Overview of Drylands Forestry Research and Development at KEFRI

B. Chikamai & G. Muturi

1

Kenya's agro-ecological zones

- Classification based on precipitation: evapotranspiration (r/e_o) ratio
- High potential areas have a ratio >0.5
- ASALs have a ratio of <0.5
- Semi arid areas have forestry expansion potential
- High potential areas have limited forestry expansion potential

2

Challenges of drylands

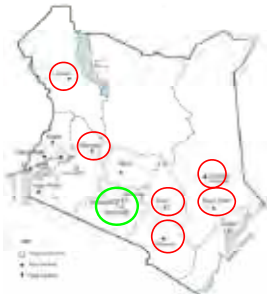
3

Research Programs at KEFRI

- **Drylands Forestry**
- **Farm Forestry**
- **Natural Forests**
- **Industrial Forestry**
- **Tree Seed program**
- *Networks and partnership*
- *Dissemination*

4

Distribution of KEFRI's Regional Research Centres, Sub-Centres and Field Stations



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Current Research Themes in Drylands

- Diversification of tree species
- Improvement of tree productivity and utilization
- Sustainable management of woodlands resources
- Development of wood and non wood resources & products
- Management of invasive tree species
- **To produce publications**

6

Diversification of tree species

- *Melia volkensii* – Kitui and Kibwezi
  - Propagation and nursery research
  - Tree crop interactions
- Silviculture (Spacing trials in Kitui and Kibwezi)
- Plantations with farmers, but tree quality ?
- Breeding for improved quality drought tolerance …….. Project

7

Diversification of tree species contd.

- *Osyris lanceolata* - Kitui & Muguga
  - Propagation
  - Field establishment
- *Terminalia brownii* – Kitui
  - Seed studies
  - Spacing / Field establishment
- *Terminalia spinosa* – Gede
  - Seed study/ Field establishment

8

Development of wood products and Improvement of tree productivity and utilization

- **Products development, refinement and incubation - Karura**
  - Aloe products
  - *Melia volkensii* pesticides
  - *Vitex payos* jam
  - *Prosopis animal* feeds supplement
  - *Tamarindus indica* jam/ Juice ……..
- Enhancement of Vitex payos fruit productivity - Kitui
- Enhancment of gum arabic production – Muguga & Kitui
- Charcoal production – Karura & Kitui

9

Sustainable management of woodlands resources

- **Rehabilitation of degraded woodlands and rangelands**
  - Range improvement and grass reseeding in Eastern Kenya
  - Range rehabilitation in Turkana (Kalatum, Pelekech)

10

Management of invasive species

- **Prosopis management is a flagship project for Kenya's vision 2030**
  - Management through utilization
  - Obtain products such as livestock feeds & Charcoal
  - Improve woodlands ecology

11

Timber

12

GUM ARABIC, FRANKINCENSE, MYRRH, HAGAR

Acacia sengal, A. seyal*, *Boswellia neglecta, Commiphora myrrha, Commiphora holtiziana

13

Basketry, dyes and thatch

Hyphaene compressa, Terminalia brownii, Ekebergia capensis, Euclea divinorum, Azanza gackeana etc

14

Aloes

Beauty and Pharmaceutical products

15

Perfumes - Osyris

16

Sustainable management of woodlands resources - Turkana

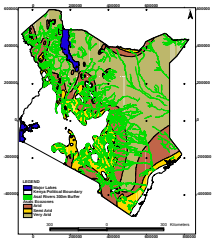
17

drylands rehabilitation – Muguga

- **Aloe planting**
- **Grass reseeding**

18

Management of invasive species (Prosopis) – Bura, Turkana, Marigat & Garissa



- •National survey on invasion
- •Piloting & upsacling management interventions
- •Factored *Prosopis* management in Vision 2030 -"Management through utilization of pods for animal feeds and *Prosopis* woody biomass"
- •Supported *Prosopis* research
- •Govt. declared Prosopis a a noxious weed through Gazette Notice No 184 of 30th December 2008, but..
- •Utilization seems to excite people, hence
- •More research needed

19

The Prosopis story

- **•Loss of fodder**
- **•Biodiversity loss**
- **•Livestock death**

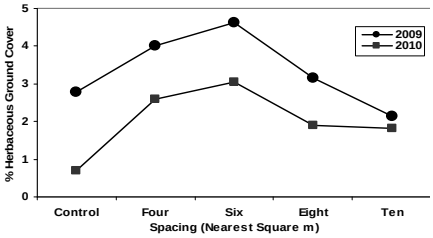
20

A well managed *Prosopis* stand

Timber, Poles, Posts and charcoal

21

Effect of spacing on herbaceous species



At spacing of 6X6m herbaceous cover is optimum

22

Utilization as a resource

Various manufactured wood products

Sawn timber

Short timber segments

Charcoal production

Luxury chairs

Wood carvings

Wood chips

23

24

Commercial processing for livestock feeds sector




25

Industrial and domestic utilization at project area


Fuelwood and poles being traded


Charcoal production


Timber production


Production of wood chips


Grinding pods


Making delicacies using *Prosopis* flour

26

27

Development of Drought Tolerant Trees for Adaptation to Climate Change in Drylands of Kenya

