Potentiality of Genetic Resources and their Conservation for Sustainable Rural Development

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United Nations Decade on Biodiversity

HISTORICAL

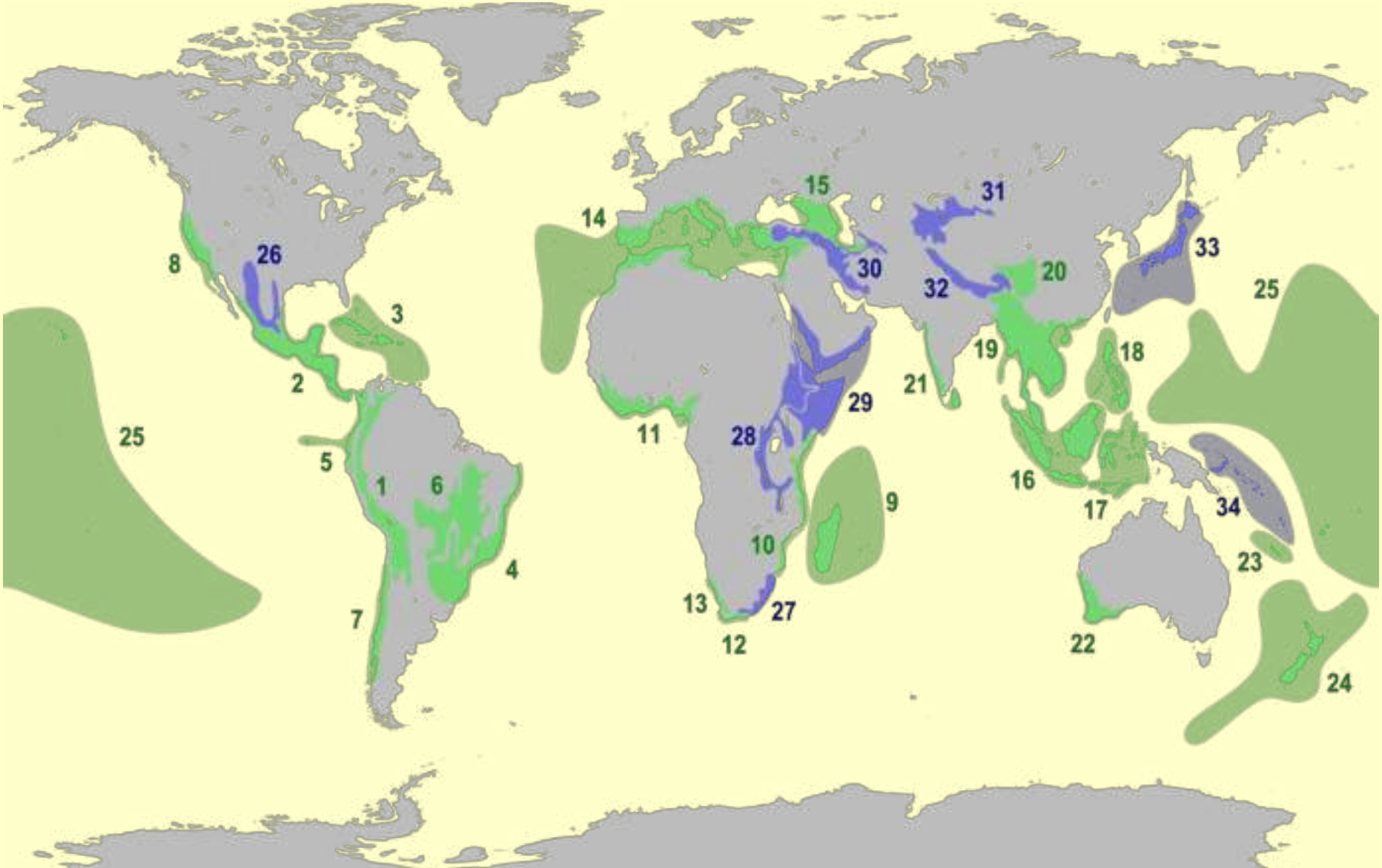
- Human society depends on Biodiversity for its diverse values. Food drives the world, access to adequate food is the primary concern for most people on earth.
- This makes agriculture one of the largest and most significant industries in the world.
- Agricultural productivity is important not only for country's balance of trade, but the security and health of its population as well.
- Agriculture shows its variations from the early evolutionary slash and burn (*Jhum* cultivation) to settle terrace & valley cultivation.

- In modern times, unwise human interference with nature has created many problems and ecosystem sustainability is threatened.
- The paradox of high variation in Agricultural practices and cropping systems, calls for identifying Research Strategies to support sustainable Agriculture.
- With increasing global challenges, such as pop. growth, climate change, and overconsumption of ecosystem services, we need further integration of the poverty alleviation and BD conservation.
- A total of 669 protected biosphere nature reserves spread across 120 countries were brought under the protected network of UNESCO.

STATUS OF BIODIVERSITY

- Around 70-80 m species are present on Earth
- Among the flowering plants, a total of 55 families contributed the domesticated food plant species (Harlan, 1975).
- A total of 2,297 species of cultivated plants belonging to 167 families from their centers of diversity in the world (Zeven and Zhukovsky, 1975).
- India is One of the 12 Mega Biodiversity centre's in the World. It has 2 "hot-spot" areas from the point of threats to Biodiversity.

Fig. 1: Global BIODIVERSITY Hotspots



- The India sub-continent has 1.6 m (8%) of plants & animals of the world.
- India hosts 49,000 plants species, 33% are endemic & 75,000 animal species.
- India region is an important center of origin and Diversity, over 356 crops are under cultivation.
- Further, 168 domesticated crop species & 26 sp. of their wild forms & close relatives have rich div. in the Indian gene centre.
- Out of the 15,000 sp. of flowering plants about 2560 (17%) are tree species.
- More than 20 Agri-Horticultural crop plants have been domesticated.

GENETIC RESOURCES- CONSERVATION

- **Germplasm is the sum total of genes present in a species.** It consists of five types of materials (1.Land races, 2.Obsolete varieties, 3. Varieties in cultivation, 4. Breeding lines, and 5.Wild forms & wild relatives).
- **Biodiversity is the variety that exists among organisms and their environments, conserved at 3 levels:**
  i) Genetic, ii) Species and iii) Ecosystem
- **Germplasm preservation is accomplished through gene banks and preservation of natural habitats (especially in centers of origin).**
- **Locating the origin of crop plants is basic to PB. This allows one to locate wild relatives, related specie and new genes - the endless search for genes.**
- **The concept of 'SEARCH FOR NEW GENES'- PL Gautam & S Kochhar (1950).**

