

Quality control of bamboo planting material through state-of- the-art technology



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- **Recent developments in technology has resulted in greatly increased utilization of bamboo biomass for industrial products and services.**
- **The demand is also driven by the search for alternatives to environmentally unsustainable materials like fossil fuels, cement, plastic and steel.**
- **The demand for bamboo biomass as industrial raw material is expected to increase exponentially and can only be met by expanding the extent of bamboo plantations around the world.**



- **Plantations of the future have to be established on sound scientific footing to maximize productivity to meet the projected demand.**
- **Such increase in the productivity can be achieved through interventions like use of appropriate species, through scientific management of plantations and use of Quality Planting Material (QPM).**
- **Several biological aspects of bamboo set it apart from other plants and special interventions are required for large-scale cultivation**



- **Bamboos have a large diversity of species and forms.**
- **They have a relatively recent history of domestication and cultivation in plantations.**
- **Genetic improvement in bamboo has lagged behind other crops due to constraints in applying conventional breeding techniques**
- **The quality of bamboo planting material originating from seeds is open to doubt as no selection is done.**
- **The availability of Quality Planting Material is clearly a priority for sustainable development of bamboo resources**

Constraints in production of QPM in bamboo

- **Difficulty in identification of bamboo in the field and nursery due to the absence of diagnostic morphological characters like flowers and culm sheath for most of the life cycle.**
- **The consequence is that misidentification of bamboo is very common both in the field as well as in nurseries where mixing up of different species and clones occur**
- **The unusual flowering behavior in bamboo - mast flowering, long unpredictable cycles, lack of synchronous flowering impose great hurdles in undertaking breeding programs**
- **The wide array of propagation methods used results in lack of standardization and difficulties in large-scale production of QPM**



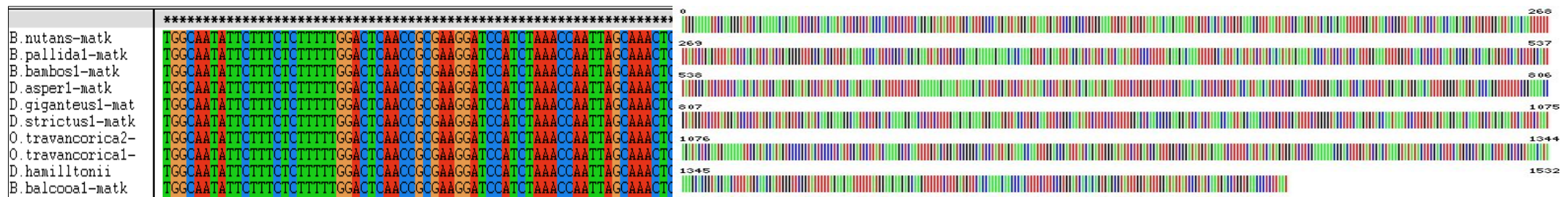


Modern technology to the rescue of bamboo

- **Many of the constraints that come in the way of efficient propagation and genetic improvement has solutions in modern biotechnology .**
- **DNA barcoding offers the solution for the vexing problem of identification of species especially at the juvenile stage.**
- **DNA fingerprinting can ensure that clonal fidelity and identity is maintained during large-scale propagation.**
- **Micropropagation or tissue culture is already being used commercially for large scale production of bamboo planting material**
- **Genetic modification of bamboo that offers great scope of precise control of traits of importance is also fast becoming a reality**

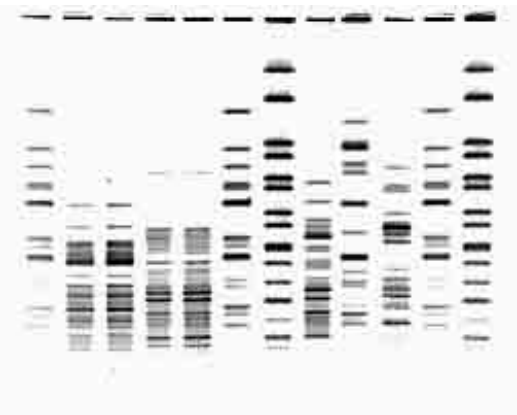
Identification of species and clones – Molecular methods