FFPRI/TBC

Genetic Research

Machua, Joseph
Omondi, Stephen

1

Examples Forest molecular genetic studies at KEFRI

1. Genetic Diversity of some *Melia volkensii* populations based on RAPDS markers
2. Genetic Diversity of *Brachylaena huilensis* populations based on RAPDS Genetic Diversity of some *Jatropha curcus* populations based on RAPDS
3. Genetic Diversity of some Acacia senegal populations based on SSRs and RAPDS
4. Genetic Diversity of some *Prosopis juliflora* populations based on RAPDS Genotyping of improved *Eucalyptus grandis* lines based SSRs

2

KEFRI human capacity for forest genetic studies

- 1 PhD - Scientist
- 2 Msc Scientist
- 1 PHD student
- 3 Msc Students
- Two molecular genetics technicians

3

KEFRI laboratory capacity

Basic equipment

- PCR machine
- Refrigerators and freezers (-20, 4°C)
- Electrophoresis systems
- Gel documentation system
- Phytotrons for Tissue Culture
- Glashouses
- Data analysis techniques

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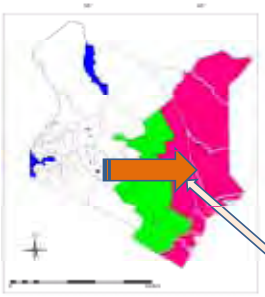
Broad Objective

Melia volkensii

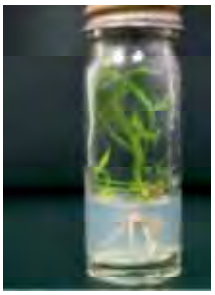


Increase drought tolerance

5

TISSUE CULTURE

Clonal multiplication of the plus trees



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Acacia tortilis

"The ASAL magic tree"

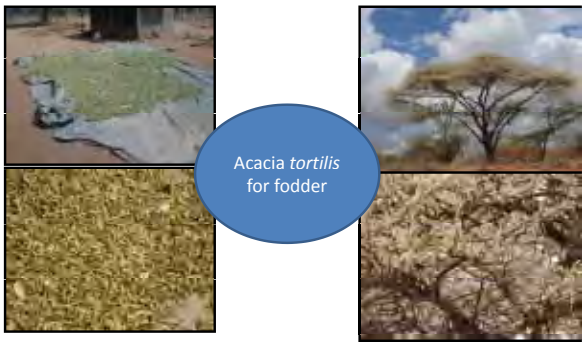
7

Broad Objective
Acacia tortilis

Understand the genetic diversity to enable selection plus trees for improvement of livestock fodder and enhanced drought tolerance

8

Candidate Plus Tree (CPT) Selection for fodder



9

Project implementation

Project plan of operation (PO)
MELIA PROJECT¥PO_Kenya_0320.xlsx

Project design Matrix PDM
PDM_Kenya_0320.docx

10

PROJECT DESIGN MATRIX

Overall Goal
Quality plantations of indigenous species are extended in the ASALs of Kenya

KEFRI's capacity for conducting research on genetic diversity of indigenous species (*Melia volkensii* and *Acacia tortilis* as pioneer trial) is strengthened.

Quality seed and seedling supply system for *Melia volkensii*is established.

Project Purpose
Research capacity and extension system necessary for promoting indigenous species plantation in the ASALs is enhanced.

KEFRI's capacity for implementing forest tree breeding of indigenous species (*Melia volkensii* and *Acacia tortilis* as pioneer trial) is strengthened.

Awareness of relevant stakeholders on the importance of quality seed and seedling is raised.

11

Thank you

Arigatoō gozaimasu

12

Development drought tolerant trees (*Melia volkensii* and *Acacia tortilis)* for adaptation to climate change (Breeding component)

J. Kariuki,
D. Muchiri,
Mary W.,
Frouza M

1

IMPACT OF CLIMATE CHANGE TO FORESTRY

Climate change is already forcing most tree species and plant associations to adapt either through shifting habitats, changing life cycles, or the development of new physical traits such height.

Climate change may also lead to alterations in the range, distribution and population density of many plants.

Climate change is also expected to significantly alter Kenya's forest diversity as species struggle to adapt to changing climatic conditions.

In general, those species with restricted climatic envelopes (such as *Melia volkensii* -Mukau), small populations and limited ability for dispersal are most likely to suffer in the face of rapid climate change.

2

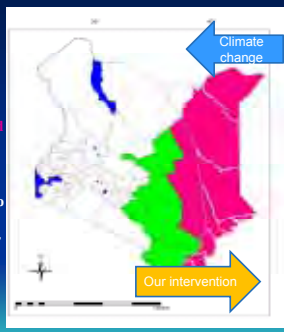
Introduction

- *Melia volkensii, (Mukau)* belongs to the family Meliacea and is endemic in drylands of East Africa.
- *Melia* is fast growing and tolerant to drought conditions
- *Melia* is valued for both its timber and non-timber products such as sawn timber, and poles 1994)
- *Melia* has been overexploited due to its high quality timber and termite resistant poles.
- Habitat fragmentation and loss of the species natural population is also on the increase especially in the highly settled areas.
- Melia is now the candidate species for dryland rehabilitation and plantation development
- Selection and Breeding for high yielding varieties is high on demand

3

Justification

- **Development of drought tolerant varieties of Melia through selection and genetic modification is necessary for improving its adaptability in the target areas.**
- **The developed varieties are expected to extend Melia's range of growth and increase its adaptability to effects of climate change.**
- **Melia grows in agroclimatic zones IV and V However, the breeding for Melia is expected to extend it to the harsher agroclimatic zone VI.**
- **Improved Melia varieties can also be used for carbon sequestration to mitigate the effects of climate change and for carbon credits.**