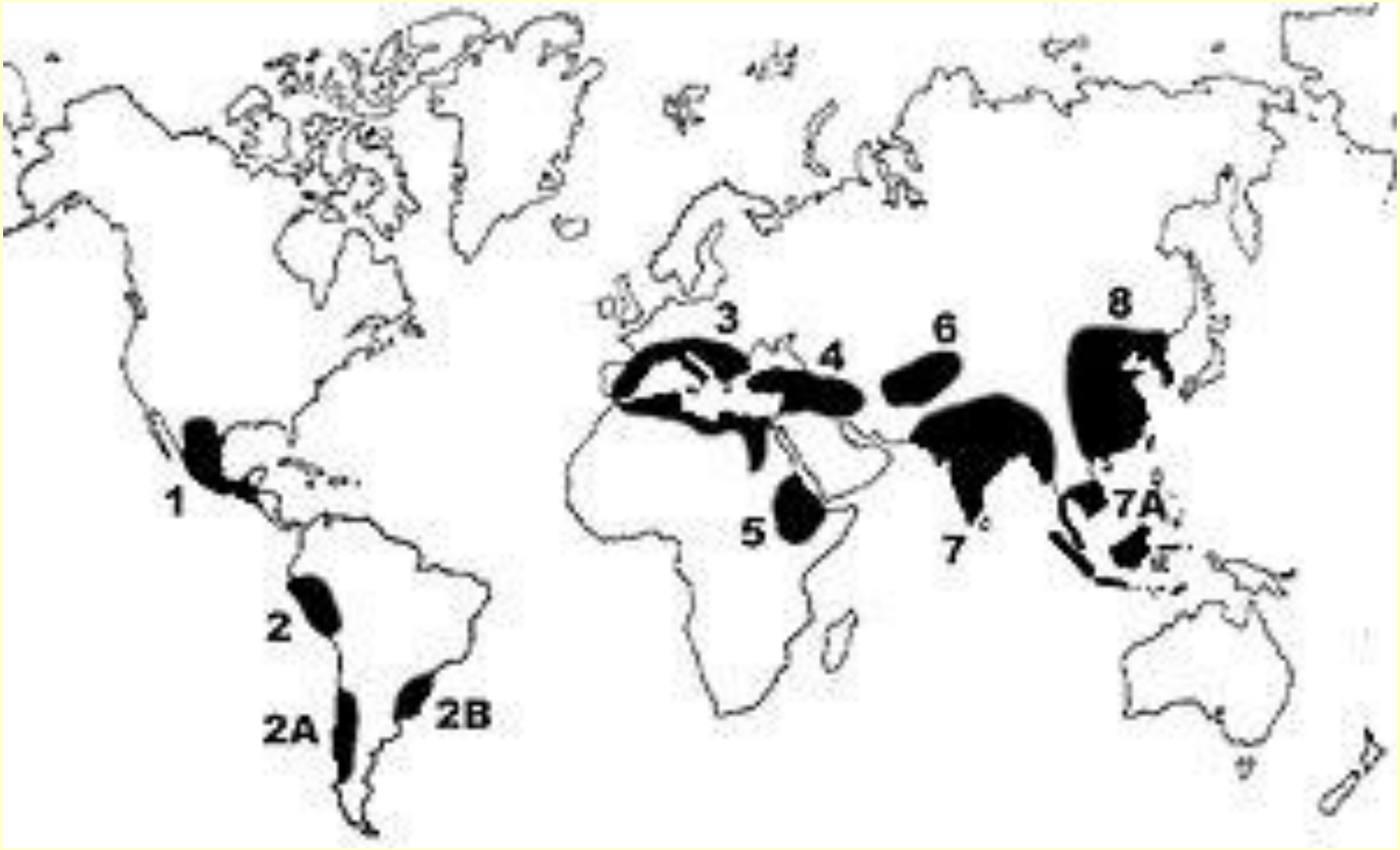
GENETIC RESOURCES-ORIGION & DIVERSITY

- The Cultivated plants were not distributed uniformly throughout the world. Certain areas show far greater diversity than others in the forms of cultivated crops & their wild relatives.
- Russian scientist Nl Vavilov (1887 - 1943) developed a theory on the Centers of Cultivated plants. 11 Centers of origin. Supported by Harlan, 1975; Zeven and Zhukovsky, 1975; Hawkes, 1983.
- In 1926, Vavilov proposed that crop plants evolved from wild species in the areas showing great diversity and termed them as primary centres of origin.
- Crop plants were not domesticated randomly, but there are regions where the domestication started.

GR - ORIGION & DIVERSITY contd..

- Crops moved to other areas due to activities of man. In some areas, certain crop species show considerable diversity, such areas are known as secondary centres of origin.
- Knowledge of the origins of crop plants is important in order to avoid genetic erosion.
- Information on Origin and Diversity of plants is Useful in Plant Breeding & Crop improvement programs.

Fig. 2: Vavilov Centers.



Collection & Conservation of GENETIC Diversity

- Among the food crops, Rice & Wheat are 2 most important cereal crops feeding the majority of worlds population.
- Genetic erosion of wild progenitors and relatives of food, fodder other crops is alarming due to the destruction of natural habitats and the replacement of traditional crops by modern varieties.
- There is an urgent need to arrest the situation for a sustainable crop production.
- Further it needs the collection of relevant germplasm in the centers of origin and diversity followed by Conservation, Characterization, Documentation and use.

OBJECTIVES OF CONSERVATION

The World population will be around 8.15b. by 2025.

In India, the popn. will be around 1.5 b. by 2030.

- **There is no scope for increasing arable land since it is shrinking further due to high human pressure.**
- **So the existing Genetic Base has to be broadened to increase the productivity levels by incorporating desirable genes.**

OBJECTIVES OF GENETIC CONSERVATION

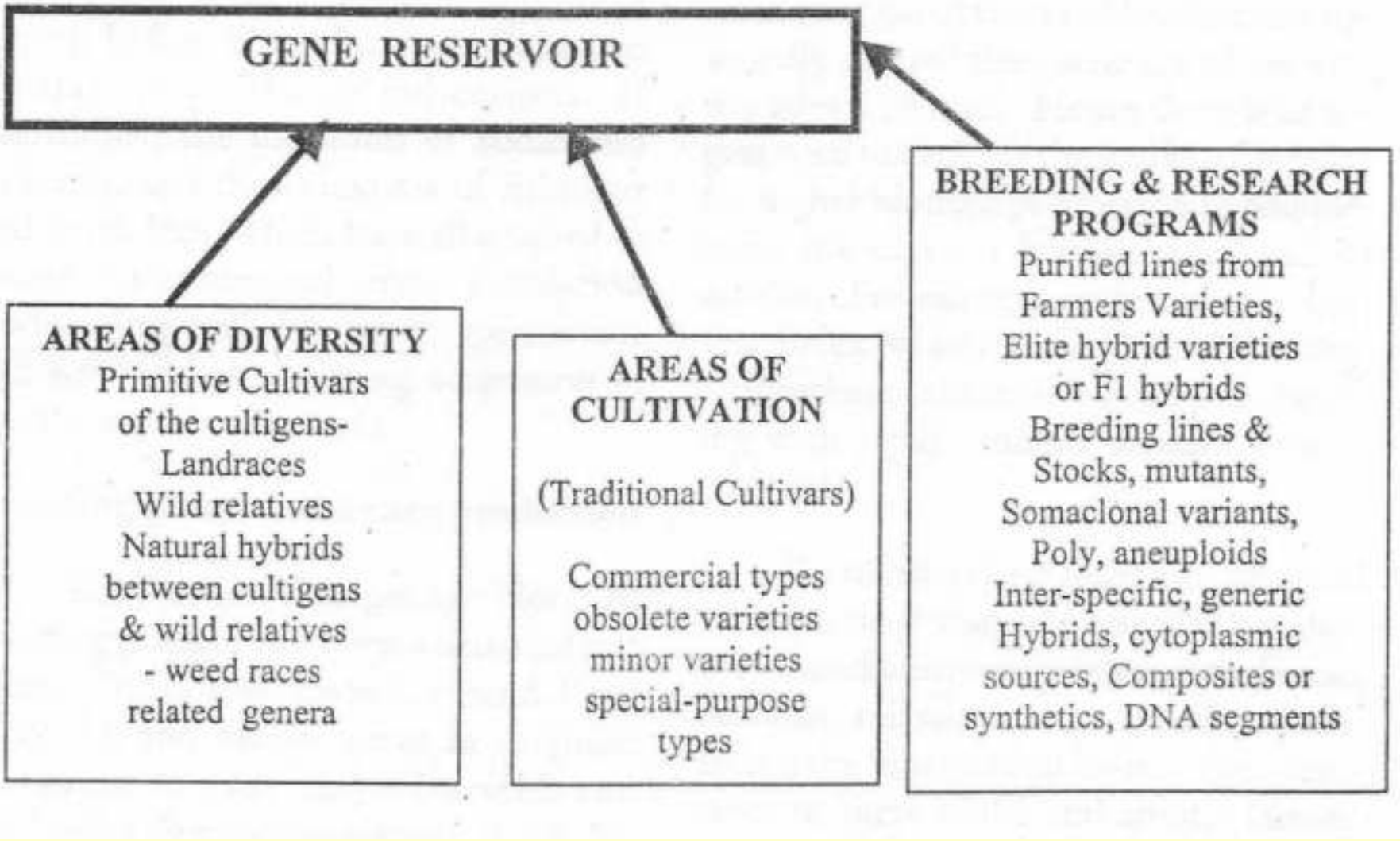
The basic germplasm materials are required for adapting crops to

- **i) Expanding Biotic and Abiotic stresses**
- **ii) Changing consumer preferences and**
- **iii) Yld increase- to feed the ever increasing world population**

Table 1: The Objective and Time scale of Concern in Genetic Resources Conservation.

