Advisory Board. The external advisors may be paid a fee for their work and be reimbursed for expenses incurred to attend meetings. The attendance of other members of the Advisory Board will be self-funded. The Chairman of the Advisory Board may permit the participation of observers at the meetings of the Advisory Board as appropriate.

1.4. The minutes of the Board are circulated to the members of the Board and interested organisations in a draft form and will be approved formally at the next meeting of the Advisory Board.

1.5. Alternate Quarantine Advisory Board meetings can be followed by meetings of the International Cocoa Quarantine Forum, which provides a platform for sharing technical information relating to quarantine and germplasm movement, including disease detection techniques, identification of off-types, quarantine procedures and data capture as well as considering priorities for germplasm transfer via ICQC,R.

2. Financial Arrangements for ICQC,R

2.1. In line with normal practice in universities in the UK, the physical infrastructure used by ICQC,R remains the property of the University of Reading in perpetuity.

2.2. Financial contributions will be paid at regular intervals in accordance with the contract between the project sponsors (currently CRA and USDA) and the University of Reading in line with the agreed budgets. CRA gratefully acknowledges the on-going financial support received from ICE Cocoa Futures Europe, Mars-Wrigley and Mondelez International which are acknowledged on the signboard at the entrance to ICQC,R.

2.3 The external project advisors will be paid by CRA following their attendance at the Advisory Board and their submission of an invoice to CRA.

2.4. The University of Reading will levy an overhead of an amount determined through negotiation between each sponsor and the University.

2.5. For the ease of management and financial accounting, ICQC,R is managed as a whole regardless of the sources of funding and will be reported on that basis to the sponsors as far as is feasible.

2.6. As of 2021, ICQC,R comprises a heated polythene-covered greenhouse covering approximately 1000 m² located at Hall Farm (run by the School of Agriculture, Policy and Development) at Aborfield just outside Reading, UK.

2.7. It is understood that should the land at Hall Farm be required for other purposes (or sold), then the University of Reading will cover fully the costs of moving the ICQC,R to an alternative location of similar size and suitability (while keeping a safe distance from any other greenhouse plants that might at that time be growing at the University of Reading).

2.8. Any publications arising directly from the work of ICQC,R will duly acknowledge all the sponsors of the Centre.

2.9. The work of ICQC,R is publicised on the following website: <http://www.icgd.rdg.ac.uk/icqc/>, through the ICQC,R Newsletter and relevant conferences/workshops.

3. Technical Arrangements for ICQC,R

3.1. ICQC,R takes a pro-active approach in its quarantine operation, liaising with genebanks and with research institutes, breeding programmes and, where appropriate, private organizations in cocoa producing and consuming countries to identify material with useful traits, and act as a vehicle to ensure its efficient and safe distribution to those who request it.

3.2. In principle, ICQC,R only accepts material for quarantining that has already been placed in the public domain by its curators under the FAO International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) and is thereby available for onward movement to cocoa breeders on the basis of a reasonable request. Wherever possible, following such International guidelines, ICQC,R will acquire accessions through the FAO Standard Material Transfer Agreement (SMTA) from the donor institution. This will provide a clear agreement on the basis on which this/these accession(s) may be distributed and, in particular, that the material will continue to be held in the public domain (See Appendix III for the format of the SMTA).

3.3. Germplasm of known provenance is accepted into the ICQC,R. Priority will be given to germplasm of proven agronomic value (e.g. disease resistance) or that is known to be genetically distinct.

3.4. Germplasm can be imported as budwood, micro-grafted plants (grown in a soil free medium and washed free of growth medium), seeds, plantlets, somatic embryos and flower buds and must be accompanied by a phytosanitary certificate from the exporting country.

3.5. The name of an established accession is recorded in the standard International Cocoa Germplasm Database (ICGD) format. For ease of management, accessions are also assigned internal ICQC,R accession numbers (“RUQ”).

3.6. Donors are required to provide as full a documentary record as possible on the origins and characteristics of imported germplasm. This information is also recorded in ICGD and passed on to recipients of the material post passage through quarantine via reference to the ICGD.

3.7. All donors of plant material must provide information on the location of the specific tree in the genebank from which the material has been provided (ideally including GPS information). This is to allow follow up actions to be taken regarding the identity or plant health status of the original plant.

3.8. Quarantine procedures. These currently involve virus indexing and weekly checks over a two-year period, in accordance with current safe movement guidelines (End *et al.*, 2017). Procedures comply with the phytosanitary laws of the UK and the European Union (Council Directive 2000/29/EC, implemented by The Plant Health (England) Order 2005). ICQC,R is overseen by the UK Animal and Plant Health Agency (APHA) (the UK official body for matters of plant health) who conduct an annual inspection of the facilities and issue phytosanitary certificates for material prior to shipment from ICQC,R.

3.9. In exceptional circumstances, and on a case-by-case basis, the Quarantine Advisory Board may give consent for a quarantine period of less than two years for a given accession. In considering such a case the Quarantine Advisory Board will take into account the origin of the material and the pathogens present at source, the means by which it has been propagated and the amount of time that it has already spent in quarantine.

3.10. Germplasm within the collection is characterised at the University of Reading for genotypic and phenotypic characteristics for the benefit of the world cocoa community and the data is recorded in the ICGD.

3.11. Every effort is made to confirm the genetic identity of a given accession before it is released. Should an accession be exported which is subsequently shown to be mislabelled then institutions that have received this material are informed as such by ICQC,R. The University of Reading does not accept liability for any germplasm that is subsequently proved to be mislabelled. The genetic fingerprint of each accession held in ICQC,R is made public via the ICGD website.

3.12. The germplasm held within ICQC,R is a working collection of plants maintained under quarantine and, as such, will not necessarily be held *ad infinitum*. Should a decision be made to remove a particular accession (e.g. due to a lack of recent demand for it), potential recipients are informed of this at least six months prior to its removal and confirmation sought that the material is represented in at least one cocoa genebank elsewhere.

3.13. The availability of accessions within the ICQC,R is communicated to potential recipients via the web site, which has a dynamic clone list. Other appropriate means of publicity are also utilised.

3.14. Recipients of germplasm must provide an import permit to ICQC,R prior to export of material. Germplasm is normally provided as budwood and treated with pesticide/fungicide according to the regulations of the importing country if stated on the import permit. Prior to export, budwood must be inspected by an APHA Plant Health Officer, who provides the appropriate phytosanitary certificate. As much prior warning as possible of export shipments is therefore required to enable the necessary arrangements to be made.

3.15. All material will be provided under a Standard Material Transfer Agreement (SMTA).

3.16. All accessions in ICQC,R are held in the public domain and are freely available on request assuming availability of material and subject to SMTA protocols.

3.17. Institutions receiving germplasm are required to advise the ICQC,R team of the safe arrival of the budwood shipments and, later, the success rate of the buddings undertaken.

3.18. An annual report shall be sent to the Cocoa Research Centre (CRC), Trinidad, and to CATIE, Costa Rica (or elsewhere) at the end of the calendar year with details of material sent out over the previous 12 months that originated from CRC and CATIE (or elsewhere), respectively. This will include the success rate of the buddings at the recipient destination. Reports shall also be prepared for other institutions providing material to ICQC,R as required.

3.19. Should external research organisations request that material is propagated and raised, for exclusive use by that entity, within the ICQC,R greenhouses then reasonable endeavours will be made to meet this request depending on available space. Given the extra costs incurred an appropriate charge may be levied according to the amount of work involved.

3.20. Should a private organisation or commercial body request that materials be quarantined on an exclusive basis at the University of Reading then reasonable endeavours will be made to do this, on the condition that it does not conflict with the proper operation of the ICQC,R. In such circumstances the full costs of the quarantine operation are expected to be covered by the organisation requesting the service.

3.21. Because of the need to maintain phytosanitary standards, access to the quarantine facilities by University staff and visitors is strictly controlled. The procedures for visitors to the ICQC,R are strictly adhered to and are described as part of the 'Working Procedures within ICQC,R greenhouses (see Appendix I).

