OVERVIEW OF COCOA RESEARCH INSTITUTE OF GHANA’S COCOA RESEARCH PROGRAMS

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INTRODUCTION

- CRIG CAME INTO BEING IN 1938 AS CENTRAL COCOA RESEARCH STATION AND LATER WEST AFRICA COCOA RESEARCH INSTITUTE
- CRIG IS A DIVISION OF GHANA COCOA BOARD
- ITS VISION IS TO BE A GLOBAL LEADER IN RESEARCH INTO COCOA AND OTHER MANDATE CROPS
INTRODUCTION - 2

- CRIG’s OBJECTIVES ARE:
  - PROVISION TO THE FARMER OF A PACKAGE OF IMPROVED HUSBANDRY PRACTICES FOR SUSTAINABLE PRODUCTION
  - ESTABLISHMENT OF STRONG LINKAGE WITH EXTENSION AND ADVISORY SERVICES FOR EFFECTIVE TECHNOLOGY TRANSFER TO FARMERS
  - DEVELOPMENT OF TECHNIQUES FOR THE PROCESSING OF COCOA BY-PRODUCTS FROM WASTES
CRIG’s research policy and directions are underpinned by the following outcomes:

- INCREASE PRODUCTIVITY
- FACILITATION OF ENVIRONMENTAL SUSTAINABILITY
- ADAPTATION OF FARMING PRACTICES TO CLIMATE CHANGE
- FARMERS’ FIND CRIG’S MANDATED CROPS ATTRACTIVE
RESEARCH PROGRAMMES

- Development of elite planting materials for farmers
- Development of husbandry practices for optimal yield
- Development of techniques for effective management of pests and diseases
- Enhancement of soil nutrient status on farmers’ farms
- Socio-economic evaluation of research outcomes to ensure consistency with farmers’ circumstances
**KEY ACHIEVEMENTS - 1**

- DEVELOPMENT OF ELITE COCOA MATERIALS TOLERANT TO DROUGHT FOR MARGINAL PRODUCTION AREAS

- DEVELOPMENT OF PHEROMONE LURES AND TRAPS FOR MONITORING MIRIDS INFESTATIONS ON FARMERS’ FARMS

- SCREENING AND USE OF NEW AND EFFICIENT PESTICIDES FOR THE MANAGEMENT OF COCOA PESTS AND DISEASES AND WEEDS
KEY ACHIEVEMENTS -2

- DEVELOPMENT AND PRODUCTION OF CRITICAL EXTENSION MATERIALS FOR EXTENSION AGENTS AND FARMERS

- EVALUATION AND RELEASE OF EFFICIENT CHEMICAL AND ORGANIC NUTRIENTS FOR SOIL NUTRIENT REPLENISHMENT

- IDENTIFICATION OF CRITICAL SOCIO-ECONOMIC BOTTLENECKS TO FARMER ADOPTION OF TECHNOLOGIES
NEW PROJECTS

- INTEGRATED MANAGEMENT OF COCOA PESTS AND PATHOGENS IN AFRICA: CONTROLLING INDIGENOUS PESTS AND DISEASES AND PREVENTING THE INTRODUCTION OF EXEGENOUS ONES (ICCO/CFC/COCOBOD)

- ENVIRONMENTAL SUSTAINABILITY AND POLICY FOR COCOA PRODUCTION IN GHANA (WCF/MONDELEZ/UNDP/COCOBOD)
NEW PROJECTS - 2

- SANITARY-PHYTOSANITARY AFRICA COCOA PROJECT (CFC/EDES-COLEACP-COCOBOD)

- CRIG-READING UNIVERSITY COCOA MAPPING PROJECT (MONDELEZ / READING UNIVERSITY/CRIG-COCOBOD)

- MAABANG MEGAKARYA SELECTION PROGRAMME (GOVERNMENT OF THE NETHERLANDS / MONDELEZ / MARS / COCOA RESEARCH UK)

- FINE FLAVOUR COCOA PROJECT (AGRO-ECO/ HERSHEY/ WCF

- QUALITY INNOVATION PROJECT (TCHO/WCF/ACI)
CONCLUSION

- CRIG HAS PLAYED HER PART IN THE EFFORT TO SERVE THE TECHNOLOGY NEEDS OF COCOA FARMERS AND PROVIDE A SOUND TECHNOLOGICAL FOOTING FOR THE COCOA INDUSTRY IN GHANA

- THE SUPPORT OF INSTITUTIONS INCLUDING WCF IS WELL APPRECIATED

- FURTHER SUPPORT IS REQUIRED TO FURTHER STRENGTHEN CRIG’s CAPACITY TO DEVELOP TECHNOLOGIES THAT MEET THE NEEDS OF FARMERS
Breakout Session C:
Planting Material: Options and Case Studies
Brigitte Laliberté – moderator, 5 June 2013, 13:30-14:30

• Introduction of the topic and panel members
• Presentation on a review of propagation methodologies – Brigitte Laliberté
• Discussion with the expert commentary panel:
  • Yaw Adu-Ampomah
  • Siela Maximova
  • Brigitte Laliberté
• General discussion
Review of Propagation Methodologies to Supply New Cocoa Planting Material to Farmers

Brigitte Laliberté
Bioversity International
WCF Partnership Meeting, 5 June 2013, Washington DC, USA

Funded by: Mars Inc, Bioversity, CacaoNet and Cocoa Research UK (CRUK)
Study carried out by Mark Guiltinan, Rob Lockwood, Siela Maximova, A. Roberto Sena Gomes and Georges Sodré.