- Precise identification of species is enabled through the technique of **DNA barcoding**
- DNA is isolated from tissue taken from vegetative part of bamboo, the sequence from standard barcoding region is compared with a database
- The *psbA-trnH* barcode region showed great promise in discriminating the major Indian bamboo species belonging to 5 genera.
- DNA Barcoding can help avoid misidentification of species in the process of selection and certification of Plus Clumps

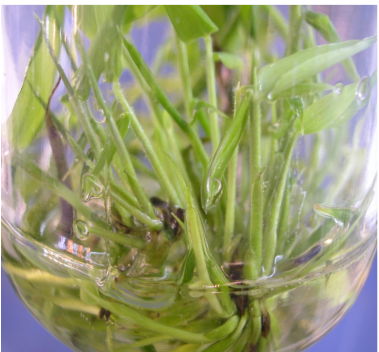
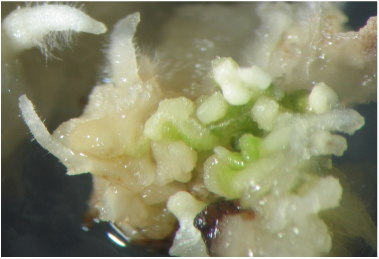


DNA fingerprinting

- Regions of DNA which vary between individuals can be used to distinguish specific clones from others within the same species.
- The method is used routinely in genetic fidelity tests of micropropagated plants as a quality control measure
- Helps determine clonal identity and prevent deliberate or accidental mix-up of planting material in nurseries.
- Protection of IPR is facilitated by use of DNA fingerprints for proprietary clones.



Bamboo Micropropagation



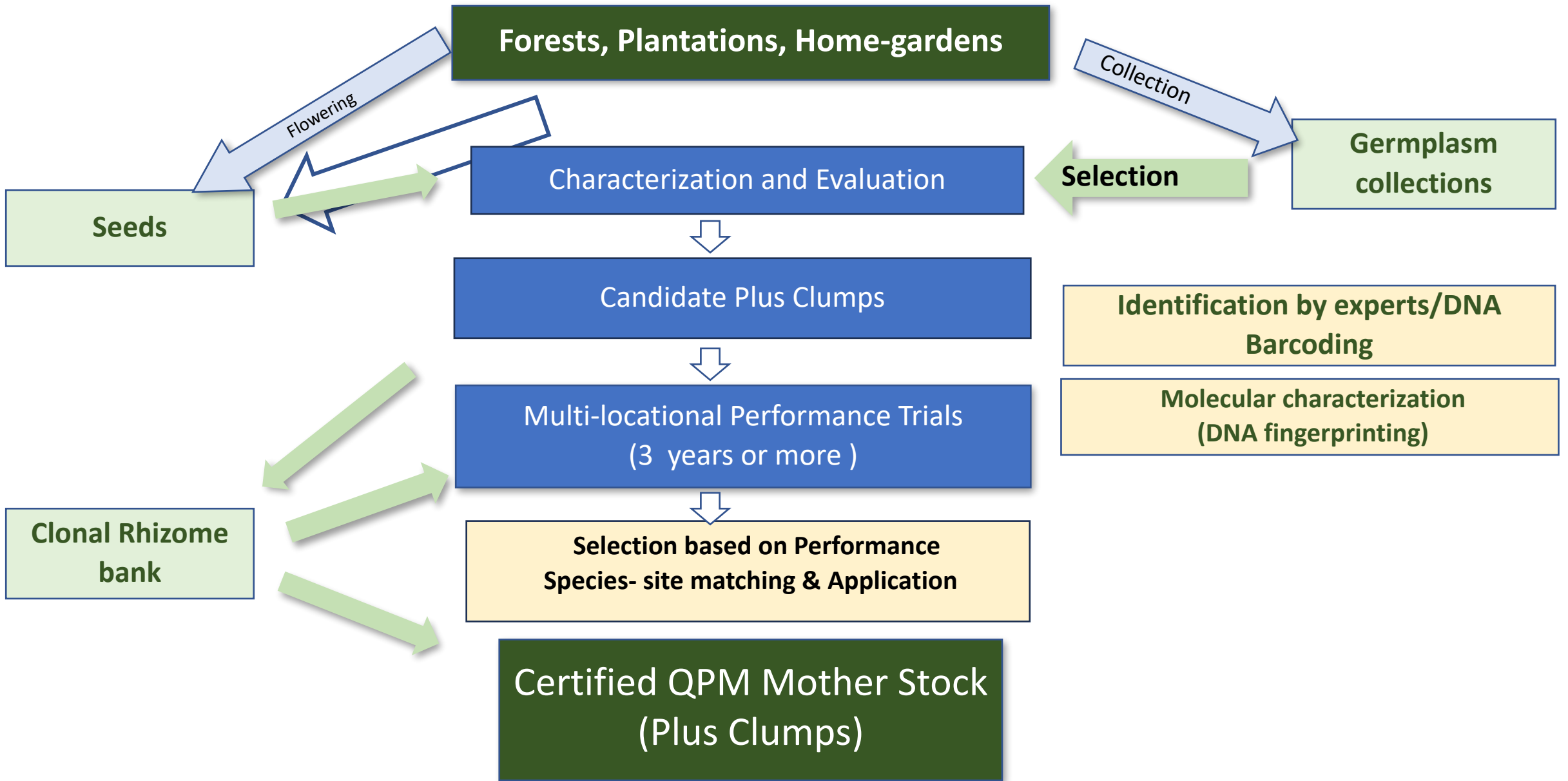
- **Tissue culture is a popular means of large-scale propagation for many commercial species**
- **Success is limited in many important species due to constraints such as high incidence of microbial contamination, recalcitrance to culture establishment and poor rooting rates**
- **Lack of automation in bamboo tissue culture is still a hurdle to reducing cost of production**
- **Poor quality control has led to issues of early flowering and death of young plants.**