Period	Operator	Objective	Time scale
< 1800 BC	Hunter-gatherer	Next meal	1 day
< 1850 AD	Primitive/traditional peasant farmer	Next crops	1 year
> 1850 AD	Plant breeder	Next variety	10 years +
> 1916	Gene conservationist	Genetic base	100 years +

Fig. 3: The full Spectrum of Germplasm in a Crop Species and its Sources.



EFFORTS IN PRIORITY AREAS

- For the past 6 decades concerted efforts have been made by various International org. (FAO, IPGRI, IRRI, CIMMYT, ICRISAT etc.),
- National org. (NBPGR) and other Agri-horticultural institutions, which resulted in the Collection, Conservation (*in situ* & *ex situ*), Evaluation, Mobilization & Documentation of Germplasm mainly in
  - Cereals, Legumes, Oilseeds & other Food and Industrial crops (eg. Rubber- RRII & IRRDB)
- The main collections are in priority crop species such as rice, wheat, sorghum, minor millets etc. in regions of its origin and diversity.

DIVERSIFICATION OF GENETIC BASE

- Limitations in traditionally cultivated areas, lead to the further expansion in the non-traditional areas.
- In this marginal areas, crops were confronted by various biotic and abiotic stresses, leading to lower crop production.
- The present yield levels in cultivated crops have reached a plateau due to narrow Genetic base.
- Therefore the existing Genetic Base has to be broadened to increase the productivity levels by incorporating desirable genes.
- The only way out is the diversification of GB. Which in turn requires the genetic analysis of existing GR., so as to identify desirable genes & their linkages.

ENETIC BASIS OF ADAPTABILITY & STABILITY

Analysis of parentage of widely adapted HYV indicates pools of diverse gene blocks from different landraces contributed to their wider adaption for various stresses

Rice : IR 60, IR 36, IR 42, C 306, 1ID 2189

Wheat : Chenab 70, Sholey and Bijiga Yellow

Pearl millet : BK 560, WC-C75, Pusa 23 and ICMH 423

Sorghum : SCH 5, CSH 9 and CS V 3541

Chickpea : JG 62, BG 203, G 130 and K 850

Analysis of parentage of HYV:

Diverse gene blocks from different landraces contributed to their wider adaption.

Rice : IR 36 - No. of land races-14, released in 1986

IR 60 - No. of land races-16

IR 42
C 306
1ID 2189

} **No. of land races-1 to 3, released in 1970-77.**

Analysis of parentage of HYV:

Wheat :

Chenab 70
Sholey
Bijiga Yellow

} No. of land races-3 to 8, released in 1965-74.

Pearl millet :

BK 560 - No. of land races-1, released in 1975.

WC-C75 - No. of land races-7, released in 1982.

Pusa 23,

ICMH 423

Analysis of parentage of HYV:

Sorghum:

SCH 5
CSH 9
CS V 3541

} No. of land races-3 to 8, released in 1965-74.

Chickpea :

JG 62
BG 203
G 130
K 850

} No. of land races-1 to 5, released in 1971-78.

GENETIC BASIS OF STABILITY

- The varieties or hybrids popular even now are released long ago and have varying no. of landraces in their parentage, which could have conferred stability and a wide range of adaptation. --There is a need for in-depth study of adaption.
- Gollin and Eenson (1977) have noted that a small set of semidwarf genes have reached the plant design which served as the basis of varietal development.
- Indicates the "narrowness" of the original "green revolution" plant design.
- Now we need a broader plant design base for more landraces based traits, to augment yield levels for the 21st century with wider adaption to various stresses

Stability contd.

- Stability of the cytoplasmic constituent is evident – protoplast –fusion products and for only ♀parents in reciprocal crosses.

- Analysis of mtDNA and the sequencing of DNA of landraces with specific adaptation eg. Salt and Drought tolerance, will be useful to characterize more precisely these genetic stocks.

- The genetics of characters associated with adaptation in landraces need to be studied in the cross between land races and HYV, and the information shall be included in the documentation (Ehdaie et al., 1988).

Diversity Analysis

- Generally, natural mutation rates are very high under some specific ecological conditions.
- GD in natural popn. with specific or wide adaptation can be assessed by the Markov process of estimating nucleotide-substitution rates.
- Such an analysis would be worthwhile in the
  Rice - Peninsular and NE Indian colln.
  Pearlmillet- Rajasthan (India) and Ghana colln.
  Sorghums- Sudan and Ethiopia colln.
  Chickpeas- Ethiopia and south Iran colln.

  which have all adapted to severe environmental stress.

DWARFING GENES & BIOMASS PRODUCTION

- Dee-geo-Woo-gen and Norin 10 dwarfing genes in rice & wheat and similar genes in sorghum and pearlmillet have complex functions influencing several characters.
- These genes improved the partitioning of dry matter from 17.0 to 34.1% and kernel weight from 22 - 29% without sign. increasing total biomass production of about 10 tonnes/ha in wheat during the last 100 years (Cox et al.1988).
- The utilization of genes for dwarfing and photoperiod- insensitivity from the local varieties, to restructure plant type in the major cereals, has enormously improved their productivity.
- A wide range of adaptation, and added stability to production in these crops was evident in the All India coordinated crop-improvement programmes of ICAR, in India.

Dwarfing Genes & Biomass prodn. Contd..

- Only a small portion of world collections have actually entered into the present day advanced lines. Further jump in cereal yield would require a greater diversification of the genetic base, including cytoplasmic diversity.
- There is an urgent need to evaluate the world collections for higher biomass production to complement the superior harvest index and its stability.
- For example, in Pearlmillet, HI widely varied over locations.

Dwarfing Genes & Biomass prodn. Contd..

- Utilization of alternative sources of dwarfing with rapid biomass accumulation is essential.
- To transfer these genes into advanced varieties, basic studies are needed on adaptation mechanisms of genotypes to disease, moisture, soil salinity and climatic stresses, and on the biochemical basis of their resistance to these biotic and abiotic stress factors.
- The adaptive mechanisms of genotypes with potentially high harvest index under these stress conditions need special attention.

NEW TOOLS FROM FRONTIER SCIENCES

- Frontier sciences like GIS, computer technology tools are useful in identification of BD hot-spots, gaps in the collections, identification, doc., retrieval & sharing of data across continents.
- Molecular techniques such as RAPD, AFLP, SSRs etc. useful for precise characterization of plant genomes and identification of genes.
- Biotechnology-Genome/Gene sequencing, CRISPR Cas technology is a simple yet powerful tool for editing genomes now provide the tools for the transfer of specific DNA sequences into new varieties.
- Similarly, protoplast fusion can be utilized to produce more productive cytosteriles.
- The sequencing of the DNA of the diverse sources of dwarfing, for example, to distinguish common and contrasting features, will help incorporation of multiple sources of efficient physiological mechanisms.

NEW TOOLS contd..