4

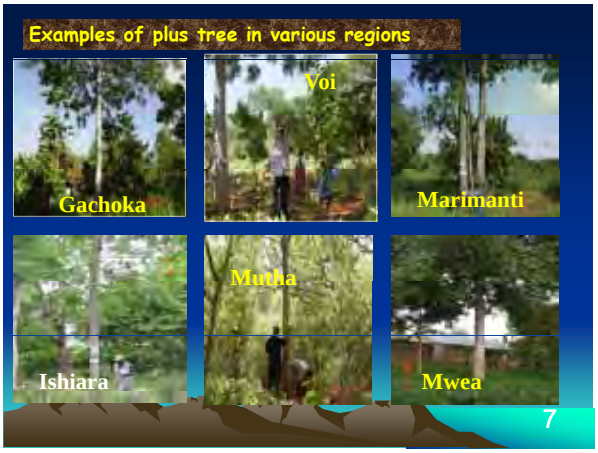
- Sites and transects used for selection of Melia plus trees

5

Table 1: Distribution of plus trees of *M. volkensii* in various regions of Kenya

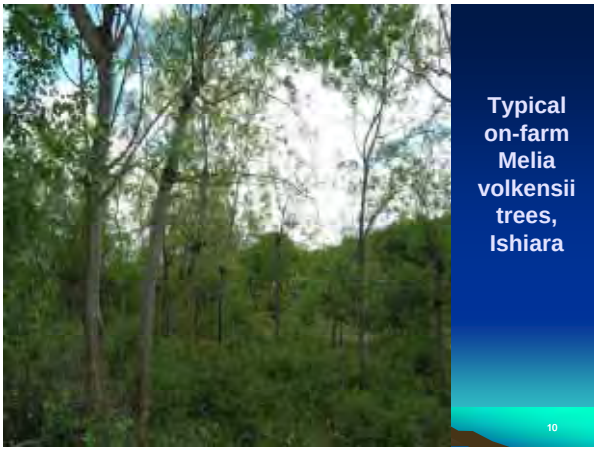
No	TRANSECT	Region	N plus trees
1	Voi – Taveta	Coastal	8
2	Mutha - Inyali	South Eastern	12
3	Kavisuni - Katulani -	Central Eastern	7
4	Mwingi - Tseikuru	Eastern	8
5	Mwingi - Nuu	Eastern	7
6	Embu - Ishiara	Eastern	7
7	Siakago - Gachoka	Eastern	8
8	Isiolo-Kina-Tharaka	Northern	7
9	Mwea Special	Central	1

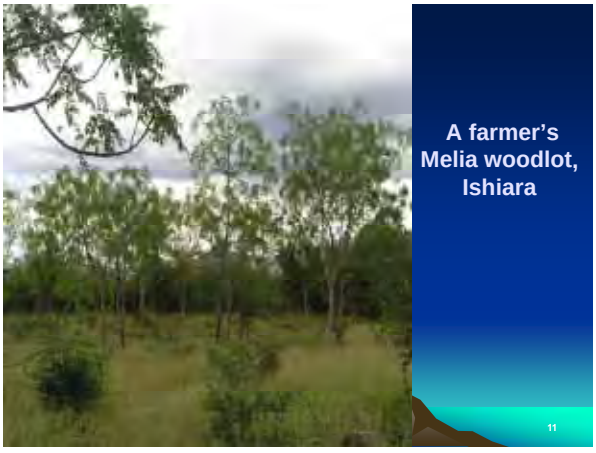
6


Examples of plus tree in various regions
Gachoka
Voi
Marimanti
Ishiara
Mutha
Mwea
7


Melia plus tree on-farm
Melia plus tree - Wild
Clonal Seed orchards/hedges
Grafts 2 wks old
Stressing
Sprouts
Grafting
8


Typical Melia trees on farm, Tseikuru
9


Typical on-farm Melia volkensii trees, Ishiara
10


A farmer's Melia woodlot, Ishiara
11


Melia volkensii plus tree in Homestead, Mbeere
12

Melia volkensii select tree in the wild, Mutha

13

- 10 year old Melia tree, Mwea
- 47.2 cm DBH
- (1.5m circumference)

14

Cypress plantation at Museve Hill (Kitui central) planted with selected materia

Mukau (Melia) plus trees selection in Tharaka

15

Overall Goal

- To develop drought tolerant tree species of for adaptation to climate change.