¹M.J. End, A.J. Daymond, P. Hadley, editors. 2017. Technical guidelines for the safe movement of cacao germplasm (Revised from the FAO/IPGRI Technical Guidelines No. 20). (third update, August 2017) Global Cacao Genetic Resources Network (CacaoNet), Bioversity International, Montpellier, France.
https://www.cacaonet.org/fileadmin/templates/CacaoNet/Uploads/publications/Safe_Movement_Guidelines_2017_En.pdf

APPENDIX I: Working procedures within the ICQC,R Greenhouses.

A. Quarantine Areas

As of 2021 the greenhouse is divided into three zones, according to the activities carried out in those areas (see Figure 1).

New Material Zone (compartment 4): This greenhouse is used for the establishment of imported material, raising of rootstocks and the production of test plants.

Quarantine Zone (compartment 5): Plants in this greenhouse undergo virus indexing (weekly visual checks of grafted test plants) and visual checks for other disease symptoms.

Post-quarantine Zone: Plants held in compartments 1, 2 and 3 have passed quarantine and are available for international distribution of budwood. Compartment 1 is also used for re-propagation of quarantined accessions and for holding second copies of clones that have particularly desirable traits (e.g. disease resistance) and materials for which a greater demand is anticipated.

Inspection of Quarantine Areas: An annual inspection of the ICQC,R greenhouses is conducted by an APHA officer and the externally appointed advisors carry out a twice-yearly inspection prior to a meeting of the Quarantine Advisory Board (QAB) and report to the QAB accordingly. The virus inspection will be undertaken one week prior to the meeting of the QAB to enable any required PCR testing to be undertaken on any suspicious plants prior to the meeting of the Board.

Access to the Greenhouses: Members of University staff who have previously been working in another greenhouse on the campus may NOT enter the ICQC,R greenhouses on the same day. Similarly, visitors who have been in recent contact with pathogens (of cocoa or other crops) may NOT enter the greenhouses (See also Section H for detailed visitor procedures).

B. Phyto-sanitary procedures

Sterilisation Procedures: Separate, labelled tools must be used for clean areas and for imported materials. Tools must always be sterilised with 70% ethanol before and after use, particularly when grafting new material and cutting budwood for export.

Imports: Imported plant material must be accompanied by a phytosanitary certificate and APHA needs to be informed in advance of a consignment arriving; a copy of the phytosanitary certificate should be sent to APHA in the event that it is not taken at the airport. The package must be opened in the laboratory and not the greenhouse. On arrival, the plant material is inspected visually for fungal or insect symptoms and staff should wear lab coats and disposable gloves during this process. The lab coat and gloves should then not be worn in the greenhouse. Any material with suspicious symptoms must be destroyed via autoclaving. In the event that insect or fungal matter is found on the imported material then the inspection area shall be sterilised with 70% ethanol. Normally plant material would have been treated prior to dispatch with a fungicide/ pesticide mixture. If there is any doubt as to whether the material has been treated, it must be treated at ICQC,R before being moved to the greenhouse. A general purpose pesticide, such as Calypso (a.i.

thiacloprid) along with a general purpose fungicide, such Systhane (a.i. myclobutanil, cyclohexanone), will be used for this.

Establishment of new material takes places in greenhouse 4. In the case of budwood, this is usually via patch budding. As a precautionary measure, newly imported micro-grafted plants or grafted material should be initially maintained in an insect-proof cage and monitored on a daily basis. Once established, they should then be subjected to a spraying programme should any signs of pests be present (as above).

Exports: Prior to scheduling an export, a valid import permit must be obtained from the country to which the material is due to be sent. An appointment should then be made for an official from the Animal and Plant Health Agency (APHA) to inspect the material via the eDomero on-line system. A copy of the import permit must also be sent to the APHA official. On the day of the export, budwood is cut, preferably from actively growing stems. The leaves are cut from the stems and green tips are removed within the greenhouse. When sending seedlings, these should be sent bare-rooted.

Budwood is inspected, treated (if necessary) and wrapped in the laboratory. Plant material should only be treated with a pesticide and/or fungicide if explicitly stated on the import permit. Similarly, the end of the budwood should be sealed with paraffin wax if stated on the permit.

Material sent in tissue culture or as flower buds should be in an appropriately sealed container. Such material also needs to be inspected by an APHA official and accompanied by a phytosanitary certificate.

Should the APHA official be satisfied with the condition of the plant material, they will then provide the phytosanitary certificate, thereby permitting the export.

Two copies of the following documents need to be sent with the plant material: -

- An import permit provided by the appropriate authority in the recipient country.
- A phytosanitary certificate provided by the APHA.
- A packing list, listing the clones provided and the corresponding accession number. The letter should state the importance of the recipient recording the accession number together with the clone name and request feedback on survival rates.
- Reference to the ICGD website as a means of obtaining characterisation data on the clones.
- A request for feedback from the recipient institution on the safe arrival of the material and at a later stage the success rate of the buddings.
- A Standard Material Transfer Agreement

If the plant material is sent via a courier, five copies of a customs declaration letter need to be included, stating the (nominal) value of the material.

As of 1st January 2021, when sending material to countries within the EU, an import permit and a pre-export inspection from the APHA official is now normally required.

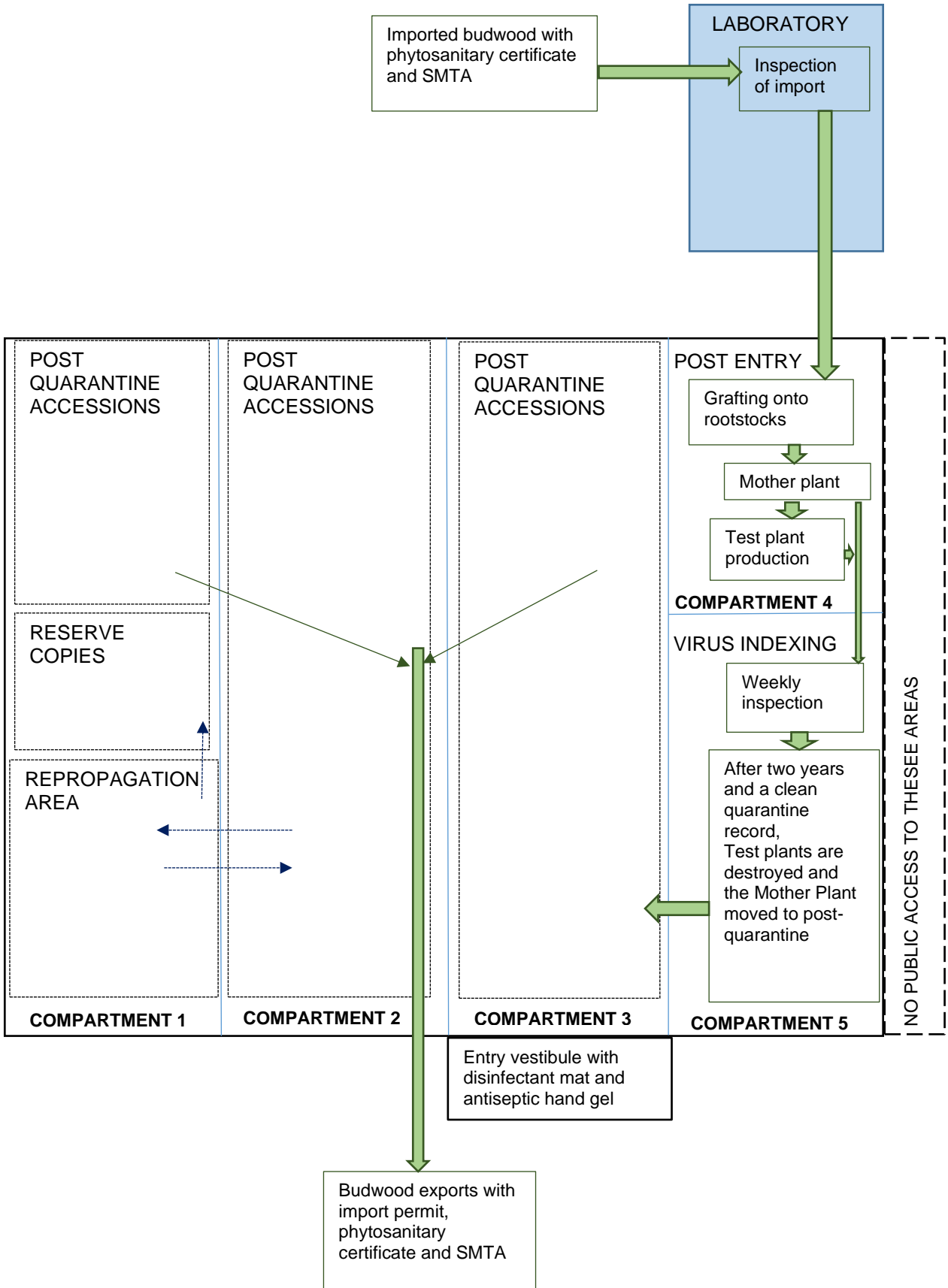


Figure 1: Layout and processes within the International Cocoa Quarantine Centre, at the University of Reading