- Genetic analysis at the molecular level, as is being done for the basic process of nondulation using non-nodulating, super-nodulating, and normal genotypes in soybean (Glycine max) can be applied to other leguminous crops.
- The inhibitors produced by the shoot in localizing nodulation in soybean helps in better understanding the transcription and translation mechanisms in the genetics of nodulation (Carroll et al. 1988).
- A similar evaluation in chickpea, pigeon pea and groundnut is necessary.
- Among the drought tolerant landraces, stage-specific resistance is common at the seedling, mid-season or terminal stages, as in some of the upland rice in India.
- Since such stage-specific adaptations are due to diverse physiological and biochemical mechanisms, integration of these genes into one genotype to face the random drought in Semi Aried Tropical countries requires biotechnological expertise for specific DNA transfer.

Fig. 4: A Scheme for Effective Utilization of Germplasm.

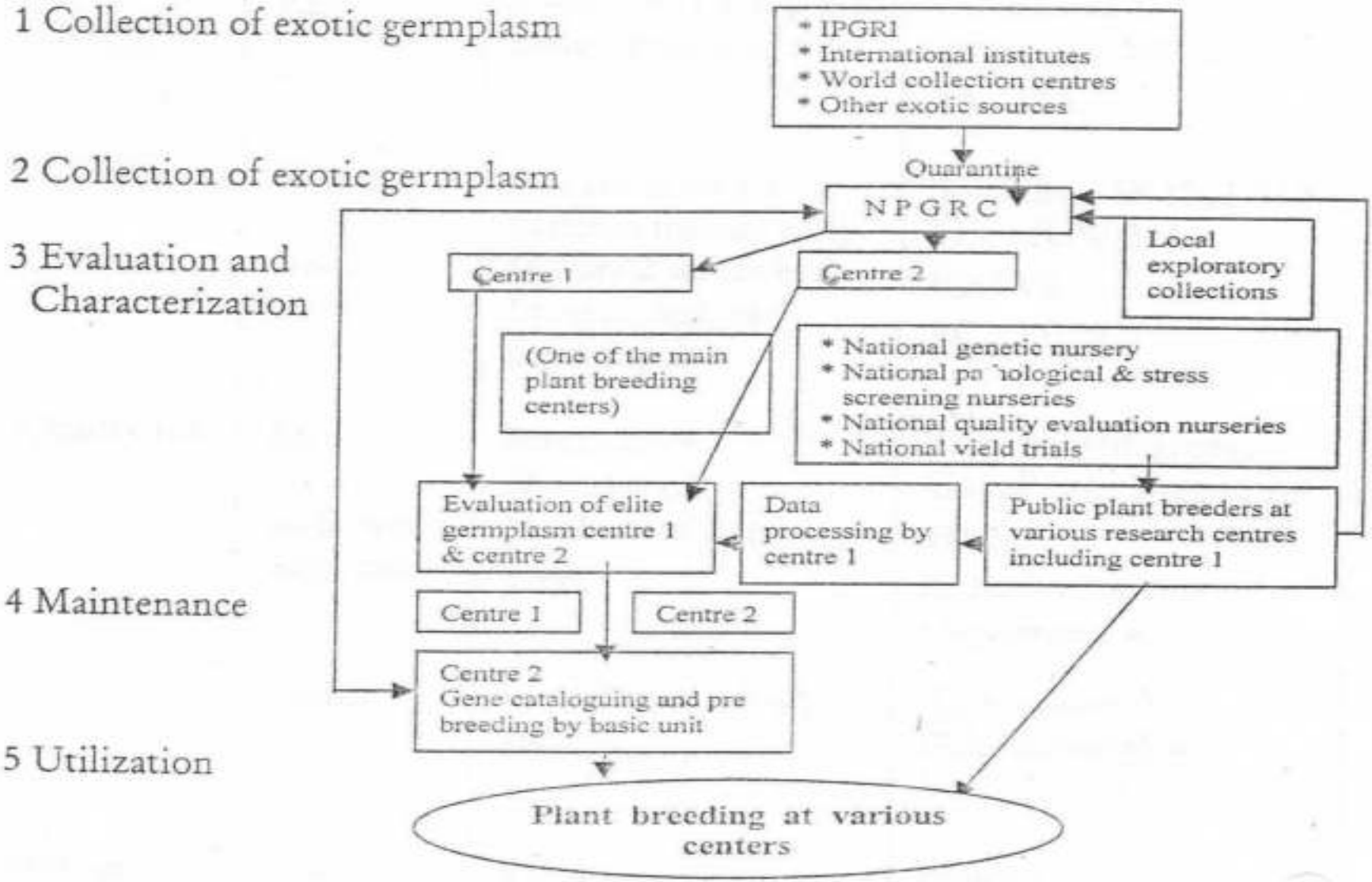


Table 2: Utilization of Germplasm in some Crop plants.

Character	Crop	Particulars	Source genotype
1. Plant height	Wheat	Dwarfness	Norin 10 (Japanese)
	Rice	Dwarfness , early-maturing	Dee-geo-woo-gen (*Japonica* rice from Taiwan).
2. Lodging resistance	Wheat	Resistance	Norin 10
	Rice	Resistance	Dee-geo-woo-gen.

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
3. Photo-thermo-insensitive	Wheat	Insensitivity	Sonalika, Kalyansona
	Rice	Insensitivity	Jaya, Ratna, Sita.
4. Earliness	Wheat	Advanced dwarf varieties mature early	Sonalika, HP 1202, UP 115, HUW 234
	Gram	Mature 2 weeks early. Long seeded, early maturing	ICC V2, EC 499759.

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
5. Dormancy	Mung, Barley, Rice	Seed germination before harvesting is a problem	Few potential genotypes available
6. Cytoplasmic male sterility	Wheat	Fertility restorer mechanism for hybrid seed production	*T. timopheevi* X *T. aestivum* = F_1 CMS
	Rice	CMS – WA cytoplasm male sterile wild rice	*O. sativa* to *O. spontana*, PMS - 1A, 2A….10A.

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
7. Quality traits	**Rice**	**Scented rice** (aromatic compound 2-acetyl-1-pyrroline)	**Basmati, Milagrosa, Gopalbhog, Begami 2-8,Mahi Suganda, Kasturi, PB1, 2,3.**
	Safflower	**37- 53% oil**	**HUS 305**
	Sugarcane	**Noblisation-hard, high yielding**	***S. barberi* X *S. officinarum* = Noble canes**
	Cotton	**Long staple, fiber quality & high yield**	***G. hirsutum* X *G. barbadense* = Varalaxmi, Savitri**
8. Storage	**Potato**	**Keeping quality**	**Phulwa, Chipsona1, Kufri Jyoti, K. puskar, K. pdati**

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
9. Plant response to Fertilizers	**Cereals & Pulse crops**	**Many modern varieties are highly response**	Wheat- Kalyan Sona, Sonalika & Rice-Jaya, Ratna & few genotypes in pulses
10. Resistance to diseases	**Wheat**	**Leaf rust** **Stem rust** **Kernel bunt** **Powdery mildew**	*Aegilops umbellulata, Arkan, Blueboy, Dove, Centurk, CIM25.* *Agropyron elongatum, Aegilops squearrosa, Aegilops longissima*
	Rice	**Bacterial leaf blight** Bacterial blight & blast **Grassy stunt virus** Yellow mottle virus	TKM 6. *O. longiglumis* (Irian, Indonesia, Papua NG) *O. nivara* *O. glaberrima* (West Africa)
	Tobacco	Tobacco mosaic virus	*N. glutinosa*

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
11. Resistance to pests	**Rice**	**Brown plant hopper** **White backed plant hopper** **Stem borer** **Stem borer & whorl maggot.** **African gall midge & Nematodes**	**Mudgo, ASD 7, Rathuhunati, Nagina 22.** **TKM 6.** *O. ridleyi* (Sourth Asia). *O. glaberrima*
	Groundnut	**Aphid**	**ICG 5240**
12. Abiotic stresses	**Sugarcane**	**Drought and Salinity**	***Scharam spontaneum***

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
12. Abiotic stresses	**Wheat**	**Drought tolerance**	*Aegilops speltoides* , **C 306, K 8027**
	Gram	**Drought tolerance**	**ICC 4958, ICC 10 448.**
	Rice	Drought, acidity and iron toxicity. Deep water tolerance. Shade tolerance & adaptation to aerobic soil	*O. glaberrima* (West Africa) Jaladhi 1, 2, TCA -4, TCA-177 *O. granulate* (S & SE Asia)
	Wheat	**Saline soil tolerance**	*Aegilops squearrosa, K. candealfen* (Argentina), Borha (Ethiopia), Karchia-65, HD 2009, C 306, WG 7357 & several F_1 ' s
	Wheat	**Alkaline soil tolerance**	HD 2009, WH 157, WG 7357

Table 2: Utilization in some Crop plants- contd..