Project objectives

- To enhance KEFRI'S capacity to undertake 'state of the art' breeding
- To screen drought tolerant trees and select candidate plus trees
- Establish clonal seed orchards for *Melia volkensii* and seedling seed orchard for *Acacia tortilis*
- To undertake genetic diversity of *Melia volkensii* and *Acacia tortilis*
- Disseminate the result to farmers and other stakeholders

16

Selection and multiplication of plus trees

- Develop selection criteria for drought tolerance
- Select preliminary drought tolerant trees
- Collect seed for testing and root stock
- Undertake nursery and greenhouse screening trials and identify tolerant trees
- Collect seed and scions from the most drought tolerant trees

17

PROJECT PLAN OF OPREATION (PO)

PO_Kenya_0320.xlsx

18

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19

Project Outputs

- Genetic structure and diversity of candidate species identified and mapped
- Selection and screening for drought tolerance of candidate species undertaken
- Massive Clonal propagation undertaken
- Clonal orchards of drought tolerant candidate species established
- Seedling seed orchard established for *A. Tortilis*
- Training of farmers and other stakeholders on the use of superior germplasm of drought tolerant species

20

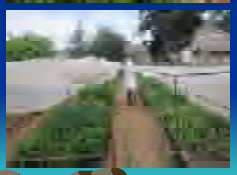
Mandate of Participants

- SEE ATTACHED MSWORD: Plan…

21

Background information on nursery

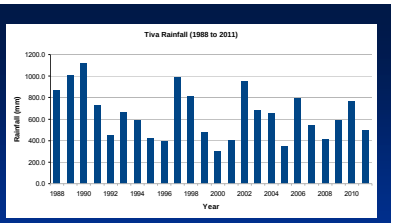
- The nursery site for raising rootstock seedlings was established at Kitui Research centre.
- A total of 8,000 Melia was sown in February 2012.
- Soils are obtained from forest sites and mixed with sand and also fertilized. The soil is fumigated to kill all unwanted microorganisms, potted in 4x6 tubes in readiness to transplanting. The soil: sand mixture is 3:1 and 1kg DAP/tonne

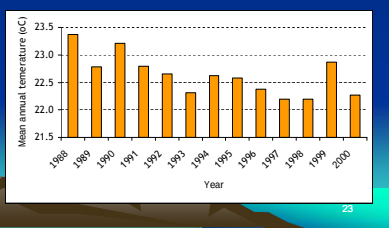


22

Description of Kitui Site

- Kitui is one of the planting sites for the seed orchard. The planting season is in October/November or December when there is enough rain
- The main wheather conditions of Kitui are as shown
- The planting season for Kibwezi is similar to the Kitui timing
- Seed orchards to be planted in KEFRI land of Government University land for a start





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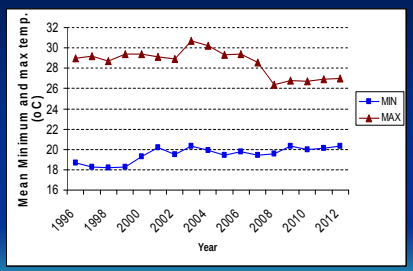
Kibwezi temp data



24

Timing of Nursery Activities

- December-January – Soil collection
- February- Soil treatment, seed collection and processing
- February/March- Seed sowing and transplanting into tubes
- August/September – Scion collection/ Grafting
- October/November - Planting

25

26

Thank you

27

DNA Analysis Training in FTBC, Japan
4th July – 24th August 2012

Training Report

Machua , Joseph **Omondi , Stephen**

Kenya Forestry Research Institute, Nairobi

1

FTBC—KEFRI-JICA PROJECT:

Development of Drought Tolerant Trees for Adaptation to Climate Change in the Drylands of Kenya

2

PROJECT DESIGN MATRIX

Overall Goal
Quality plantations of indigenous species are extended in the ASALs of Kenya

GENETICS GROUP
To strengthen KEFRI's capacity for conducting research on **genetic diversity of indigenous species** (*Melia volkensii* and *Acacia tortilis)* as pioneer trials)

Project Purpose
To enhance research capacity and extension system necessary for promoting indigenous species plantation in the ASALs.

To establish quality seed and seedling supply system for *Melia volkensii*

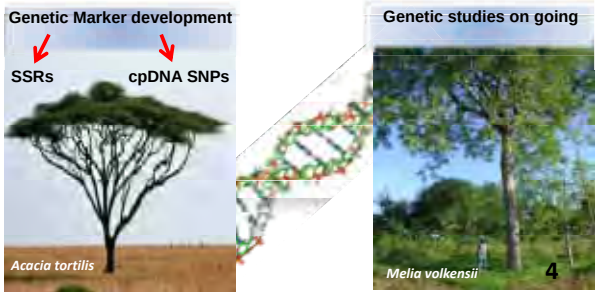
To strengthen KEFRI's KEFRI's capacity for implementing forest tree breeding of indigenous species (*Melia volkensii* and *Acacia tortilis* as pioneer trial)

To raise awareness of relevant stakeholders on the importance of quality seed and seedlings.

3

THE TRAINING GOAL:

Technology transfer for studying genetic diversity and genotyping Melia and Acacia



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Objectives of training

1. **To learn tissue culture techniques at FTBC**
2. **To optimize DNA isolation protocol**
3. **To isolate and sequence *Acacia tortilis* SSRs regions**
4. **To design at least 100 (hyaku!) *A. tortilis* SSR primers**
5. **To screen the designed primers on *A. tortilis* samples**
6. **To obtain sequences of *A. tortilis* cpDNA and search for SNPs**
7. **To design SNP markers if > 5 SNPs are detected**

5

Tissue Culture Training
July 10- 13th 2012

Materials and Methods

- Media preparation
- Choice of explant source
- Surface sterilization
- Inoculation
- Subculture
- Habituation
- Facilities
- Planting out

6

Media preparation

Basically a Tissue Culture media is composed of;