Disposal Procedures

New Material Zone (Compartment 4):-

- New budwood: Any waste material remaining after the buds have been excised must be autoclaved prior to disposal.
- Rootstocks that have been grafted with new material that hasn't taken (i.e. the bud patch has died) must be autoclaved prior to disposal.
- Imported micro-grafted plants that do not survive must be autoclaved prior to disposal.
- Test-plants that do not take must be incinerated or autoclaved.
- Leaf material (when tidying up) must be incinerated or autoclaved.
- Packaging material must be incinerated or autoclaved.

Virus-Indexing Zone (Compartment 5):

- Plants that die must be incinerated after undertaking an inspection to ascertain the cause of death.
- Leaf material (when tidying up) must be incinerated.
- Test plants that have completed the two-year inspection period do not need a special disposal procedure since they have been shown to be clean.

Post-Quarantine Zone (Compartments 1-3):

- Since these plants are clean, no special disposal procedure is normally needed, unless a pathological cause of death of a plant is suspected.

C. Quarantine Observations

Recently Imported Material: Material that has recently been imported is kept under routine observation for the presence of pests and diseases. Should an exotic pest be discovered on a plant, the following steps should be followed: -

- i. The plant(s) should be isolated.
- ii. The APHA and the relevant external appointed advisor should be informed.
- iii. According to the recommendation of the APHA and the relevant advisor, the plant should either be destroyed or subjected to an appropriate spraying programme.
- iv. The plant(s) should only be re-introduced into the main greenhouse area when it is clear that they are clean.

Should signs of fungal infection be observed, the plant should be isolated and a sample should be sent to an appropriate authority for identification such as the CABI Plant Clinic. Should a plant be infected with a pathogenic fungus then it must be destroyed by incineration. An inspection visit should be undertaken by the appointed external pathology advisor at an early stage.

Virus Indexing: Virus indexing is carried out according to the guidelines set out in End *et al.* (2017). Budwood should be tested for the presence of Cacao Swollen Shoot Virus and other Badnaviruses by grafting on to Amelonado seedlings, which show conspicuous CSSV symptoms when infected. The seedlings (test plants) are then observed weekly for a period of two years. A given clone can only be released after the quarantine record and the test plants have been double-checked either by Prof Paul Hadley or Dr Andrew

Daymond. During the early stages of visual viral testing, the material is also tested using sets of PCR primers developed at the University of Reading and elsewhere. In the event of a positive PCR result, any products generated from this suite of tests are purified and further assessed using a direct-DNA sequencing service. The sequencing procedure helps determine the relatedness of them to the known Badnaviral sequences previously detected in cacao.

D. Procedure for Import and Quarantine of Material from West Africa

Prior to sending plant material to ICQC,R a number of specific steps must be taken at the West African origin as follows:-

- i. For a given clone, the designated trees and their neighbours will be examined for visual signs of CSSV and seemingly healthy individuals will be identified and labelled as donors with a durable label attached to the branch from which budwood is cut. Trees will not be selected within 20 m of any cocoa (or other) trees that are showing viral symptoms.
- ii. Two leaves from each selected tree (from separate branches) will be sent to Reading and tested using PCR primers. The leaves should be recently hardened from actively growing branches.
- iii. The molecular screening technique (developed by Dr Joël Allainguillaume and Dr Andy Wetten) will involve the use of degenerate primer pairs that target four conserved regions of the CSSV genome. Any products generated from this suite of tests will be purified and further assessed using an overnight direct-DNA sequencing service.
- iv. Should the results of the PCR tests be negative then ICQC,R will proceed to receive budwood from the selected labelled trees. If the result of the PCR procedure is positive then an alternative donor tree will be identified and the process will re-commence.
- v. When collecting the budwood in the field, particular care will be needed to ensure that the material is insect-free (especially free of mealybugs, since they are virus vectors). The budwood should then be dipped in an appropriate pesticide solution as per standard procedures.

On receipt of material at Reading, the following specific steps must be taken:-

- i. The budded plants will be kept in a separate insect-proof cage for three months.
- ii. Once established, leaf material from the growing-out scion (subsequently referred to as the Mother plant) will be PCR-tested using the procedure above.
- iii. Test plants will then be generated by budding from the established scion onto Amelonado rootstocks. At least three test-plants will be generated per clone established, which will then be inspected weekly (as per the current procedure) for two years.
- iv. Further PCR-tests will be conducted, taking samples from both the Mother plants and the tests plants at three-monthly intervals for the first year.
- v. Once the material has passed quarantine with a clean record then the Mother plant will be moved to the Collection and the test plants destroyed.
- vi. If more than one plant has been established for a given clone, then only the Mother plant, which has been subjected to virus-indexing will be maintained. Other copies of the clone will be destroyed once the Mother plant is firmly established and growing well.

E. General Husbandry and Greenhouse Maintenance

Daily Greenhouse Records

The following data will be recorded daily in each greenhouse to establish correct function of the heating, cooling and irrigation systems:-

- Maximum and minimum temperatures.
- Maximum and minimum humidity.
- Absence of interruptions to the heating. This can be seen from the graphical data on the control computer.
- That the backup heater pilot lights are on.
- That the automatic irrigation system has run (indicator jar in each greenhouse compartment has water in it).

Additionally checks should be made of the irrigation system which is located in compartment 3 where the following should be recorded:-

- pH of the solution in the mixing tank.
- Electrical conductivity (E.C.) of the solution in the mixing tank.

Temperature Control

Heating in each compartment is principally via a gas-powered boiler, which is thermostatically controlled to maintain a minimum temperature of 19°C at night and 25°C during the day. A low-temperature alarm is triggered if the temperature falls below 15°C. Two propane heaters provide back-up should there be a failure of the main heater. Cooling is achieved via a fan and louvre system that is triggered above a temperature of around 30°C. Vents are also present in the roof in greenhouses 1-3 which open if a temperature of 30°C is exceeded. All temperature set-points can be altered from the control computer.

Two override thermostats are present within each greenhouse compartment in case of computer failure. One of these is a low-temperature thermostat that triggers the heaters to come on if the temperature falls below 18°C. The second is a high-temperature thermostat that in the event of excess heating, causes the heaters to cut out and fans to come on should the temperature rise above 35°C.

Out of Hours Cover

During weekends and University closure periods, the daily checks stated above are carried out by ICQC,R and other University of Reading staff on an out-of-hours rota. A list is maintained by the University security section of staff who may be contacted in the event of an emergency (such as the activation of the low temperature alarm).

Plant Culture

All plants are grown in an inert medium of sand, gravel and vermiculite mixed in a ratio of 1:2:2. Plants are supplied with a nutrient solution (a modified form of Long-Ashton Solution developed at Reading) via an automatic irrigation system. The plants are watered through this system for 5 minutes at 5 times a day (8,10,12,14,16 hours). The nutrient stock solutions are maintained in two tanks ("A" and "B") and acid in a third tank. The conductivity in the mixer tank is controlled to 2.1 mS and pH to 5.7. The length of the irrigation cycle needs to be long enough to allow a significant run-off from the plant pots, thus preventing a potentially harmful build-up of electrical conductivity in them. The nutrient control system is calibrated on a monthly basis.