Character	Crop	Particulars	Source genotype
13. Heterosis	**Wheat & other crops**	**High yield and other traits**	**Spring wheat X winter wheat**
	Gram	**Drought tolerance**	**ICC 4958, ICC 10 448.**
14. Other specific factors as and when conditions arises	**Common bean *(Fhaseolus vulgaris)***	**Upright, determinate growth & high yield**	**EC 502154- 58.**
	Khesari pulse seed *(Lathyrus sativus)*	Contains neurotoxin N-oxalylamin alanin (BOAA) – causes paralysis.	**Elimination of toxic substances**
	Chilli 9,23,000-1,001,304 SHU	**Very High pungent vatriety- Scoville HU., Defence use.**	*Capsicum frutescens var.* Nagahariof (Bhut Jolokia) from Tezpur, Assam

Table 3: Status of base collections in National Gene Bank (-18° C). (NBPGR AR, 2019).

Crop Group	No. of accessions conserved
Cereals	1,64,842
Millets	59,413
Forages	7,249
Pseudo Cereals	7,752
Grain Legumes	66,819
Oilseeds	60,545
Fibre crops	15,746
Vegetables	26,786
Fruits & Nuts	280
Medicinal & Aromatic plants & Narcotics	8,126
Spices, Condiments & flavour	3,237
Ornamental	666
Agroforestry	1,653
Duplicate safety samples	10,235
Trail Material (Wheat, Barley)	10,771
Total	**4,19,382**

Table 4. Status of selected categories of germplasm in tissue culture & cryopreservation (NBPGR AR, 2019).

Crop Group	No. of accessions conserved
***In vitro* bank**	
Tropical fruits	435
Temperate & minor tropical fruits	360
Tuber crops	518
Bulbous crops	171
Medicinal & Aromatic plants	175
Spices & industrial crops	227
Total	**1,886**
***In Vitro* Cryobank**	
Total	**217**

Natural Rubber (*Hevea brasiliensis*)

- **Para rubber is an eco-friendly perennial tree of Amazon river basin, South America, centre of origin of the genus *Hevea*.**
- **It meets around 99% of global requirement of NR, finds use in about 50,000 products.**
- **Most recently domesticated crop species, has most profound influence on man.**

Natural Rubber contd..

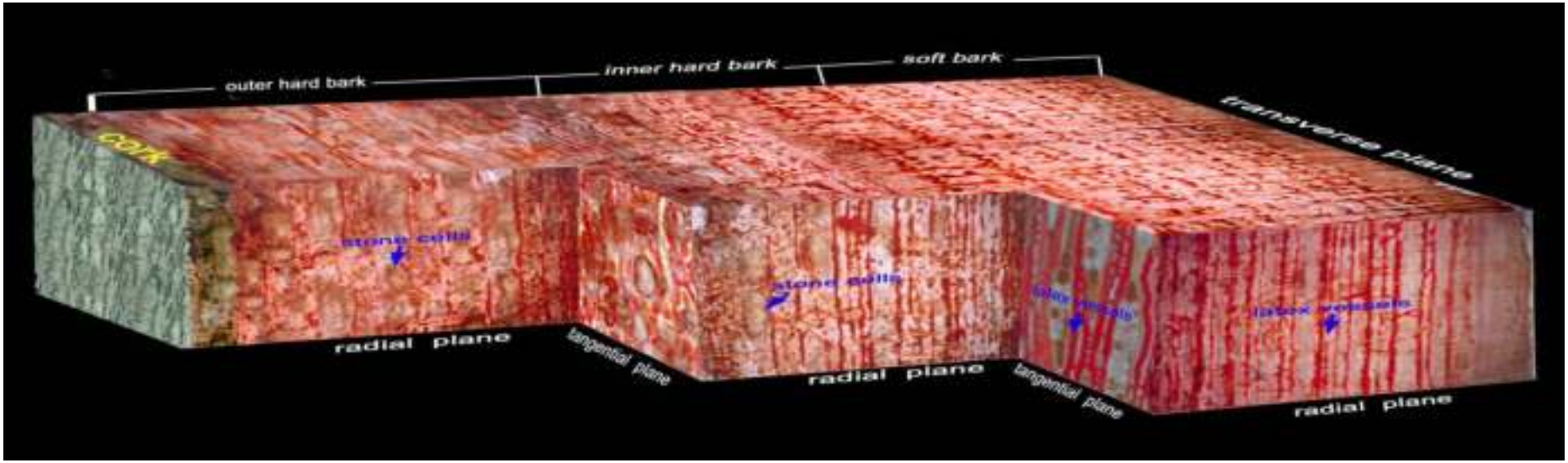
- Globally rubber is cultivated in an area of 1,00,51,700 ha, production 12,070,000 tonnes and consumption of 12,159,000 tonnes (2014-15).
- Asia accounts for 93.10% of production.
- India: Area 518,000 ha (5^{th}), production 8,44,000 tonnes (6^{th}), Av. Yield- 1629 kg./ha (3^{rd}) and consumption of 981,520 tonnes (2^{nd}).
- Provides livelihood to over 1.32 million small farmers in India.
- Foreign exchange-exports- Rs.155.3 billions.
- Supports an industry worth an annual turn over of Rs. 30, 000 crores in India