1. Salts
2. Vitamins
3. Carbon source

4. Gelling agent (Optional
5. Varying concentration of PGRs (Optional)
6. Remedials e.g PVP, activated charcoal

7

Sterilization and Inoculation

Source of explant

Explants were obtained from

- Glasshouse grown seedlings
- vitro cultures plantlets

Surface sterilization

- This was achieved by 1% Benzalkonium chloride and
- 1% – Sodium hypochlorite

8

Tissue culture process

KEFRI scientists inoculating Melia tissues

Callus formation from Melia nodal tissues

Habituation of Cryptomeria

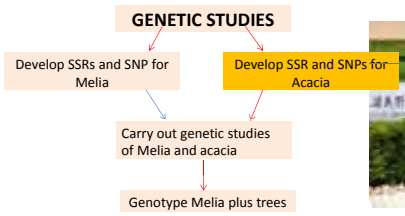
Planting TC Jatropha

Assessing TC Cryptomeria

9

DNA Analysis training July 9th – August 24th 2012

In order to study genetic diversity of Melia and Acacia and genotype plus trees, genetic markers must be developed.



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DNA Analysis training

Materials and methods

1. **DNA extraction**
2. **SSR development**
   - Restriction
   - Cloning
   - PCR
   - Sequencing
   - SSR design
   - SSR screening
3. **SNP detection**
   - PCR
   - Sequencing
   - SNP search
4. **SNP marker development**

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DNA Isolation

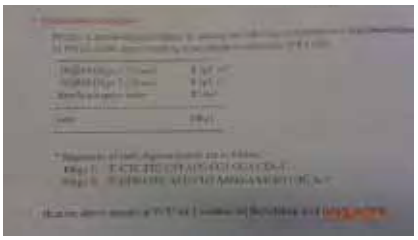
CTAB Method

Shiraishi S, Watanabe A (1995)

12

Preparation of adapter

A double stranded adapter was prepared to ligate the digested DNA fragments



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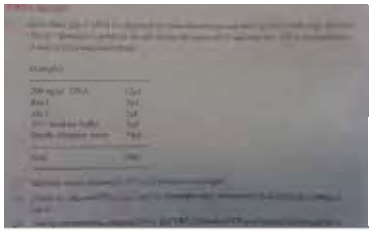
DNA Digestion + Adapter ligation

- *A. Tortilis* DNA was digested with *Rsa*I and *Alu* I as one reaction and EcoRV in another reaction
- The sticky ends were ligated to the prepared double stranded adapter.



14

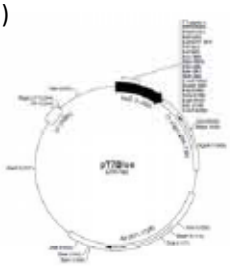
SSR Capture and collection

- The *A. tortilis* SSRs regions were captured by Biotin labeled $(GA)_{10}$ and $(CA)_{10}$ SSR probes
- SSR were collected using a magnetic particle concentrator (MPC)
- Non SSR fragments were washed out
- SSR fragments were then purified
- SSR fragments were enriched in a PCR reaction using one of the adapters as a primer
- The PCR products were further purified for vector ligation

15

Vector ligation, transformation and cloning

The PCR products were ligated to a pT7Blue vector (Novagen)



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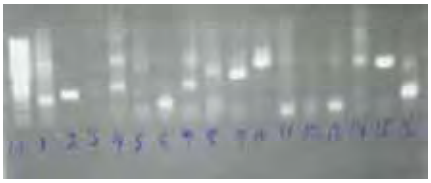
Transformation and vector cloning

- The ligated vector was cloned on Ecos™ DH5α competent cells
- Transformation was carried out at 42^0C for 10 minutes
- X-gal (5-bromo-4-chloro-indolyl-β-D-galactopyranoside) was sprayed on the LB media plate and the transformed cells spread out using glass beads
- Positive white transformants were selected
- A touch down colony PCR of positive clones was performed.

17

Results of colony direct PCR

- A direct colony PCR was performed to confirm presence of cloned microsatellite regions.
- Several clone were positive as shown below



18

Plasmid vector isolation (Miniprep)

- The plasmid vector was isolated from the positive clones
- A Minprep (plasmid isolation) was performed.

19

Vector sequencing

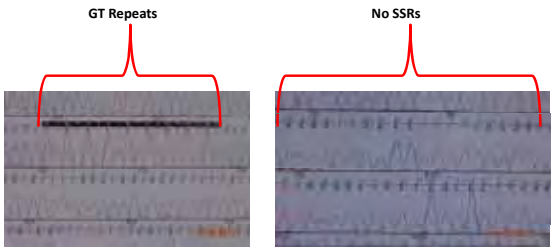
The plasmid vector was sequenced using ABI 3130 Sequencer

Sequence reaction	
Reagent	Volume
Water	4.5ul
Big Dye terminator	1ul
Sequence buffer	1.5ul
Primer(U19)	1.0ul
Template DNA	2ul
Total	10ul
Capillary electrophoresis	
Add Hi-Di formamide	
Denature at 95° C for 3 minutes and put on ice for 5 minutes then load to ABI	

20

SSR Designing

- 144 SSR Primers were designed using online Primer 3 plus software



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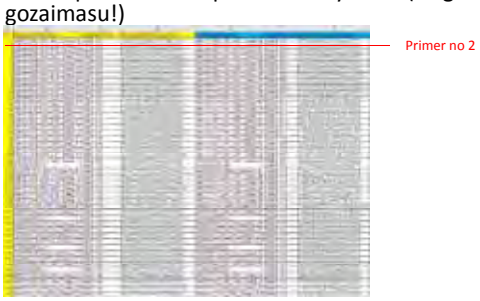
SSR Designing

- All the primers were purchased by FTBC (Arigato gozaimasu!)