Supplementary Nutrient Feeding

In the event that particular plants exhibit iron or zinc deficiency symptoms, foliar feeding applications should be made as follows:

- Iron feeding: *Maxicrop* seaweed plus sequestered iron is applied at a rate of 4% (i.e. 16ml per litre of water) for plants showing significant signs of chlorosis or 1.4% (i.e. 14 ml per litre of water) for plants with first signs of chlorosis or as a preventative treatment. These treatments are applied using a 25 litre sprayer with 5ml of wetting agent (per 25 litres of water) using a fine cone nozzle to achieve a thin covering of moisture over the leaves. Iron EDTA can be added as a pot drench at a rate of 2% (i.e. 20g per litre of water). The pH of the solution needs to be adjusted to 5.6, this is done using Nitric Acid.
- Zinc feeding: Zinc sulphate ($ZnSO_4$) should be applied at a rate of 0.3% (i.e. 3g per litre of water) as above.
- Plants are monitored after a foliar feed and, if necessary, a second application made after two weeks. However, care must be taken not to over-feed as this may induce toxicity symptoms.

Potting Regime

Seeds are sown into small propagation seed trays with lids with around 6 seeds per tray. Care needs to be taken not to plant too many seeds in one tray since this may result in competition for nutrients. Germinated seedlings should be transplanted to 1 litre pots after 6-8 weeks. Grafted clones need transplanting to 3 litre pots after about 6 months. These are then later transplanted to 10 litre and finally to 50 litre pots when transferred to the collection. Virus test plants are maintained in a 3 litre pot for one year and then transferred to a 5 litre pot for the remaining year.

Thermal Screens/ Shading

Moveable thermal screens are present in all of the polytunnels. These are operated by light sensors that trigger them to close above a particular light threshold that is set on the control computer. The settings on the control computer also ensure that the screens close at night, thus contributing to energy saving.

Pest Control

A zero-tolerance policy of pests is maintained within the greenhouses of the quarantine centre. *In particular, exotic pests, such as mealybugs must never be allowed to become established.*

To achieve pest-free status, the following procedures are followed:-

- i. All greenhouses are thoroughly checked on a weekly basis.
- ii. Should insect or arachnid pests be present then these must be treated immediately. For localised outbreaks, a fogging device can be employed. For more widespread outbreaks a motorised sprayer is more appropriate.
- iii. A systemic pesticide such as Flonicamid should be applied on an annual basis. This will reduce the chance of sap-sucking insects, such as aphids, taking hold.
- iv. Biological control may be used in the event that pesticides are ineffective, particularly on juvenile plants.
- v. Yellow and blue sticky traps should be maintained in each greenhouse compartment for insect monitoring and be monitored on a weekly basis.
- vi. Staff and visitors entering the facility use a hand disinfectant and footbath.

The specific pesticides used will vary from time to time according to restrictions and recommendations. Care should be taken not to over-use a particular pesticide in order to prevent the build-up of resistance.

F. Plant Labelling

All accessions passing through quarantine should be labelled with the following information: -

- Clone name
- Accession number for ICQC,R (i.e. RUQ code)
- Date of receipt
- ID of seeding rootstock

Accessions that have passed quarantine should have a larger label, which in addition to the above information has the following:-

- Donor genebank
- Information on the origin of the clones (where available)

Any plants that are discovered to be mislabelled should be re-labelled using the convention in Turnbull *et al.* (2004) (See Appendix II).

G. Records

Records of each accession within the collection are maintained within a database which is accessible to staff on-line. This includes information on:-

- The date when the accession was received
- Where it was received from
- The plot and tree number in the donor genebank (with GPS data if available)
- Date when virus indexing began
- Date when released from quarantine
- Countries to which the clones have been exported

Information on where clones have been imported from and exported to is made available on the website.

Records of energy use are provided by the University's Utility Finance Administrator

Data security is ensured by maintaining copies of the database on the University main-frame system.

Once the virus-indexing process has begun for a given clone, a separate physical record sheet is kept for the observations on test plants.

H. Procedures for Visitors to ICQC,R

Visitors are asked to sign in before entering the greenhouse premises. The list of visitors during a given reporting period are tabled during the meeting of the Quarantine Advisory Board.

The following information is provided to prospective visitors of the ICQC,R:-

“Welcome to the International Cocoa Quarantine Centre at the University of Reading. The Centre exists to facilitate the safe movement of cocoa planting material. Quarantine procedures are vital to ensure that pests and diseases of cocoa are not transferred between cocoa-growing regions. It is important also to be aware that people themselves have the potential to transfer fungal spores and pests from their clothing, footwear etc. For this reason the International Cocoa Quarantine Centre has a Standard Operating Procedure for receipt of visitors as follows:-

1. When planning your visit, please be aware that visitors are not permitted to enter the quarantine facilities if:-
 - a. They have been on a cocoa farm or visited a cocoa field trial in areas where frosty pod rot (*Moniliophthora roreri*) is present (Central and South America and in Jamaica) during the previous two weeks.
 - b. They have been on a cocoa farm, visited a cocoa field trial or have been in contact with cocoa pests or pathogens in any other region within one week of the visit.
2. Visitors who are travelling to the UK from other countries should allow at least one day from arrival in the UK to the time they come to the facility.
3. Please do not wear any clothing including footwear and accessories (glasses, watches) that you have recently worn on a cocoa farm or a cocoa field trial or bring a camera that you have recently used in the field. Prior to entry, all visitors will be required to sign the Register of Visitors and state their name, affiliation and email address.
4. Visitors and University staff/ students shall not enter the ICQC, R greenhouses after being in other greenhouses on the University campus on the same day.
5. In the case of UK visitors, on the day of your visit, please refrain from handling plant material in your garden or greenhouse that might have pests or diseases on them (we are particular concerned that persistent and difficult to control pests such as mealybugs and scale insects do not enter the facility).
6. Space is provided in the office building for you to leave your personal effects (bags etc.) before entering the greenhouses. You are not allowed to bring these into the greenhouses of the facility.
7. Please be aware that you will be asked to walk over a disinfectant mat and sterilise your hands with a gel before entering the greenhouse.
8. Please ask ICQC,R staff if you are unsure about entering the facility.

Thank you for your understanding in observing the above procedures and we hope that you enjoy your visit to the International Cocoa Quarantine Centre.”

Appendix II: Procedure for renaming offtypes

Tackling Mislabelling in Cocoa Germplasm Collections

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³ Alternate Crops and Systems Lab, Plant Sciences Institute, Beltsville Agricultural Research Center, USDA/ARS, Beltsville, MD 20705. USA.

⁴ CIRAD/BIOTROP, TA 40/03, Avenue Agropolis, 34398 Montpellier Cedex 5. France.

Introduction

Cocoa is unusual amongst crop species in that its germplasm has to be maintained as live collections. This is because its recalcitrant seed are ill suited for long-term storage. Incorrectly labelled accessions have always been a problem in these collections, and until recently, the tools have not been available to clearly identify mislabelled clones. However, the emergence of reliable genetic fingerprinting techniques has enabled great strides to be made in the molecular characterisation of cocoa germplasm held in *ex situ* collections. Incorrectly labelled accessions can be broadly divided into the following 3 categories: a) synonymous designation, where the same genotype carries different names; b) homonymous designation, where different genotypes carry the same name; and c) non-designation, where accessions lack any name. Cocoa is not unique in having a significant mislabelling problem in *ex situ* collections. Indeed, mislabelled clones have been identified in collections of a variety of tree species including Eucalyptus (Keil and Griffin, 1994), Sitka spruce (Wilhelmina *et al.*, 1995) and oil palm (Purba *et al.*, 2000), and even in crop genebanks such as potato (Huamán *et al.*, 2000) and enset (Negash *et al.*, 2002).