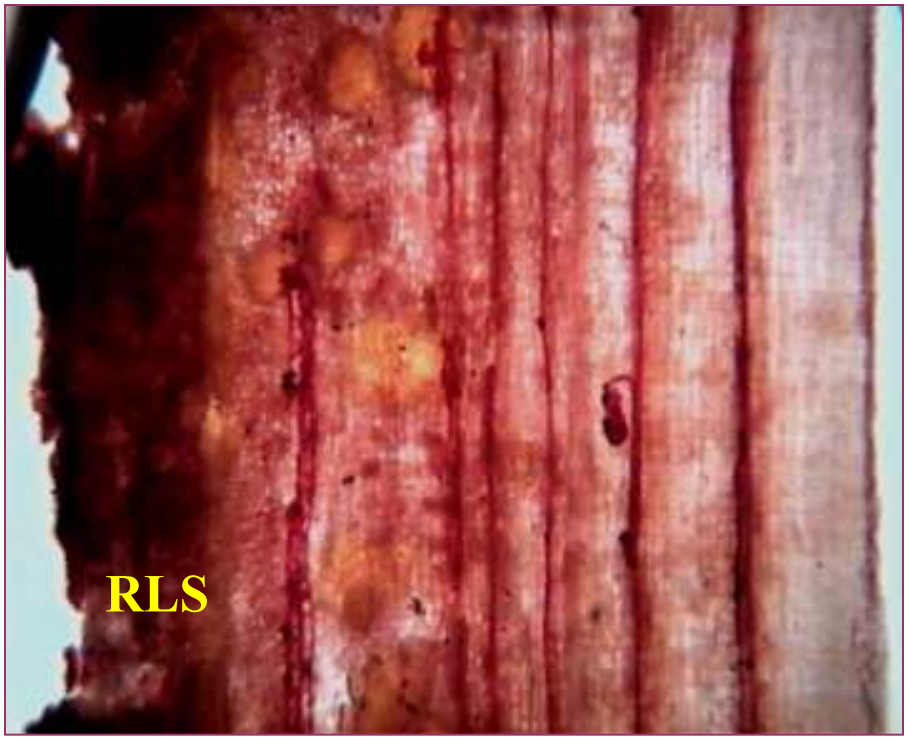
Mature Rubber Plantation

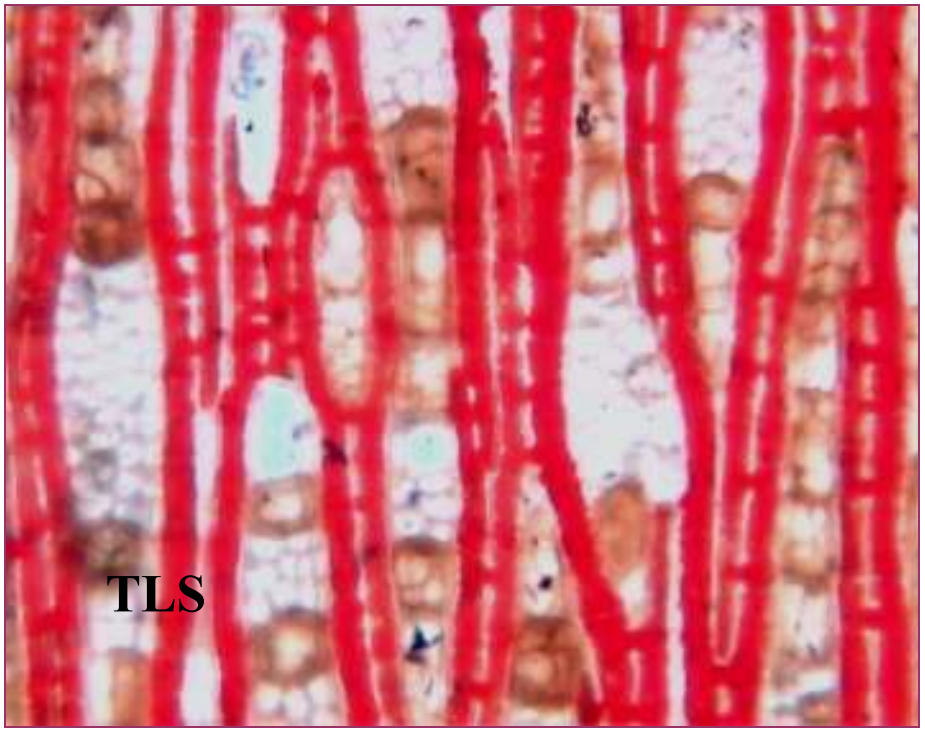
Tapping for Latex Rubber in *Hevea*

- Tapping is a process of controlled wounding of the bark for latex extraction
- Tapping cut: top left to bottom right slope
- Latex vessels - compound articulated anastomosing tangentially oriented 3-7^{o} to the vertical (anti clock wise direction)
- Latex- aqueous serum of rubber (30-45%) & non-rubber particles

Bark structure







HISTORICAL

- An introduced crop from Amazon forests of Brazil during 1876 by Sir Henry Wickham
- Seedlings shipped to Sri Lanka and Singapore
- The 22 seedlings that survived the shipment to Singapore formed the basis of entire NR cultivation in SE Asian countries
- Rubber was originally introduced into India from Sri Lanka & commercial planting started in 1902/ 03
- Initial yield level from seedling plantations was 300kg/ha/yr.
- Through Breeding yield levels improved, potential yield ranged 3000 - 4000 kg/ha/yr.
- Genetic base of present plantation is very narrow

Fig. 1. Distribution of the genus *Hevea*

Major Rubber Producing Countries

Hevea brasiliensis

Grown in Tropical Asia, Africa and America,
in
Countries like
Malaysia, Indonesia, Thailand,India, Sri Lanka, China, Vietnam, Cambodia Burma, Bangladesh, Nigeria,Cameroon, Central Africa, Ivory Coast, Ghana, Zaire, Liberia, Brazil and Mexico

RUBBER GROWING CONDITIONS

- Rubber prefers an equatorial climate, well distributed rainfall of 200 cm. (200- 450 cm). Deep well drained soils, pH below 6.5.
- We do not have the best agro-climatic conditions in India for cultivating rubber.
  - Skewed rainfall distribution
  - Heavy rains during monsoon (diseases)
  - Long, dry and hot summer (drought)
  - Extremely low temperatures (cold) in NT areas.
- Shallow soils
- Slow growth: immaturity period is 7+ years (5-6 yr. in SE Asia).

Areas of Rubber Cultivation in India

NARROW GENETIC BASE

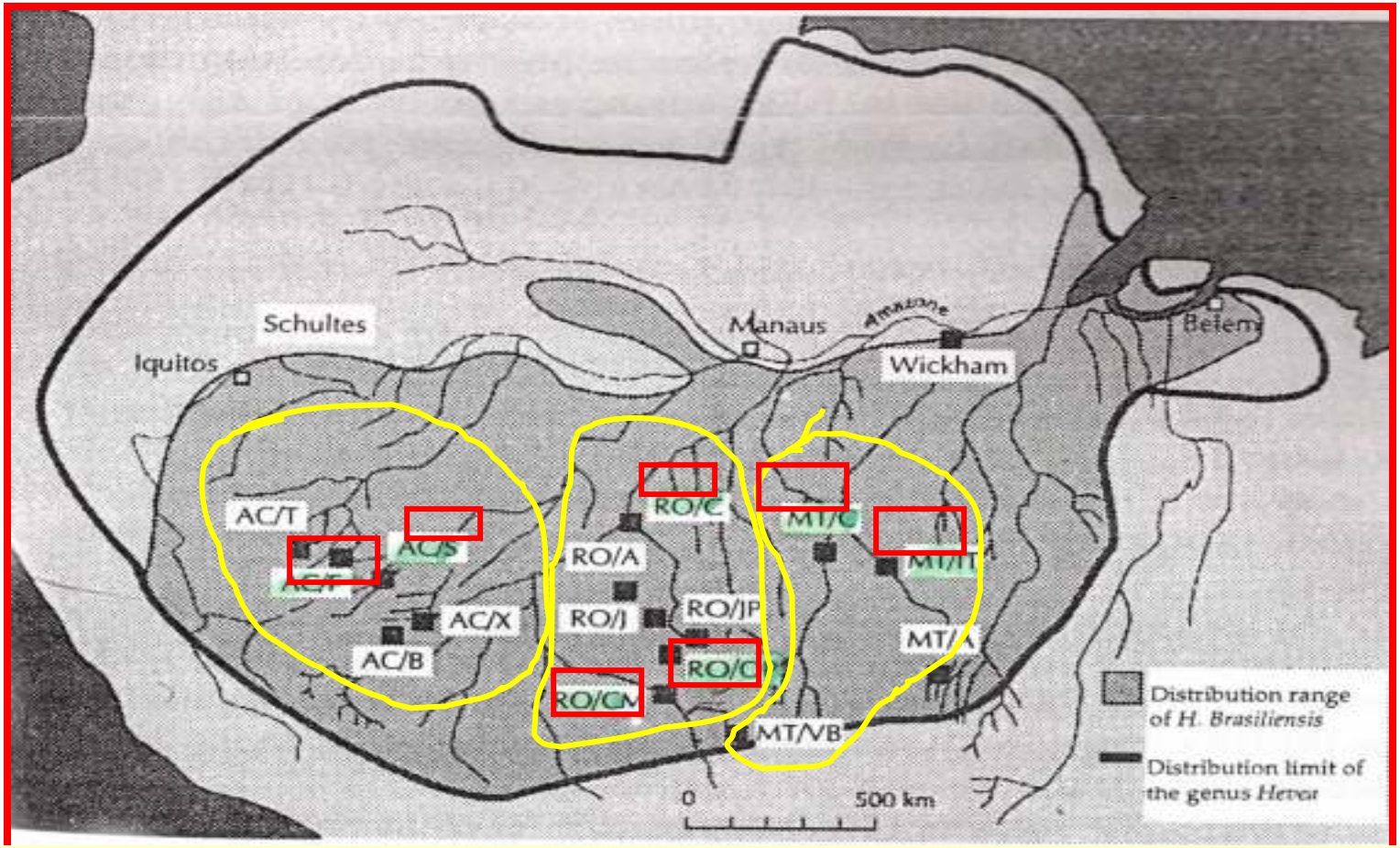
- Genetic variability is a pre-requisite for crop improvement programs
- In *Hevea*, further gains in recent phases of breeding have slowed down due to narrow genetic base (Tan 1987; Simmonds 1989).
- There is an urgent need to broaden the genetic base of the cultivars by introgression with fresh genes.
- 1981 IRRDB expedition in the centre of origin- Brazilian rain forests- resulted in the collection of 64,736 seeds & 194 ortets.