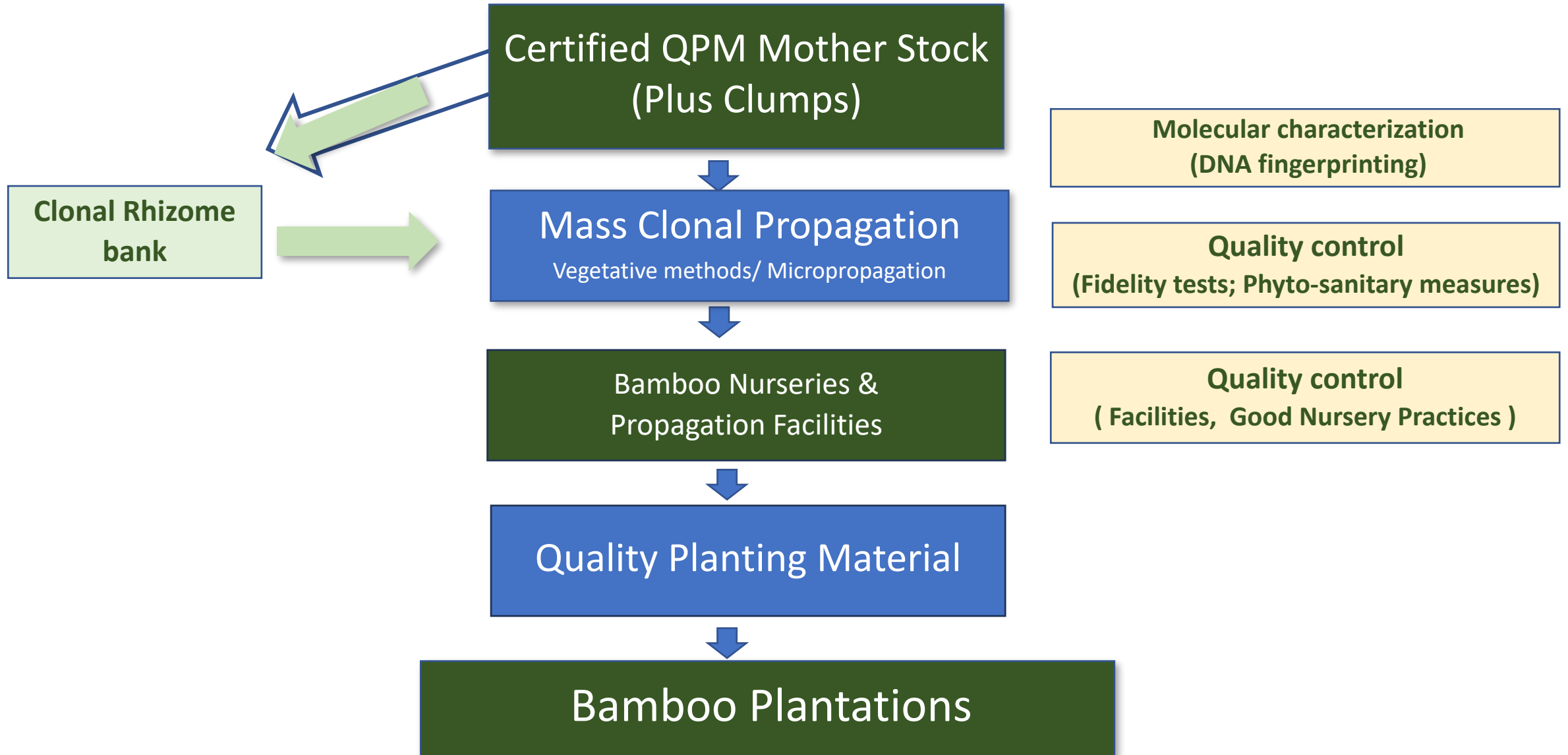
Steps in Certification of QPM in Bamboo

- **Survey and collection of germplasm from natural populations and plantations**
- **Characterization of the collections for useful physical, mechanical and chemical parameters**
- **Selection of promising provenances and Candidate Plus Clumps**
- **Evaluation in multi-locational field trials for growth performance and other qualities**
- **Selection of the best Plus Clumps to serve a Quality Planting Material (QPM)**