Photo credit: Allan Mata/ Wilbert Phillips, CATIE
Content

• Facts
• Challenges
• Demand for new planting materials
• Background and approach to the review
• Seed propagation
• Conventional vegetative propagation
• Tissue culture
• Advantages and constraints
• Considerations when choosing a propagation method
• Conclusions
Facts

• Demand for cocoa is increasing rapidly with emerging countries consumption (Brazil, China, Eastern Europe and India), now exceeding production
• An additional 1 million tons will be needed by 2020 (25%)
• Demand for new planting materials to increase dramatically over the coming years due to:
  ✓ need to replace large number of aging or diseased cocoa trees
  ✓ demand for planting new land to cocoa
  ✓ demand to increase recommended plant density
  ✓ release of new, high value, disease resistant varieties
  ✓ increased demand for special high-flavour cocoa varieties
Challenges in supplying improved materials to farmers

Challenge: Speed up the development and deployment of improved materials with high multiplication rate and scalability.

• Most of the planting material is low yielding
• 30-40% of the global production is lost every year due to pests and diseases alone – a loss estimated at $2-3 billion/year
• Many cocoa farms have low productivity which can be improved by:
  ✓ Controlling weeds
  ✓ Managing shade
  ✓ Managing pests and diseases
  ✓ Maintaining and improving soil fertility
  ✓ Pruning existing trees into optimal architecture
  ✓ Supplying improved higher yielding cocoa planting material to farmers
Demand for new planting materials

• Estimated 10 billion cocoa trees under production worldwide
• About 500 million new cocoa plantlets (5%) are required each year just to keep up with current replanting demands (based on replanting every 25 years)
• Many farmers do not have good access to improved planting materials
• Good quality, locally adapted planting material are continuously required, whatever country, region or farming system
• Clear need for a status report and a strategy for improving productivity by supply of improved planting material to farmers
• We are late in addressing this issue and need to act urgently!
Background to the review

Purpose:
• To develop an impartial evidence-based document, serving as a basis for the assessment and implementation of propagation strategies for providing quality planting material to farmers, adapted to the current and future conditions and needs (cultural, institutional, technical, environmental and financial).

Output:
• Guidelines and decision-making recommendations for policy-makers, donors and implementing agencies.

Target audience:
• Countries wishing to increase cocoa production
• Ministries of Agriculture of the cocoa sector
• Farmers and researchers
• Decision-makers, policy-makers, implementation agencies
Approach of the review

- A small group of experts developed technical reports in the area of their expertise:
  - Seed propagation – Rob Lockwood
  - Conventional vegetative propagation – A. Roberto Sena Gomes and George Sodré
  - Tissue culture – Siela Maximova and Mark Guiltinan
- The individual reports were pulled together into one overarching review document
- Group of 10 additional expert reviewers have been invited and met during a workshop in London 13-15 May 2013
- The review describes how and where the different methodologies are applied among the cocoa producing countries.
- Review will be finalised by end of this year
Seed propagation

- Seedling supply of bi-parental hybrids from bi-clonal seed gardens.
- Farmer nursery, i.e. using planting material from farmers’ own selection where farmers set up small nurseries or sow directly using seeds from their own farm (or from a neighbour), and will often select the most robust seedlings for replanting areas of their farm.
Conventional vegetative propagation:

• Cloning via grafting or rooted cuttings.
• Side grafting: grafting of scion (budwood) from a selected clone onto the trunk or chupon of a mature tree. Once the graft “takes”, the older part of the tree can be cut away.
• Top grafting: grafting an improved variety onto a rootstock.
• Rooted cuttings: explants taken from a selected variety and induced to root.
• Used to generate large numbers of grafted plants from a selected improved variety.
• Usually carried out professionally and supplied to a farmer as a young plant but side grafting can also be used to rehabilitate existing plantings.
• Budwood gardens are used to generate scion material for grafting.
Photo Credits: All photos
A. Roberto Sena Gomes
Tissue culture

- Cloning by regeneration of somatic embryos from floral tissues and maturation of these embryos into plantlets.
- Laboratory-based procedure used to multiply large numbers of a selected, improved varieties.
- Supplied to farmers as young plants.
Floral parts

Secondary Embryogenesis

Staminode ----> Embryogenic calli ----> Somatic embryos

Petal

Seedling

Germinating embryo

Mature embryos

Photo Credits:
- Top left – Siela Maximova
- Bottom Left – CATIE, Wilbert Phillips
- Top right – Siela Maximova
Seed propagation – advantages:

- Recommended bi-parental crosses have been developed and tested in many cocoa growing areas, including West Africa, to produce high yields of good quality cocoa under local environmental and pest/disease conditions.
- Farmers in West Africa find seed easy to establish and are familiar with the management of seed-raised trees (planting, agronomy, pruning etc).
- Seed is easily and economically transported to farmers and not known to transmit viruses.
- Cost of each seed is low.
- A coordinated approach can be taken to plan and plant seed gardens as progress is made in breeding programmes, particularly when new “male” parents are identified for existing seed garden “female” trees.
- Once established, a seed garden can produce about 700,000 seeds/hectare/year after the 5th year of planting.
- Labour needed to maintain plants and carry out manual pollinations: one skilled pollinator can carry out over 400 pollinations per day giving over 8,400 seeds.
Seed propagation – constraints:

• Seed gardens need careful management to ensure seed is “true to type”
• Parental trees should be correctly labelled, and manual pollination carried out effectively and non-manual pollinated pods removed, to avoid any open-pollinated seed
• Care is needed to avoid spreading pests/diseases if farmers are supplied with whole pods rather than seeds
• Seeds are often produced at inconvenient time of the year for farmers to plant it
• Many countries in West Africa do not have the required seed garden capacity and many existing seed gardens are ageing
• Planting/re-planting seed gardens can be limited by the availability of budwood of the parental types if planning is not fully integrated with breeding programmes, and it may be several years before the trees come into full bearing. Starting with 1,000 buds, it may take 9 years to plant 100 hectares
• Resistance to some pests/diseases has proved very difficult to breed for seedling varieties
Vegetative propagation – advantages:

- A small number of clones have been selected in Latin America and Southeast Asia which have one or more of the following characteristics: high yield, good tree architecture, ease of propagation, particular flavour characteristics, pest/disease resistance
- Farmers in Latin America are familiar with the management of vegetatively propagated trees (often requires staking to establish good tree architecture)
- Side-grafting/canopy replacement can be used to rehabilitate existing plantings of unimproved seedling trees with better performing clones
- Well managed operations can produce 400,000 clonal garden plants /hectare/year
- Farmers can be trained to propagate their own materials from a single stock plant (eg in Central America)
Vegetative propagation – constraints:

- Genetic uniformity of clones may pose risks of pest and disease infection, especially with the utilization of low resistant varieties and in monoclonal plantings.
- From forestry experience, c.30 clones would be needed to minimise this risk but there is a lack of proven clones with very few clonal trials carried out.
- Viruses can be transmitted through vegetative propagation.
- Skilled labour needed for budding/grafting and efficient nursery operations required.
- Clonal plantings are more costly and difficult to establish than those planted with seed.
Tissue culture – advantages:

• A small number of clones have been selected in Latin America and Southeast Asia which have one or more of the following characteristics: high yield, good tree architecture, ease of propagation, particular flavour characteristics, pest/disease resistance.
• Unlike most vegetative propagation techniques, tissue culture produces a tree with a seedling habit.
• Plantlets produce their own root system.
• Can be performed year round and synchronised to optimum planting season.
• High multiplication rate: potentially 50+ embryos from each flower and more than 10,000 plants can be produced per flower.
• Cacao somatic embryogenesis technology can be used for production and testing of disease free materials. Evidence that CSSV is highly unlikely to be transmitted through somatic embryogenesis.
• Genetic uniformity of clones may pose risks of pest and disease infection, especially with the utilization of low resistant varieties and in monoclonal plantings.

• Some genotypes exhibit very low somatic embryogenesis potential. For these, optimization of media and hormone concentrations may be necessary.

• Risk of somaclonal variation but techniques developed to minimise risk and no field evidence of problems to date.

• The initial investment is higher, due to cost of building laboratory facilities.
Considerations for choosing a propagation method

• What proven materials are available?
• What material is to be propagated?
• How fast – time scale?
• How many plants are required?
• Where is the farm?
• How big is the farm?
• Need for new planting vs rejuvenation?
• Area with a new pest or disease?
• What funds are available?
• What is the cost per plant?
• What are the risks?
• What level of technical skills does the farmer need to reach?
• What is the national institutional support?
Conclusions - materials

• High performing varieties have been developed but are often limited in availability.
• 80% of farmers cannot access improved planting materials.
• Few clones with global proven field performance that equal best seedlings material in best situations.
• There are proven seedlings but inadequate capacity to produce in required quantity.
Conclusions – methodologies:

• No single method is the answer
• Having the right materials for each method (parental lines and clones), and screening for that materials is critical
• Need to ensure:
  ✓ Clean/virus free material for multiplication and distribution
  ✓ Best agricultural and managements practices for each method
  ✓ Quality control and after delivery care
  ✓ Adequate long-term secure funding
• Farmers will decide which technologies to adopt and will do so only if the risks vs the rewards appear to be attractive enough
Final remarks

• The technology is there, we have adequate propagation methodologies
• Need to have practical plant breeding programmes in place
• Starter planting material should be evaluated carefully
• Call for research to make these methods more efficient
• Priority of the Global Cocoa Agenda and national cocoa plans – beyond 2020
Thank you!