LONE SURVIVOR: An aerial view shows a single tree seen on land that was previously jungle in Mato Grosso State, one of the Brazilian States suffering from deforestation, on Wednesday. The Brazilian Government announced the latest data on deforestation of the Amazon Basin, with a total of 26,130 sq. km of rainforest destroyed, equivalent to more than nine football fields every minute, during the 12-month period ending in August 2004. The Amazon is home to up to 30 per cent of the planet's animal and plant species. — *Reuters*

1981 IRRDB EXPEDITION in Brazil

1981 IRRDB EXPEDITION & INTRODUCTION:

- Collection from Brazil in 1981
- Introduced into India from 1981 – 1990 through Malaysia



Acre : Brasileia, Feijo, Sena Madureira, Tarauaca, Xapuri

Rondonia – Ariquemes, Calama, Costa Marques, Jiparana, Ouro Preto, Pimenta Bueno, Jaru

Mato Grosso: Aracotuba, Cartriquaca, Itauba, Vila Bella

Management of *Hevea* gene pool in India

Domesticated gene pool

183

Wild gene pool (1981 IRRDB)

4548

3576(RRII) 972(NE RRSs)

Other related species:**5**

- *H. benthamiana*
- *H. spruceana*
- *H. pauciflora* (2 accns.)
- *H. nitida*
- *H. camargoana*

Activities

Conservation : Clone museum/SBNs

Characterization : Morphological / Molecular

Evaluation : Nursery, PET, FET, OFT

Screening programmes:

- **Abiotic & Biotic stress resistance : Drought & cold**
- **Screening for disease resistance : All major diseases**
- **Screening for Timber traits : Quantitative & qualitative**
- **Documentation : Accession Register**
  Computer database
- **Utlization : HP & OP**
  Generation of mapping popln.
  Direct selection

Hevea Germplasm Conservatory

CHARACTERIZATION

Morphological characterization

- "**Descriptors for Rubber** (*Hevea brasiliensis* Willd. ex Adr. de Juss.*)* Muell. Arg." was published by Germplasm Division, Rubber Research Institute of India
- So far, **98 % of the collection characterized** in the juvenile stage using **22** morphological traits. Wide variability observed, as indicated by the Shannon-Weaver Diversity Indices.
- Five accessions which show **floral and fruit variation**: suspected to be inter-specific hybrids.

Descriptors for Rubber

(*Hevea brasiliensis* Willd. ex Adr. de Juss.) Muell. Arg.

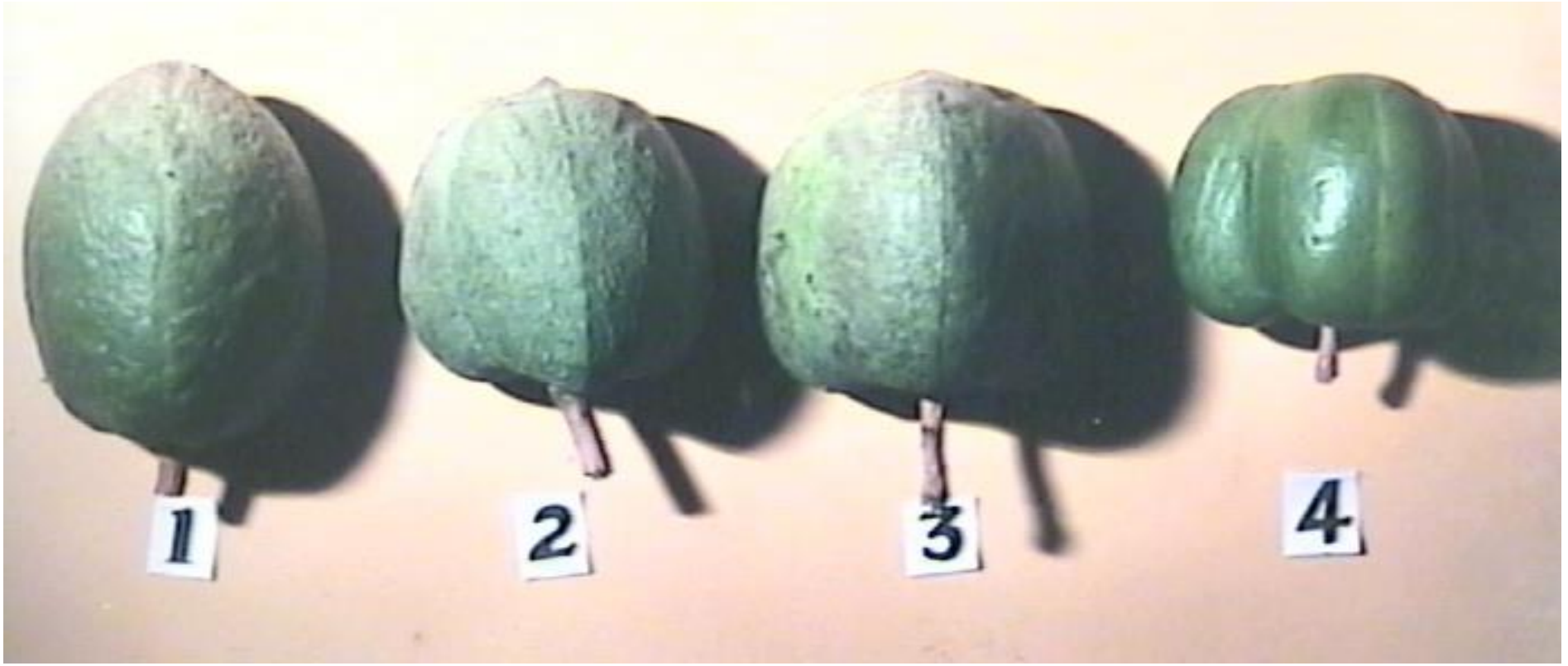
G. Prabhakara Rao, Saji T. Abraham
C. P. Reghu, Y. Annamma Varghese

Rubber Research Institute of India

A floral variant in wild germplasm with red pigmentation

Variability

Variation in branching pattern among wild germplasm



Variation in fruit size and shape

Molecular Characterization

- Molecular markers useful in managing the large collection and cataloguing of diversity of *Hevea*.
- PCR based DNA markers useful for documenting DNA profiles of accessions, identification of possible duplicates and formation of core collections
- RAPD profiling in 110 accessions with 16 primers; 8 clusters were identified. Grouping based on geographic distribution is evident.
- Diversity was analyzed, indicates very high div. in gpm.
- A core set of 27 accessions was identified from a total of 81, using PCA based on 12 quantitative morphological traits, and validated using SDI values from 18 qualitative traits.

Preliminary Evaluation Trials

- Wide variability and significant differences for agro-morphological traits, bark structural traits and juvenile yield
- Superior accessions (Out of 553 accessions evaluated in 5 PETs) girth: 125; latex vessel rows: 29; bark thickness: 41
- Yield (relatively high) in the immature phase: 55 accessions.
- In general, MT accessions showed yield high and resemble the Wickham clones, while AC and RO are more vigorous than those from Mato Grosso provenance

Further Evaluation Trials (FET)

- ✓ Further evaluation of potential selections in detailed evaluation trials, in multilocations, including hotspots for abiotic stress resistance
- ✓ Direct selections for yield to be finally evaluated in On-farm trials
- ✓ One accession (AC166) already in OFT.

