Supplying New Cocoa (*Theobroma Cacao* L.) Planting Material to Farmers: *A review of cacao propagation methodologies*

Augusto Roberto Sena Gomes[1], George Andrade Sodré[2], Mark Guiltinan[3], Rob Lockwood[4], Siela Maximova[5]
Editors: Brigitte Laliberté[6], Michelle End and Stephen Weise[6]

[1] Trv. Nações Unidas, Duque de Caxias, Itabuna, Bahia, Brazil; [2] Executive Commission for Cacao Farm Planning (CEPLAC), Itabuna, Bahia, Brazil; [3] Huck Institute of Life Sciences and The Department of Plant Science, The Pennsylvania State University, University Park, USA; [4]30 St Martins Drive, Eynsford, Dartford, Kent, UK; [5]Huck Institute of Life Sciences and The Department of Plant Science, The Pennsylvania State University, University Park, USA; [6]Bioversity International, Headquarter, Rome ,Italy

Background

Cacao production levels are under threat due to:

Ageing tree stocks
The use of sub-optimal material
Incidence of pests and diseases
Recent climate change shocks
Declining soil fertility

The Review contribution

The review aims to describe the various methods currently available for the **production and supply of large numbers of cacao plants to growers.**

It sets out to:

- Compile relevant scientific background information on each of the propagation methods (technical, genetic, plant health, economic and situational): Propagation by Seed, Conventional Vegetative Propagation and Vegetative Propagation using Tissue Culture.
- Analyse the advantages and constraints, including current supply limitations and costings for each propagation methods.

Methodology

An **impartial**, **evidence-based**, **overarching, multi-institutional**, **multi-authored expert** report on cacao propagation methods.

It serves as a basis for the **assessment and implementation of strategies** for providing farmers with **quality planting materials** that are adapted to current and future conditions and needs.

Conventional Vegetative Propagation:

Seedling rootstocks, top and side grafting, budding, rooted cuttings, marcotting or air layering.

Main advantages:

+ Plants genetically identical to the source material.
+ Clones selected with an architecture offering advantages of lower canopy height and thus easier management when propagated using plagiotropic material.
+ Clonal gardens can provide a ready source of vegetative materials for propagation in nursery or farmers' fields.
+ Rootstocks for budding and grafting can be chosen to confer resistance to some diseases (e.g. *Ceratocystis*).

Challenges and opportunities:

- Although genetically identical, the phenotype may vary with environmental factors.
- Since tree architecture and growth characteristics of clones differ whether it is propagated from plagiotropic material or orthotropic material, it is important to select and evaluate clones propagated using the same method used for the large-scale propagation to farmers.
- Good sanitation required in clonal gardens and nurseries to increase propagation success rates and prevent spread of pests/diseases.
- Since vegetative materials can transmit viruses, regular screening/indexing of source materials should be undertaken in areas where they occur to reduce risk of spreading the virus (e.g. CSSV).

Propagation by Seed:

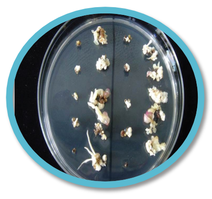
Seeds are planted directly in the ground at final growing position ('at stake') or raised in a nursery before planting as a three- to seven-month-old seedling.

Main Advantages:

+ Low-cost, efficient technology easy to apply.
+ Seedling habit and structure familiar to most farmers.
+ Seeds not known to transmit some viruses (such as CSSV).

Challenges and opportunities:

- Unless the mother tree is homozygous and cross-pollination is carried out using pollen from a known parent, seed-derived trees may be highly variable in characteristics and performance.
- Careful pruning may required to prevent the tree from becoming too tall.
- Care must be taken to avoid spreading pests/diseases present on pod husks when whole pods are distributed; good phytosanitary treatments and training may be required to ensure that healthy pods are distributed.



Vegetative Propagation – Tissue Culture (somatic embryogenesis):

Production of clonal plants with a seedling habit through floral tissue culture.

Main advantages:

+ Plants genetically identical to the source material.
+ Trees grow uniformly with a consistent jorquette height.
+ Trees propagated usually come into bearing more quickly than seed-raised material.
+ Method is useful for rapidly increasing stocks of plants where only a limited amount of parent material is available.
+ Can be performed year round in a laboratory setting.
+ Method can be used for production and testing of disease-free materials.
+ Somatic embryogenesis may reduce risk of CSSV transmission.

Challenges and opportunities:

- Although genetically identical, the phenotype may vary to environmental factors.
- Some genotypes vary in their capacity to form somatic embryos – technique may need to be optimized for specific clones.
- Care must be taken to reduce risk of somaclonal variation (more likely to occur in older cultures or certain genotypes).
- Tissue culture facilities and nurseries for acclimating plantlets have higher capital costs and running costs.
- Trees need to be producing flowers to be cultured.
- Technique requires highly skilled technicians.

What should be considered when deciding the propagation method?

- Farmers' financial situation, production objective and preference for type of planting material
- Production objective, scale and timeframe
- Planting materials characteristics desired
- Technical issues and institutional support
- Financial considerations
- Social and economic context

Moving forward:

- All cocoa-producing countries need a policy for developing or acquiring better planting material, and a strategy on how to propagate it and supply plants to farmers.
- Each technique has its own advantages and constraints, particularly in terms of availability of source materials, scalability, timescale and cost.
- Particular care must be taken at all stages to minimize the risk of spreading pests and diseases.
- Estimating demand for plant material is key to ensure a steady supply.
- Particular consideration must be given to the genetic background of the materials distributed to ensure appropriate levels of diversity are present with careful management to ensure source material is correctly identified.

Photo by Phillips and Mata, CATIE

Next steps:

- Develop the decision-making tool to allow for precise cost estimates for specific projects comparing the main methodologies at a specific country and site level.
- Implementation or recommendation at country level.

CGIAR
Science for a food secure future

Bioversity International is a CGIAR Research Centre. CGIAR is a global research partnership for a food-secure future. www.cgiar.org

Bioversity Headquarters
Via dei Tre Denari 472/a
00054 Maccarese, (Fiumicino)
Rome, Italy
Tel. (39) 06 61181
Fax. (39) 06 61979661
Email: bioversity@cgiar.org

www.bioversityinternational.org