Preliminary work performed on material held in the International Cocoa Genebank collection in Trinidad (ICG,T) using RAPD analysis suggested that up to 30% of trees may be mislabelled (Christopher *et al.*, 1999). However more recent work by Motilal (2004) revises this estimate downwards to around 12% on the basis of the more reliable SSR technique. There is no intrinsic reason to suggest that there are fewer mislabelling events elsewhere, particularly since ICG,T has historically acted as a major donor of cocoa material for other collections. Motilal and Butler (2003) provided circumstantial evidence in support for this view when they estimated the global figure of putative off-types to stand at about 30% on the basis of a survey of the International Cocoa Germplasm Database (ICGD). DNA fingerprinting, together with an increasing body of morphological descriptors for cocoa now make it possible for curators to identify mislabelled clones within their collections with some ease. Once a tree within a collection has been identified as being mislabelled, a simple mechanism is needed for renaming this individual in a clear and unambiguous way. Here, we propose a system for renaming mislabelled clones, intended as a guide for curators of all cocoa germplasm collections. If the system is implemented widely, it is hoped this will minimise the potential confusion that could arise from unstructured approaches to the renaming of clones around the world.

How can mislabelling occur?

There are a number of ways in which mislabelling can occur:

- Plants may lose their labels or the labels may become illegible;
- Plants may be moved before being properly labelled;
- Labels may get mixed up during vegetative propagation;

- Detached labels on the ground may be re-attached to the wrong plant;
- Dieback may result in labels being lost when a dead branch breaks;
- Chupons may grow from the rootstock and be confused with the scion;
- Established seedlings may be confused with the original tree;
- Some plants may be mislabelled in the greenhouse (human error);
- Introduction of synonymous germplasm (with different names) from abroad;
- Simple transcription errors can occur during plant propagation or label replacement.

Genotypes are difficult to distinguish on the basis of appearance during greenhouse propagation and when initially planted in the field, since there are usually no flowers or pods. Consequently, identification at this stage relies heavily on the plant labels and field maps. However, maps become outdated when trees die or are replaced, or even when an old tree falls and a new “main trunk” becomes established in a new location. Furthermore, hand annotation of maps is prone to misinterpretation and the problem can be confounded by high planting densities and irregular-shaped field plots with unclear boundaries; this can lead to ambiguities if individual trees are not labelled.

What is being done in Trinidad (ICG,T)

Trees in original plantings:

Many original trees, which are located at Marper Farm, act as vital reference genotypes for many international clones that have been distributed around the world. A number of steps have been taken to tackle the mislabelling problem in this collection:

- Trees found growing in Marper Farm with no labels were given new labels and assigned new names (CRU 1 to CRU 155).
- While revising maps in 2001-2002, more trees were found with uncertain identities and assigned new names (MARPER 1 and MARPER 55).
- It has been possible to re-assign original clone names to some “CRU” and “MARPER” accessions using historical hand-written records.
- Even where the original identity of accessions have been lost, we still know something about the germplasm; it is either Pound’s Refractario collection from Ecuador (1937) or his Upper Amazon collection from Peru (1938).
- Furthermore, it may soon be possible to learn more of the genetic origin of these clones by their classification/grouping based on DNA fingerprints (Sounigo *et al.*, 1996; J-C Motamayor, pers. com.).
- Using 116 PA accessions maintained at Marper farm and 57 ICS accessions maintained at the Cheeseman field as two test cases, we have assessed the extent of mislabelling in the reference genotypes. The result of SSR fingerprinting showed that only 2-3% of the PA and ICS trees were synonymously mislabelled (the same genotype given different names). Moreover, for all the mislabelled trees, comparing the SSR profile of the mislabelled ones with its neighbours allowed us to make corrections. This result shows that there is a trustworthy reference that can serve as a baseline for individual identification.

Trees in replicate plantings:

Many clones have been replanted in replicated blocks at ICG,T. Here too, a number of steps have been taken to tackle mislabelling which can occur amongst replicates in individual clonal plots:

- It is usually possible to check the identity of trees replicated in a new location by comparison with the original tree:

- Initially fruit and flower morphology are compared;
- In cases of doubt, DNA fingerprints can be compared.
- Where such comparisons are feasible, it is possible to determine which trees are true to type and which are off-types with confidence.
- It is often difficult to confirm the identity of a replicate where the “original” tree no longer exists. Passport data can help enormously, though this has been lost in many cases.
- However, general characteristics of accession groups can be used to confirm that a clone fits into an appropriate group (such as NA, PA and IMC) in the absence of a reference tree.

How should we proceed?

In order to fully identify mislabelling within cocoa collections, morphological and molecular characteristics of clones for all accessions in the international collections need documenting:

- CRU has been recording morphological characteristics of accessions in the ICG,T for the last 12 years;
- DNA has been extracted from all the accessions in the CATIE collection (about 800 clones) and the ICG,T (about 2,300 clones); in all cases sampling the most original tree. These DNA samples are being used by USDA Beltsville to generate genetic fingerprints that will make it possible to compare replicate trees in the two Universal cocoa collections. To date, about 700 CATIE accessions and 900 ICG,T accessions have been genotyped.
- The entire collection at the University of Reading intermediate quarantine facility has been fingerprinted.

Similar procedures should be followed for all cocoa collections world-wide, to obtain reference DNA fingerprints from as many original trees as possible. This is an urgent matter, since many collections are aging.

Most of the laboratories involved in genetic fingerprinting are already using the CERVUS software package (Marshall *et al.*, 1998; Slate *et al.*, 2000) and other statistical tools to compare profiles that have been generated by a set of standard markers provided by CIRAD, France (Lanaud *et al.*, 1999; Risterucci *et al.*, 2000). The community has agreed to use a set of standard alleles provided by Nick Cryer, as controls for calling allele size, for the international set of markers. It has also been agreed that when using other microsatellites, standard genotypes should be used to compare output from different laboratories. The result we obtained so far confirmed that the set of 15 pairs of SSR primers can give sufficient statistical power for cocoa cultivar identification.

Using microsatellite data for the confirmation of clone identity is dependent on the existence of a known example of that genotype. We must define one clone for each accession to be the true-type specimen (the original tree if available or the source of distributed material).

What should happen to mislabelled plants?

There are three possible ways of dealing with a mislabelled plant once it has been identified:

- If positively matched to a known clone that is already growing in the collection, the plant could be removed;
- If positively matched to a known clone that is not growing in the collection, the plant could be relabelled with its proper clone name;
- If the plant does not match a known clone, it should be given a new name.

Although the curator of the germplasm collection will make the final decision, off-types that do not match a known clone should not automatically be removed since they may have valuable agronomic traits. Several of the “CRU” accessions have been shown to have useful traits subsequent to their establishment in the ICG,T. Similarly, resistance to *Moniliophthora* has been found in two accessions in CATIE which are now known to be off-types.

Renaming mislabelled clones

There is a need for a coordinated policy on the renaming of mislabelled accessions that can be followed by all curators of cocoa germplasm collections. Newly assigned names should be unique to the clone, they should have some meaning and should assist in documenting the origin of an off-type.

We propose the following procedure to avoid future confusion and provide mislabelling information for other users of the clone:

- The new name should begin with a unique identifier used within the collection. This would typically be the collection accession number, for example ICGT 123;
- In addition, the new clone name would include further information in brackets to indicate that the clone was originally misidentified:
 - The identifier MIS denotes that the clone has been mislabelled;
 - This is followed by a 7 letter code identifying the country and collection in which the mislabelled clone was found, e.g. ICG,T is TTOICGT (already used by ICGD and CocoaGenDB);
 - The full name on the original label is retained at the end of the new clone name, for example CLONE A/1 [TTO]. This could be 'UNKNOWN' or left blank if, for example, the plant had lost its label;
- These parts would be separated by underscores (not previously used in clone names) for clear identification of the parts, so the full clone name might be:
ICGT 123 (MIS_TTOICGT_CLONE A/1 [TTO])

Although this new name may seem very long, for discussions and correspondence the short first part of the name (ICGT 123) can be used since it is unique. The full name need only be used in written records (publications, labels, etc.) in order to highlight the mislabelling event. The shorter version could be used in publications, particularly in tables and graphs where space is limited, if the full name is referred to earlier in the article.

It is also possible that some off-types may only be renamed temporarily, since a positive identification might be possible once a comprehensive database of DNA fingerprints is available.