22

SSR Primer screening

- The designed SSR primers were screened using the *A tortilis* DNA and analysed using ABI Genemapper sofware.
- A total of 17 primers for *A. tortilis* were selected out of the 144 designed
- The figure below show one of the designed and screened SSR marker Kfat 119 genotyping 4 *A tortilis* samples

23

Development of SNP markers for *A.tortilis* cpDNA

Several cpDNA markers were selected to amplify the **conserved** of cpDNA genes and intergenic regions

24

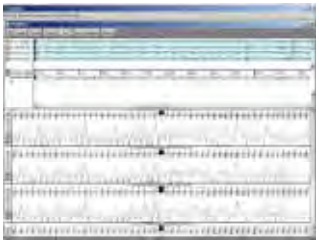
cpDNA PCR

cp DNA	Touch down PCR						
94°C	5Mn						
94°C	40Sec		94°C	40Sec			
55°-50°C	90Sec	X10	50°C	90Sec	X30		
72°C	90Sec		72°C	90Sec		72°C	10Mn
4°C∞							

25

CpDNA sequences

- No SNP s were detected
- No SNP primers were designed
- SNP search will continue with other cp DNA primers such as universal cpDNA primers or other Acacia cpDNA primers in the database



SNP search on A.tortilis using P13F. A contig of 4 samples

26

Conclusions

Tissue culture

- Media preparation - Well done
- Explant source – Jatropha, Calophyllum & Melia
- Surface sterilization - Well done
- Inoculation – Jatropha, Calophyllum & Melia – well done
- Subculture – Well done
- Somatic embrogenesis – More training needed
- Habituation – Introduced.. More training needed
- Facilities- More training needed in , Multiplication, Habituation, GMO
- Planting out – Jatopha TC was planted

27

Conclusions

DNA Analysis

1. DNA isolation protocol - Achieved
2. Isolation and sequencing *A.tortilis* SSRs – Will require more primers
3. Design at least 100 (hyaku!) working *A. tortilis* SSR primers-144 designed and only 17 Primers were positive. More primers are required.
4. Test the designed primers-Testing done on 8 samples. Test for 90 samples required
5. Sequence *A. tortilis* cpDNA and search for SNPs – No SNPs were found
6. If > 5 SNPs are available design SNP markers – No SNPs was found
7. More cp DNA will be sequenced for SNP detection

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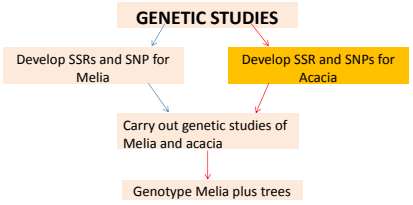
Way forward.



1. Start genetic studies for *Melia volkensii*
2. Test the designed *A.tortilis* primers on > 90 samples
3. Training and screening more SNPs to continue
4. Training on various molecular analysis softwares to start
5. Training on Somatic embryogenesis and habituation to continue

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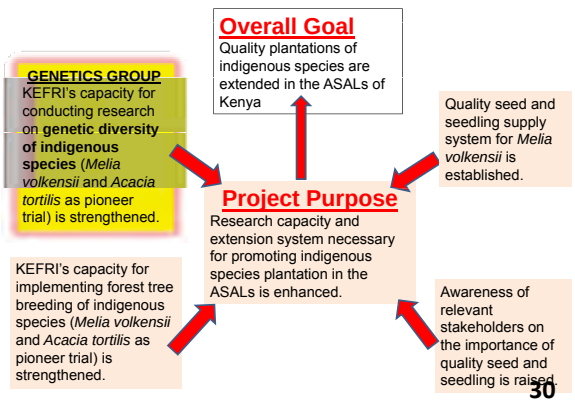
PROJECT DESIGN MATRIX



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MINASAN
ARIGATÓ GOZAIMASHITA

31

Forest field test visits

By

Omondi SF and Machua J

1

Forest management for water resources conservation

- Most mountains (Japan) have protected forests for water conservation (Private lands).
- The Centre for Forestry and Agric. development (CFAD) and FFPRI are implementing afforestation projects.
- Participation of private land owners, government (CFAD and FFPRI)-give technical and financial support and community based organizations (CBOs)-labor (80 years contract)
- Benefit sharing at 50:40:10 ratio
- Challenge is the cost of management (weeding)
- Fast growth species trial set up (C. japonica)

2

3

Crytomeria japonica progeny trial in Kanto plains (Kanuma)

- Controlled, open pollinated and local progenies.
- The parents (control pollinated progenies) are known and their heritability (fast growth) established. The soil characteristics where they grow have also been adequately studied.
- Replicated in 3 sites (genotype and environment) and in each site 3000 seedlings per ha (1.8x1.8 m) are planted.
- Assessments are done after every 5 years but also at the 8th and 13th year.
- It is planned that 3 thinning will be done during the crop rotation.
- At 13 years superior performance (18m) is recorded.
- The good performance is attributed to soils, superior source environmental conditions.

4

Kanto 47 progeny test

- Established 30 years ago
- Controlled pollinated (superior performance).
- 1.8x1.8 m spacing with 3000 seedlings/trees per ha.
- Growth performance is good and better than general (local) materials.
- Second generation selection has been done based on stem form (straightness) rather than growth rate.
- This is because target market is construction industry (straight wood is priority).