Screening of wild germplasm for biotic stress resistance

1. **Screening for resistance to *Phytophthora sp.***

   : 151 accns.

2. **Screening for resistance to *Oidium sp.***

   : 2 accns.

3. **Screening for resistance to *Corynespora sp.***

   : 200 accns.

4. **Screening for resistance to *Colletotrichum sp.***

Field tolerance of accessions from Mato Grosso (right) against *Phytophthora* leaf fall disease.

Screening for drought & cold tolerance

- **RRS, Dapchari, Maharashtra:**

  24 potential drought tolerant accessions identified based on 2-4 years' field performance. Undergoing detailed further evaluation

- **RRS, Sukma, Chattisgarh:**

  5 accessions recorded vigorous growth out of which 1 showed high yield potential also.

- **RES, Nagrakata, W. B. :**

  9 potential accessions identified based on field performance.


Drought tolerant and susceptible accessions
21 12 11
RO 2976
RO 1575

MT 1591- wild accession showing drought adaptation

Field screening for cold tolerance at RRS, Nagrakata, W.B

Screening for Timber traits

Timber Quantity

- Large stem diameter
- Longer boles
- Less branching

Timber Quality & durability

- High wood density
- Low Tension wood formation
- High level Lignification

Development of : Latex-Timber clones (LTC)

Timber Clones

Rubber wood furniture

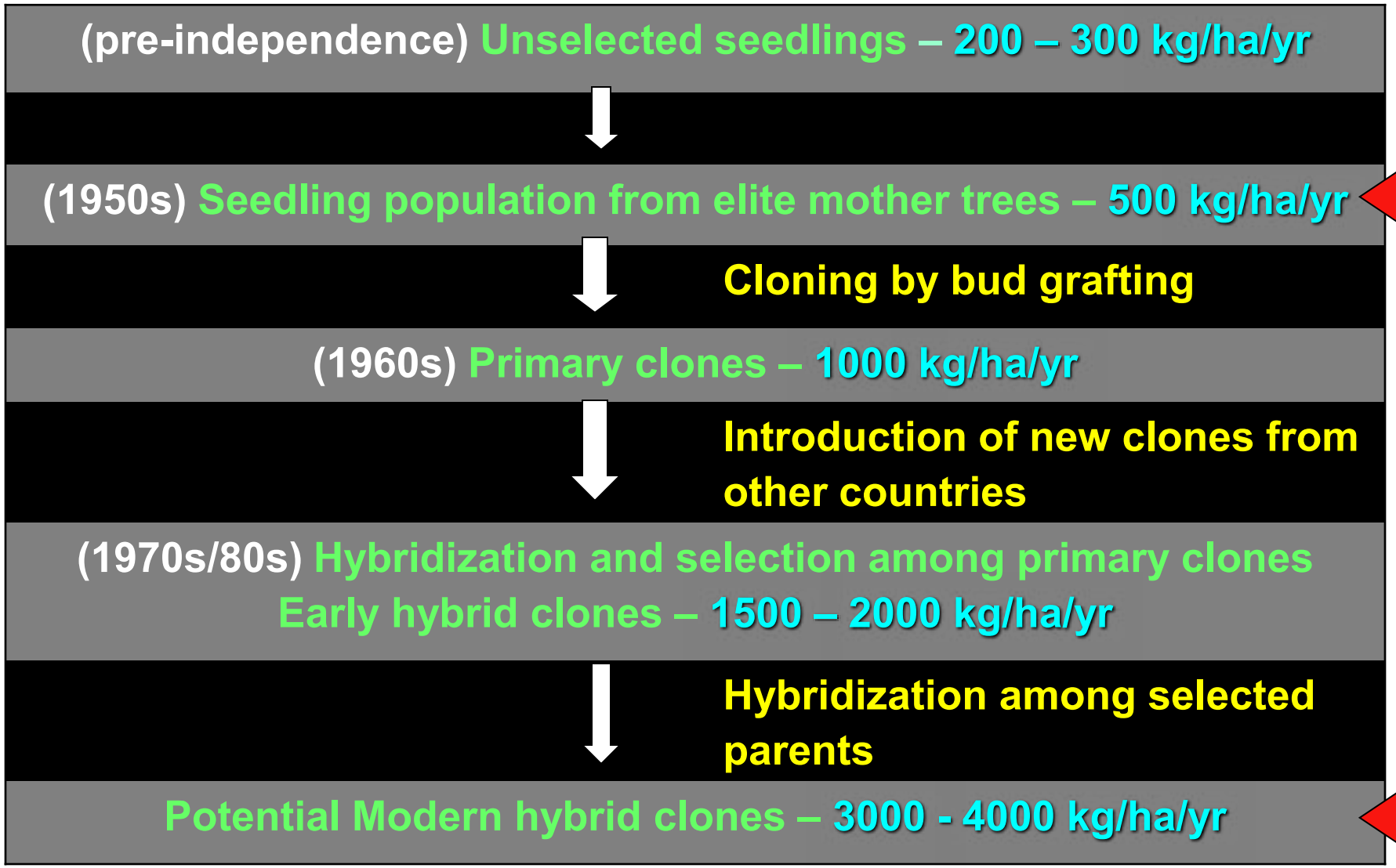
Utilization of Wild *Hevea* Germplasm

- **Direct selections for yield: 3 potential accessions in the final stages of evaluation**
- **Crop improvement through introgression of useful wild genes into cultivars.**
- **Broadening the genetic base of the cultivated clones.**
- **Wickham x Amzonian hybridization programes: 4 sets of crosses made and the progeny in various stages of evaluation. A few promising recombinants identified preliminarily.**
- **However, there is a long way to go before realizing the expected genetic advance from such a large collection of wild germplasm.**

Wild *Hevea* Germplasm: Current status

			Selections
1	Conservation		4548
2	Characterization :	Morphological	3620 (80%)
3	Evaluation:	Nursery (1261)	66
		PET (571)	33
		FET (immature)- 123	7
		FET (mature) – 80	10
		OFT (5 locations)	1
4	Disease screening :	*Phytophthora*	151
		Oidium	2
		Corynespora	200
		Colletotrichum	3
5	Abiotic stresses :	Drought tolerance	25
		Cold tolerance	9
6	Timber screening :	Quantitative	19
		Qualitative (CAD/Lignin)	9
7	Hybridization :	Wickham X Amazonian	16
		W X other species	1
		Breeding garden	8
		W X A (OP Garden)	W (8) + A (21)

Yield improvement in Indian NR sector



Our flagship clone- RRII105

Tappable area under RRII 105	:	3.95 Lakh ha
Additional production per annum (due to RRII 105)	:	0.138mt
Net revenue added in 2013-14 (US$ 315 millions)	:	Rs.1257crores

CONCLUSSION

- Despite several constraints in cultivation, India occupies third place in productivity.
- The RRII clones were the best in the world. **Traditional region**: RRII 105, RRII 430, RRII 414, RRII 417, RRII 422, PB260
- **Non-traditional region**: RRIM 600, RRII 208, RRII 105, GT 1, PB 235, RRII 203, PB 260, RRII 430, RRII 429, RRII 417, RRII 422.
- Effective extension activities, enlightened rubber growers.
- High yielding RRII series of clones are popular among grows in India.

CONCLUSSION contd..

- Wild germplasm - untapped source of many valuable genes.
- The best raw material for realizing the current objectives- yield, stress tolerance and location specific clones.
- Combining conventional and molecular techniques in *Hevea*, will lead to achieve higher yields and stability over locations for a sustainable development in the years to come.

THANK YOU