The role of the International Cocoa Germplasm Database (ICGD)

The ICGD will include detailed notes providing information on any mislabelling, including the technical data that provided evidence for the mislabelling and, where possible, the most likely identity or similarity based on genetic fingerprinting information.

If the mislabelled clone (e.g. CLONE A/1 [TTO]) is found to be identical to another (e.g. COCOA 1), then this is the name that should be used (i.e. COCOA 1). Notes would be included in ICGD to say that this clone was mislabelled at the particular station (e.g. COCOA 1 mislabelled as CLONE A/1 [TTO] at TTOICGT).

If there was a period of time between identifying a mislabelled clone and finding its true identity, then the name given to the mislabelled accession would become a synonym of the true clone name. For instance, in the example given above, ICGT 123 (MIS_TTOICGT_CLONE A/1 [TTO]) would still be maintained in the database, but as a synonym of COCOA 1.

The entire collection of the University of Reading Intermediate Cocoa Quarantine Facility has been fingerprinted using the international set of 15 microsatellite markers and the data has been included in the ICGD. These profiles are also being submitted to CocoaGenDB (<http://cocoagendb.cirad.fr>), a new cocoa genomics database being developed through a collaborative project involving ICGD, CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France) and USDA (United States Department of Agriculture, USA). It is hoped that the large number of profiles being generated in other laboratories using SSR markers will soon be submitted to CocoaGenDB (e-mail: tropgenedb@cirad.fr) and that this will continue as new fingerprinting projects develop. ICGD Online (<http://www.icgd.rdg.ac.uk>) will continue to include microsatellite profiles generated from the standard 15 markers to complement morphological data used for clone identification.

Summary

The level of mislabelling of cocoa clones in germplasm collections is fairly high. Although not a new problem, the availability of genetic fingerprinting technologies has allowed projects to be developed that use microsatellite markers to compare clones. However, it is important that when clones with the same name are found to have different profiles, one is determined to be the true type (with reference to the most original material). Off-types should be kept for their potential agronomic value, but with a unique new name.

We have proposed a format for renaming that highlights the mislabelling event and which includes references to the source germplasm collection and the name originally given to the clone.

Acknowledgements

The ICGD project is financed by Euronext.liffe¹ members and is administered by the Biscuit, Cake, Chocolate and Confectionary Association (BCCCA).

Maintenance of the ICG,T is supported by the BCCCA² and the Government of the Republic of Trinidad and Tobago.

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¹ This is now ICE Cocoa Futures and CRA

² Now CRA Ltd

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Citation: INGENIC Newsletter 2004, 9. 8-11

APPENDIX III

STANDARD MATERIAL TRANSFER AGREEMENT³

PREAMBLE

WHEREAS

The International Treaty on Plant Genetic Resources for Food and Agriculture (hereinafter referred to as “the **Treaty**”) was adopted by the Thirty-first session of the FAO Conference on 3 November 2001 and entered into force on 29 June 2004;

The objectives of the **Treaty** are the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture** and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security;

The Contracting Parties to the **Treaty**, in the exercise of their sovereign rights over their **Plant Genetic Resources for Food and Agriculture**, have established a **Multilateral System** both to facilitate access to **Plant Genetic Resources for Food and Agriculture** and to share, in a fair and equitable way, the benefits arising from the utilization of these resources, on a complementary and mutually reinforcing basis;

Articles 4, 11, 12.4 and 12.5 of the **Treaty** are borne in mind;

The diversity of the legal systems of the Contracting Parties with respect to their national procedural rules governing access to courts and to arbitration, and the obligations arising from international and regional conventions applicable to these procedural rules, are recognized;

Article 12.4 of the **Treaty** provides that facilitated access under the **Multilateral System** shall be provided pursuant to a Standard Material Transfer Agreement, and the **Governing Body** of the **Treaty**, in its Resolution 1/2006 of 16 June 2006, adopted the Standard Material Transfer Agreement.

³ In the event that the SMTA is used for the transfer of Plant Genetic Resources for Food and Agriculture other than those listed in Annex 1 of the Treaty:

The references in the SMTA to the "Multilateral System" shall not be interpreted as limiting the application of the SMTA to Annex 1 Plant Genetic Resources for Food and Agriculture, and in the case of Article 6.2 of the SMTA shall mean "under this Agreement"; The reference in Article 6.11 and Annex 3 of the SMTA to "Plant Genetic Resources for Food and Agriculture belonging to the same crop, as set out in Annex 1 to the Treaty" shall be taken to mean "Plant Genetic Resources for Food and Agriculture belonging to the same crop".

ARTICLE 1 — PARTIES TO THE AGREEMENT

1.1 The present Material Transfer Agreement (hereinafter referred to as “**this Agreement**”) is the Standard Material Transfer Agreement referred to in Article 12.4 of the **Treaty**.

1.2 **This Agreement is:**

BETWEEN: The University of Reading of PO Box 217, Whiteknights, Reading, Berkshire, RG6 6AH, United Kingdom (hereinafter referred to as “the **Provider**”),

AND: (*name and address of the recipient*) (hereinafter referred to as “the **Recipient**”).

1.3 The parties to **this Agreement** hereby agree as follows:

ARTICLE 2 — DEFINITIONS

In **this Agreement** the expressions set out below shall have the following meaning:

“**Available without restriction**”: a **Product** is considered to be available without restriction to others for further research and breeding when it is available for research and breeding without any legal or contractual obligations, or technological restrictions, that would preclude using it in the manner specified in the **Treaty**.

“**Genetic material**” means any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity.

“**Governing Body**” means the **Governing Body** of the **Treaty**.

“**Multilateral System**” means the **Multilateral System** established under Article 10.2 of the **Treaty**.

“**Plant Genetic Resources for Food and Agriculture**” means any **genetic material** of plant origin of actual or potential value for food and agriculture.

“**Plant Genetic Resources for Food and Agriculture under Development**” means material derived from the **Material**, and hence distinct from it, that is not yet ready for **commercialization** and which the developer intends to further develop or to transfer to another person or entity for further development. The period of development for the **Plant Genetic Resources for Food and Agriculture under Development** shall be deemed to have ceased when those resources are **commercialized** as a **Product**.

“**Product**” means **Plant Genetic Resources for Food and Agriculture** that incorporate⁴ the **Material** or any of its genetic parts or components that are ready for **commercialization**, excluding commodities and other products used for food, feed and processing.

“**Sales**” means the gross income resulting from the **commercialization** of a **Product** or **Products**, by the **Recipient**, its affiliates, contractors, licensees and lessees.

“**To commercialize**” means to sell a **Product** or **Products** for monetary consideration on the open market, and “**commercialization**” has a corresponding meaning. **Commercialization** shall not include any form of transfer of **Plant Genetic Resources for Food and Agriculture under Development**.

ARTICLE 3 — SUBJECT MATTER OF THE MATERIAL TRANSFER AGREEMENT

⁴ As evidenced, for example, by pedigree or notation of gene insertion.

The **Plant Genetic Resources for Food and Agriculture** specified in *Annex 1* to **this Agreement** (hereinafter referred to as the “**Material**”) and the available related information referred to in Article 5b and in *Annex 1* are hereby transferred from the **Provider** to the **Recipient**, subject to the terms and conditions set out in **this Agreement**.

ARTICLE 4 — GENERAL PROVISIONS

4.1 **This Agreement** is entered into within the framework of the **Multilateral System** and shall be implemented and interpreted in accordance with the objectives and provisions of the **Treaty**.

4.2 The parties recognize that they are subject to the applicable legal measures and procedures, that have been adopted by the Contracting Parties to the **Treaty**, in conformity with the **Treaty**, in particular those taken in conformity with Articles 4, 12.2 and 12.5 of the **Treaty**.⁵

4.3 The parties to **this Agreement** agree that (*the entity designated by the **Governing Body***),⁶ acting on behalf of the **Governing Body** of the **Treaty** and its **Multilateral System**, is the third party beneficiary under **this Agreement**.

4.4 The third party beneficiary has the right to request the appropriate information as required in Articles 5e, 6.5c, 8.3 and *Annex, 2 paragraph 3*, to **this Agreement**.