- **Certification of QPM Mother Stock for large-scale multiplication**

Quality Planting Material in Bamboo



Quality Planting Material in Bamboo



Outline of the Nursery Accreditation scheme

1. Nursery infrastructure and Trained staff

Adequate facilities and trained staff to undertake large scale bamboo propagation

2. Certified QPM Mother Stock:

Correctly identified at species and clonal level, Field evaluated and matched to agroclimatic zones and applications

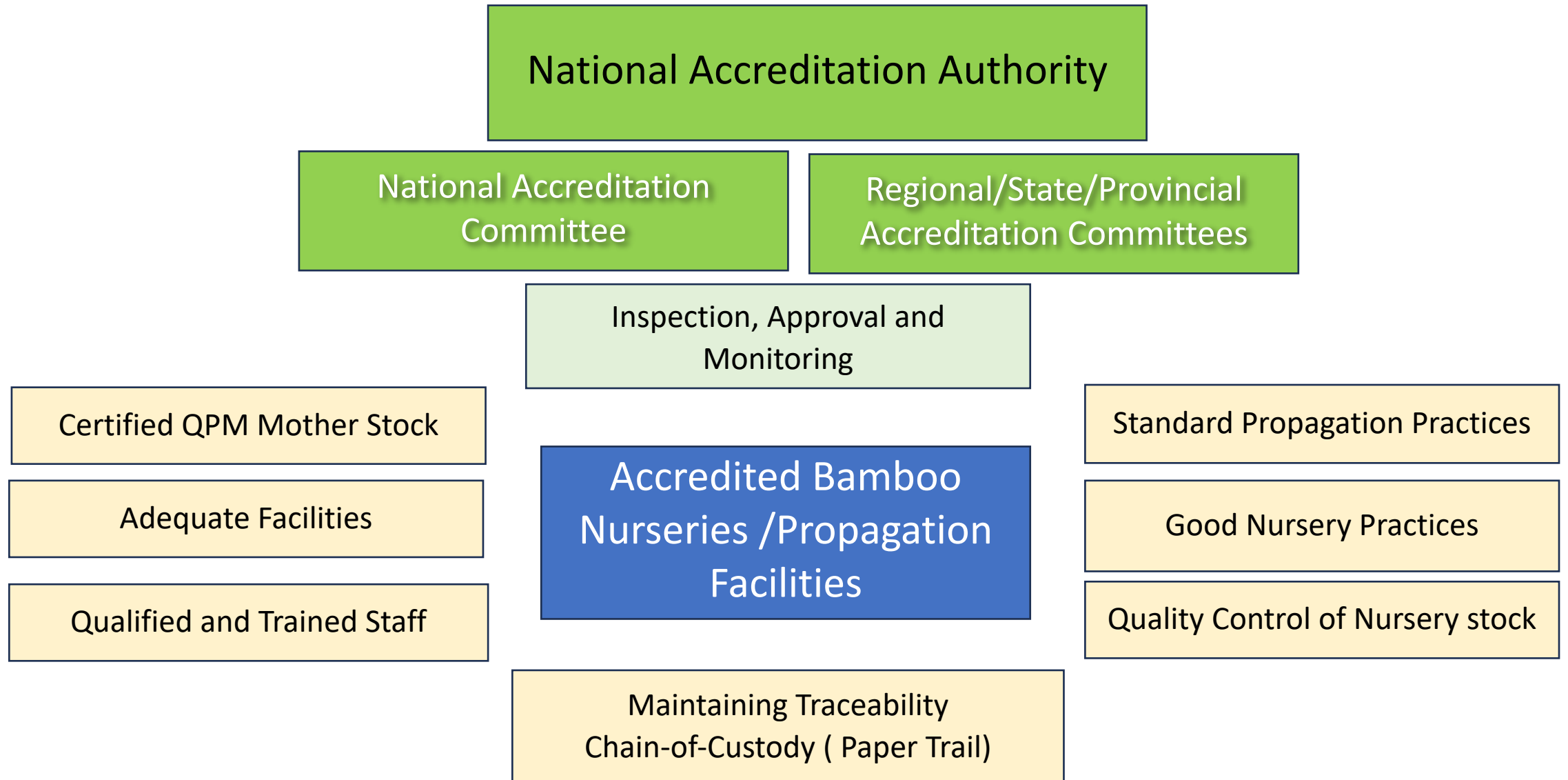
3. Standardized large-scale propagation methods:

- a. Appropriate propagation method: Propagule meeting quality criteria.
- b. Good nursery practices: Proper phytosanitary and prophylactic measures

4. Traceability

- a. Proper documentation (Paper trail) of chain-of-custody from certified mother stock to nursery stock at point of sale.

Scheme for Accreditation of Bamboo Propagation Facilities



Criteria for assessing the quality of bamboo planting stock in the Nursery (Sympodial Bamboo)

i. Shoot System:

- a. Good quality: 4 or more sturdy shoots of 50 cm or more in length .
- b. Acceptable : At least 3 sturdy shoots which are 50 cm or longer with healthy leaves.
- c. Rejected : Only 1-2 shoots or leafless/ poorly developed shoots.

ii. Rhizome System:

- a. Good Quality : Number of rhizomes are the same as the shoots or more.
- b. Acceptable : Number of rhizomes at least the same as shoots.
- c. Rejected : Without any well developed rhizomes/with damaged rhizomes

iii. Root System:

- a. Well Developed: Each shoot with profuse roots having root hairs.
- b. Acceptable : Planting material with at least two functional roots per shoot.
- c. Rejected : Lacking well developed root system



- **National scheme adopted in India by the National Bamboo Mission for Certification of Bamboo Quality Planting Material and Accreditation of Bamboo Nurseries since 2019**
- **The Maharashtra State in India has adopted a simpler modified scheme in 2024**
- **The National Certification System for Tissue culture Plants (NCP-TCP) of the Department of Biotechnology, certifies micropropagation facilities across India including bamboo units.**



Conclusions

- **The potential of current technologies to overcome the major constraints of genetic improvement in bamboo is amply demonstrated although not fully realized in practice around the world.**
- **The current best option is to survey the natural variation select the best genotypes after characterization and field evaluation to be certified as QPM mother stock.**
- **Large scale clonal propagation of the QPM mother stock in Accredited Propagation facilities ensures maintenance of quality and traceability to QPM mother stock.**
- **Planted bamboo forests of the future established from QPM and managed on scientific principles will go a long way to meet the projected demand for bamboo in a sustainable manner.**

A scenic view of a mountain range with mist or fog, framed by the silhouettes of bamboo trees in the foreground. The text "Thank You" is centered in the image.

Thank You