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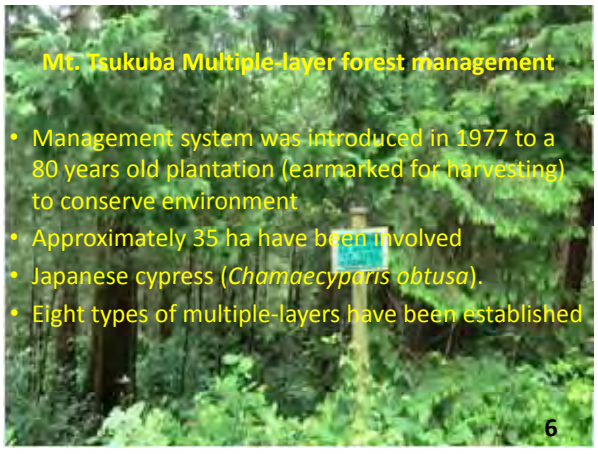

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Osawa test site

- This test site is located in Osawa national Forest (21 ha) and it is expected to span for 76 years (1996-2072).
- Forest management system was introduced to facilitate species diversification through planting of broadleaved species
- Broadleaved species for conservation and conifers for lumber production.
- The species : *C. japonica*, *C. obtusa* and other broadleaved species.
- Some *Pinus densiflora* of natural regeneration (most of them died due to pine nematodes).

8

Implementation strategies

- Ridge preservation -to improve forest tree diversity by introducing broad-leaved species near water ways after thinning .
- Conifer trees plantation area- based on superior growth and production efficiency. The purpose of these areas is to grow forest tree with economic value
- Two-storied area with conifers and broadleaved trees- Form the transition area(biodiversity ecotone) between the conifer and broad-leaved tree area for both lumber production and biodiversity conservation.

9

Conti……..

- Broad-leaved tree nurtured area- these were established in the ridges where plant growth is poor and commercial plantation is difficult (Increase biodiversity by felling the planted trees and allowing natural regeneration of broad-leaved species).
- Current broad-leaved tree area- consist of *Castanea crenata* and *Quercus serrata*.
- Others: Provision of nesting trees for birds.

10

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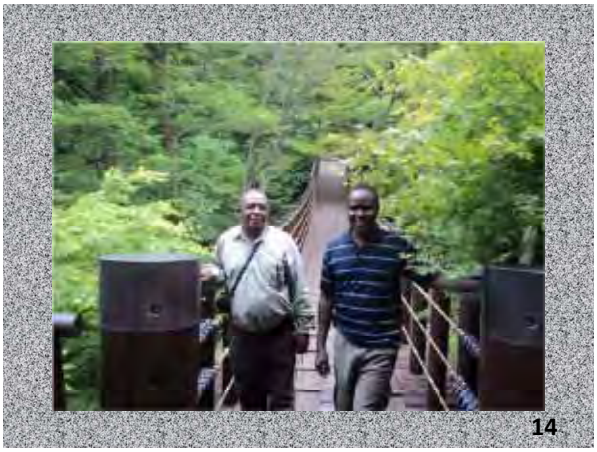

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Thank you
Iroiro arigatō gozaimashita

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Tree Breeding Theory Training in Japan
Japan 4th July – 10th August 2012

Training Report

Kariuki J. G. **Muchiri D. K.**
Kenya Forestry Research Institute, Nairobi

1

INTRODUCTION

- The background to the training held in Japan – Project on '***Development of Drought tolerant trees for adaptation to Climate Change' in Kenya***'.
- One of the Project objectives is '***To enhance KEFRI'S capacity to undertake 'state of the art' breeding***'
- To achieve the objective, short-term trainings are to be held in Japan on various aspects related to the Project.
- The training reported in this presentation was on 'Tree Breeding Theory" held between 5th July 2012 and 10th August 2012
- Training had 3 main components
  - Core Lectures – Mainly held at FTBC 10th – 13th July
  - Field Visits:
  - Practicals – Both at FTBC and Field
- Discussions of New Project

2

1: Core Lectures

- Lectures were held everyday from 10th August 2012 to 13th August 2012
- The topics covered included a wide range of issues that are relevant to implementation of the new project:
- LEC 1: Evaluation and selection of plus trees based on quantitative genetics
  - ✓ Mass selection
  - ✓ Quantitative genetics principles and estimation of genetic parameters- h2, BV, GCA, GxE interaction
  - ✓ Evaluation and selection of plus trees – Use of breeding values, GCA, various forward and backward selection methods were studied
  - ✓ Short vs long term breeding and the need to balance gain and breeding value

3

LEC 2: Use of REML in Tree breeding

- Calculation of BLUP in linear mixed models and advantages over linear models as ANOVA such as:
  - Efficient handling of missing values,
  - Calculation of Breeding values
  - Use in backward selection
  - Use in calculation of G/E interactions
  - BLUP calculates the breeding value

LEC 3: Forest Tree improvement in Japan

- The lecture dealt in detail with tree improvement practice in Japan
  - Forest types, area and species distribution
  - Wood demand
  - Main objectives of improvement for *C. japonica*: Growth, hardiness, pollinosis