4.5 The rights granted to the (*the entity designated by the **Governing Body***) above do not prevent the **Provider** and the **Recipient** from exercising their rights under **this Agreement**.

ARTICLE 5 — RIGHTS AND OBLIGATIONS OF THE PROVIDER

The **Provider** undertakes that the **Material** is transferred in accordance with the following provisions of the **Treaty**:

- a) Access shall be accorded expeditiously, without the need to track individual accessions and free of charge, or, when a fee is charged, it shall not exceed the minimal cost involved;
- b) All available passport data and, subject to applicable law, any other associated available non-confidential descriptive information, shall be made available with the **Plant Genetic Resources for Food and Agriculture** provided;
- c) Access to **Plant Genetic Resources for Food and Agriculture under Development**, including material being developed by farmers, shall be at the discretion of its developer, during the period of its development;
- d) Access to **Plant Genetic Resources for Food and Agriculture** protected by intellectual and other property rights shall be consistent with relevant international agreements, and with relevant national laws;
- e) The **Provider** shall periodically inform the **Governing Body** about the Material Transfer Agreements entered into, according to a schedule to be established by the **Governing Body**.

⁵ In the case of the International Agricultural Research Centres of the Consultative Group on International Agricultural Research (CGIAR) and other international institutions, the Agreement between the Governing Body and the CGIAR Centres and other relevant institutions will be applicable.

⁶ By Resolution 2/2006, the Governing Body “invite[d] the Food and Agriculture Organization of the United Nations, as the Third Party Beneficiary, to carry out the roles and responsibilities as identified and prescribed in this Agreement, under the direction of the Governing Body, in accordance with the procedures to be established by the Governing Body at its next session”. Upon acceptance by the FAO of this invitation, the term, “the entity designated by the Governing Body”, will be replaced throughout the document by the term, “the Food and Agriculture Organization of the United Nations”.

This information shall be made available by the **Governing Body** to the third party beneficiary.⁷

ARTICLE 6 — RIGHTS AND OBLIGATIONS OF THE RECIPIENT

6.1 The **Recipient** undertakes that the **Material** shall be used or conserved only for the purposes of research, breeding and training for food and agriculture. Such purposes shall not include chemical, pharmaceutical and/or other non-food/feed industrial uses.

6.2 The **Recipient** shall not claim any intellectual property or other rights that limit the facilitated access to the **Material** provided under **this Agreement**, or its genetic parts or components, in the form received from the **Multilateral System**.

6.3 In the case that the **Recipient** conserves the **Material** supplied, the **Recipient** shall make the **Material**, and the related information referred to in Article 5b, available to the **Multilateral System** using the Standard Material Transfer Agreement.

6.4 In the case that the **Recipient** transfers the **Material** supplied under **this Agreement** to another person or entity (hereinafter referred to as “the **subsequent recipient**”), the **Recipient** shall

- a) do so under the terms and conditions of the Standard Material Transfer Agreement, through a new material transfer agreement; and
- b) notify the **Governing Body**, in accordance with Article 5e.

On compliance with the above, the **Recipient** shall have no further obligations regarding the actions of the **subsequent recipient**.

6.5 In the case that the **Recipient** transfers a **Plant Genetic Resource for Food and Agriculture under Development** to another person or entity, the **Recipient** shall:

- a) do so under the terms and conditions of the Standard Material Transfer Agreement, through a new material transfer agreement, provided that Article 5a of the Standard Material Transfer Agreement shall not apply;
- b) identify, in *Annex 1* to the new material transfer agreement, the **Material** received from the **Multilateral System**, and specify that the **Plant Genetic Resources for Food and Agriculture under Development** being transferred are derived from the **Material**;
- c) notify the **Governing Body**, in accordance with Article 5e; and
- d) have no further obligations regarding the actions of any **subsequent recipient**.

6.6 Entering into a material transfer agreement under paragraph 6.5 shall be without prejudice to the right of the parties to attach additional conditions, relating to further product development, including, as appropriate, the payment of monetary consideration.

⁷ The Standard Material Transfer Agreement makes provision for information to be provided to the **Governing Body**, in the following Articles: 5e, 6.4b, 6.5c and 6.11h, as well as in *Annex 2*, paragraph 3, *Annex 3*, paragraph 4, and in *Annex 4*. Such information should be submitted to:

The Secretary
International Treaty on Plant Genetic Resources for Food and Agriculture
Food and Agriculture Organization of the United Nations
I-00100 Rome, Italy

6.7 In the case that the **Recipient commercializes a Product** that is a **Plant Genetic Resource for Food and Agriculture** and that incorporates **Material** as referred to in Article 3 of **this Agreement**, and where such **Product** is not **available without restriction** to others for further research and breeding, the **Recipient** shall pay a fixed percentage of the **Sales** of the **commercialized Product** into the mechanism established by the **Governing Body** for this purpose, in accordance with *Annex 2* to **this Agreement**.

6.8 In the case that the **Recipient commercializes a Product** that is a **Plant Genetic Resource for Food and Agriculture** and that incorporates **Material** as referred to in Article 3 of **this Agreement** and where that **Product** is **available without restriction** to others for further research and breeding, the **Recipient** is encouraged to make voluntary payments into the mechanism established by the **Governing Body** for this purpose in accordance with *Annex 2* to **this Agreement**.

6.9 The **Recipient** shall make available to the **Multilateral System**, through the information system provided for in Article 17 of the **Treaty**, all non-confidential information that results from research and development carried out on the **Material**, and is encouraged to share through the **Multilateral System** non-monetary benefits expressly identified in Article 13.2 of the **Treaty** that result from such research and development. After the expiry or abandonment of the protection period of an intellectual property right on a **Product** that incorporates the **Material**, the **Recipient** is encouraged to place a sample of this **Product** into a collection that is part of the **Multilateral System**, for research and breeding.

6.10 A **Recipient** who obtains intellectual property rights on any **Products** developed from the **Material** or its components, obtained from the **Multilateral System**, and assigns such intellectual property rights to a third party, shall transfer the benefit-sharing obligations of **this Agreement** to that third party.

6.11 The **Recipient** may opt as per *Annex 4*, as an alternative to payments under Article 6.7, for the following system of payments:

- a) The **Recipient** shall make payments at a discounted rate during the period of validity of the option;
- b) The period of validity of the option shall be ten years renewable in accordance with *Annex 3* to **this Agreement**;
- c) The payments shall be based on the **Sales** of any **Products** and of the sales of any other products that are **Plant Genetic Resources for Food and Agriculture** belonging to the same crop, as set out in *Annex 1* to the **Treaty**, to which the **Material** referred to in *Annex 1* to **this Agreement** belongs;
- d) The payments to be made are independent of whether or not the **Product** is **available without restriction**;
- e) The rates of payment and other terms and conditions applicable to this option, including the discounted rates are set out in *Annex 3* to **this Agreement**;
- f) The **Recipient** shall be relieved of any obligation to make payments under Article 6.7 of **this Agreement** or any previous or subsequent Standard Material Transfer Agreements entered into in respect of the same crop;
- g) After the end of the period of validity of this option the **Recipient** shall make payments on any **Products** that incorporate **Material** received during the period in which this Article was in force, and where such **Products** are not **available without restriction**. These payments will be calculated at the same rate as in paragraph (a) above;
- h) The **Recipient** shall notify the **Governing Body** that he has opted for this modality of payment. If no notification is provided the alternative modality of payment specified in Article 6.7 will apply.

ARTICLE 7 — APPLICABLE LAW

The applicable law shall be General Principles of Law, including the UNIDROIT Principles of International Commercial Contracts 2004, the objectives and the relevant provisions of the **Treaty**, and, when necessary for interpretation, the decisions of the **Governing Body**.

ARTICLE 8 — DISPUTE SETTLEMENT

8.1 Dispute settlement may be initiated by the **Provider** or the **Recipient** or the (*the entity designated by the **Governing Body***), acting on behalf of the **Governing Body** of the **Treaty** and its **Multilateral System**.

8.2 The parties to **this Agreement** agree that the (*the entity designated by the **Governing Body***), representing the **Governing Body** and the **Multilateral System**, has the right, as a third party beneficiary, to initiate dispute settlement procedures regarding rights and obligations of the **Provider** and the **Recipient** under **this Agreement**.

8.3 The third party beneficiary has the right to request that the appropriate information, including samples as necessary, be made available by the **Provider** and the **Recipient**, regarding their obligations in the context of **this Agreement**. Any information or samples so requested shall be provided by the **Provider** and the **Recipient**, as the case may be.

8.4 Any dispute arising from **this Agreement** shall be resolved in the following manner:

- a) Amicable dispute settlement: The parties shall attempt in good faith to resolve the dispute by negotiation.
- b) Mediation: If the dispute is not resolved by negotiation, the parties may choose mediation through a neutral third party mediator, to be mutually agreed.
- c) Arbitration: If the dispute has not been settled by negotiation or mediation, any party may submit the dispute for arbitration under the Arbitration Rules of an international body as agreed by the parties to the dispute. Failing such agreement, the dispute shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce, by one or more arbitrators appointed in accordance with the said Rules. Either party to the dispute may, if it so chooses, appoint its arbitrator from such list of experts as the Governing Body may establish for this purpose; both parties, or the arbitrators appointed by them, may agree to appoint a sole arbitrator, or presiding arbitrator as the case may be, from such list of experts. The result of such arbitration shall be binding.

ARTICLE 9 — ADDITIONAL ITEMS

Warranty

9.1 The **Provider** makes no warranties as to the safety of or title to the **Material**, nor as to the accuracy or correctness of any passport or other data provided with the **Material**. Neither does it make any warranties as to the quality, viability, or purity (genetic or mechanical) of the **Material** being furnished. The phytosanitary condition of the **Material** is warranted only as described in any attached phytosanitary certificate. The **Recipient** assumes full responsibility for complying with the recipient nation's quarantine and biosafety regulations and rules as to import or release of **genetic material**.

Duration of Agreement

9.2 **This Agreement** shall remain in force so long as the **Treaty** remains in force.

ARTICLE 10 — SIGNATURE/ACCEPTANCE

The **Provider** and the **Recipient** may choose the method of acceptance unless either party requires **this Agreement** to be signed.

Signature

I, Gemma Lowe, represent and warrant that I have the authority to execute **this Agreement** on behalf of the **Provider** and acknowledge my institution's responsibility and obligation to abide by the provisions of **this Agreement**, both by letter and in principle, in order to promote the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture**.

Signature..... Date.....
Name of the **Provider**: The University of Reading

I, an Authorised Signatory of the Recipient, represent and warrant that I have the authority to execute **this Agreement** on behalf of the **Recipient** and acknowledge my institution's responsibility and obligation to abide by the provisions of **this Agreement**, both by letter and in principle, in order to promote the conservation and sustainable use of **Plant Genetic Resources for Food and Agriculture**.

Signature..... Date.....
Name.....
Name of the **Recipient**:

Annex 1 of the SMTA

LIST OF MATERIALS PROVIDED

This *Annex* contains a list of the **Material** provided under **this Agreement**, including the associated information referred to in Article 5b.

This information is either provided below or can be obtained at the following website:
www.icgd.reading.ac.uk

The following information is included for each **Material** listed: all available passport data and, subject to applicable law, any other associated, available, non-confidential descriptive information.

Budwood derived from cocoa clones:

Annex 2 of the SMTA

RATE AND MODALITIES OF PAYMENT UNDER ARTICLE 6.7 OF THIS AGREEMENT

1. If a **Recipient**, its affiliates, contractors, licensees, and lessees, **commercializes a Product or Products**, then the **Recipient** shall pay one point-one percent (1.1 %) of the **Sales** of the **Product or Products** less thirty percent (30%); except that no payment shall be due on any **Product or Products** that:

(a) are **available without restriction** to others for further research and breeding in accordance with Article 2 of **this Agreement**;

(b) have been purchased or otherwise obtained from another person or entity who either has already made payment on the **Product or Products** or is exempt from the obligation to make payment pursuant to subparagraph (a) above;

(c) are sold or traded as a commodity.

2. Where a **Product** contains a **Plant Genetic Resource for Food and Agriculture** accessed from the **Multilateral System** under two or more material transfer agreements based on the Standard Material Transfer Agreement only one payment shall be required under paragraph 1 above.

3. The **Recipient** shall submit to the **Governing Body**, within sixty (60) days after each calendar year ending December 31st, an annual report setting forth:

(a) the **Sales** of the **Product or Products** by the **Recipient**, its affiliates, contractors, licensees and lessees, for the twelve (12) month period ending on December 31st;

(b) the amount of the payment due; and

(c) information that allows for the identification of any restrictions that have given rise to the benefit-sharing payment.

4. Payment shall be due and payable upon submission of each annual report. All payments due to the **Governing Body** shall be payable in *United States dollars (US\$)* for the following account established by the **Governing Body** in accordance with Article 19.3f of the **Treaty**:

**FAO Trust Fund (USD) GINC/INT/031/MUL,
IT-PGRFA (Benefit-sharing),
HSBC New York, 452 Fifth Ave., New York, NY, USA, 10018,
Swift/BIC: MRMDUS33, ABA/Bank Code: 021001088,
Account No. 000156426**

**TERMS AND CONDITIONS OF THE ALTERNATIVE PAYMENTS SCHEME
UNDER ARTICLE 6.11 OF THIS AGREEMENT**

1. The discounted rate for payments made under Article 6.11 shall be zero point five percent (0.5 %) of the **Sales** of any **Products** and of the sales of any other products that are **Plant Genetic Resources for Food and Agriculture** belonging to the same crop, as set out in Annex 1 to the **Treaty**, to which the **Material** referred to in *Annex 1* to **this Agreement** belong.
2. Payment shall be made in accordance with the banking instructions set out in paragraph 4 of *Annex 2* to **this Agreement**.
3. When the **Recipient** transfers **Plant Genetic Resources for Food and Agriculture under Development**, the transfer shall be made on the condition that the **subsequent recipient** shall pay into the mechanism established by the **Governing Body** under Article 19.3f of the **Treaty** zero point five percent (0.5 %) of the **Sales** of any **Product** derived from such **Plant Genetic Resources for Food and Agriculture under Development**, whether the **Product** is **available or not without restriction**.
4. At least six months before the expiry of a period of ten years counted from the date of signature of **this Agreement** and, thereafter, six months before the expiry of subsequent periods of five years, the **Recipient** may notify the **Governing Body** of his decision to opt out from the application of this Article as of the end of any of those periods. In the case the **Recipient** has entered into other Standard Material Transfer Agreements, the ten years period will commence on the date of signature of the first Standard Material Transfer Agreement where an option for this Article has been made.
5. Where the **Recipient** has entered or enters in the future into other Standard Material Transfer Agreements in relation to material belonging to the same crop[s], the **Recipient** shall only pay into the referred mechanism the percentage of sales as determined in accordance with this Article or the same Article of any other Standard Material Transfer Agreement. No cumulative payments will be required.

**OPTION FOR CROP-BASED PAYMENTS UNDER THE ALTERNATIVE PAYMENTS
SCHEME UNDER ARTICLE 6.11 OF THIS AGREEMENT**

I (*full name of **Recipient** or **Recipient's authorised official***) declare to opt for payment in accordance with Article 6.11 of **this Agreement**.

Signature.....

Date.....⁸

⁸ In accordance with Article 6.11h of the Standard Material Transfer Agreement, the option for this modality of payment will become operative only once notification has been provided by the **Recipient** to the **Governing Body**. The signed declaration opting for this modality of payment must be sent by the **Recipient** to the **Governing Body** at the following address and whether or not the **Recipient** has already indicated his acceptance of this option in accepting **this Agreement** itself:

The Secretary,
International Treaty on Plant Genetic Resources for Food and Agriculture
Food and Agriculture Organization of the United Nations
I-00100 Rome, Italy

The signed declaration must be accompanied by the following:

- The date on which **this Agreement** was entered into;
- The name and address of the **Recipient** and of the **Provider**;
- A copy of Annex 1 to **this Agreement**.