4

- Zonation of tree improvement: 5 zones and differences in climate and therefore species emphasis
- Main steps in Tree improvement from
  - Consideration of current state and decision making on focus of target species and traits to improve eg of Cryptomeria
  - selection of candidate trees, Orchards, Progeny tests, deployment of material and subsequent generations
- Establishment of seed orchards
  - Collection of scions and when/position to collect
  - Design and management of orchards (cutback, fertilizer hormone treatment disease control
  - Seed Supply, (59 orchards in Kanto) Miniature orchards
- Detailed Progeny testing procedure
  - Different types according to objectives and may include advance generation breeding, genetic evaluation
  - Deployment of improved material

5

- Mating designs
  - Open pollinated, Polycross, single pair mating (not good for estimation of parameters), diallel and factorial designs
- Field design: Normal tests and genetic tests
- Provenance testing
- Data Analysis
- Advanced generation breeding
  - Use of controlled crossing
  - Use of diallel and factorial designs
  - Early selection using individual BV
  - Wood testing

6

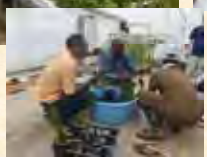
7

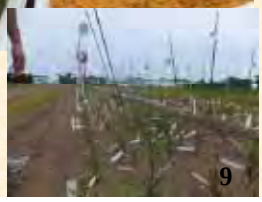
LEC 4: Propagation

- Goals of Tree breeding in Japan
- Selection of plus trees
- Selection for pest resistance – e.g. against *Bursaphelenchus mucronutus*
- Seed purity testing and research
- Nursery practice at FTBC: Seedling and clones, potted vs bareroot; Nursery pests and diseases
- Grafting:
  - Stock: Scion matching
- Nursery pests & diseases
- Mass propagation

8

- Scion collection procedures, including timing, proper labelling, storage; Q: best time for collection for Melia?
- Seed collection, sowing, soils fumigation, nursery bed preparation





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LEC 4: New methods for pedigree and individual management in seed orchards & trial sites

- Review of steps in tree breeding, emphasising importance of accurate data collection
- Possible stages where mistakes occur in data collection and documentation from scion collection to assessment
- Examples of mistakes in handling of documentation
- Accurate Management of pedigree and evaluation using DNA fingerprinting at FTBC (Time constraints)
- Challenges of contamination
- Current methods of documentation: – Waterproof label, number tape
- New methods: - PDA (Personal digital assistants and RFID (radion tag

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FIELD VISITS

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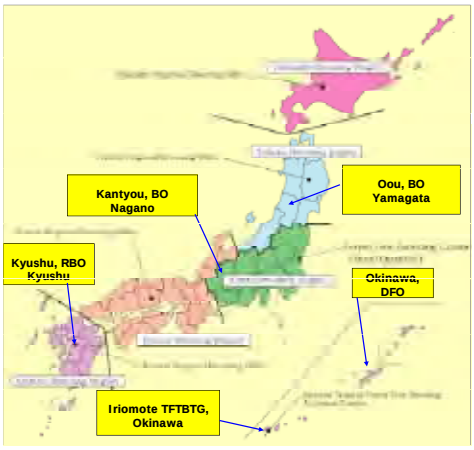

Site Visit areas

RBO: Regional Branch Office;

BO: Branch Office

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OOU BRANCH OFFICE OF TOHOKU

Activities observed

- Gene conservation- protected species of Cryptomeria and demonstration of scion garden with C. japonica
- Miniature size seed orchard of C*ryptomeria japonica*
- Clone bank –snow pressure resistant varieties of *Cryptomeria japonica*
- Less pollen varieties of *Cryptomeria japonica* with 56 clones

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- Plus trees of *Pinus thunbergii*
- Plus trees of Cryptomeria japonica
- Breeding orchard -Plus trees of C. japonica
- Foundation stock garden maintained at 1.3 m

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NAGANO BRANCH OFFICE

- Established in 1957 as Kanto Forest breeding station
- Currently is a branch office of FTBC
- Area -33.29Ha
- ALT.920-1050M
- Conducts forest tree improvement /forest tree breeding for Japanese larch
- Other spp- *Abies homolepis, A. veltchi etc*
- *Plus tree trees preserved here include Japanese larch,spruce, Korean pine, shirabe fir and Uraziro fir*

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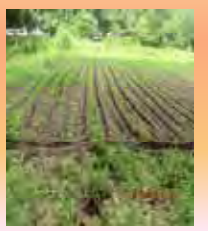
Types of activities

- *gene conservation- area 12.95 ha*
- Clone bank 5 ha
- Breeding orchard 7 ha
- Trials 0.72ha
- Wind break 3.41ha
- Nursery 0.66ha

- Marigold cultivated to kill wilt in soil in rotation of 4yrs

4 blocks 1 every year with marigold.



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- Marigold also used as mulch
- European red pine trial for wilt resistance .seedlings raised from seedlings

- Collaboration with finish institute for wilt problem
- Increase in temp increase wilt activity
- Wilt dispersed by insects like long horn beetle

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WOOD UTILISATION SITES

WADA PRIMARY SCHOOL

- Wada village population - 2,500
- Rebuild school in 1998 by use of wood in Japanese traditional post and beam technology
- 130 Japanese larch trees and 12 Japanese cedar were used
- Solar air heating system is applied for heating in winter
- Student population in year 2004-Class 1-6 is 109, Teachers 18



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ZENKOUJI BUDDHIST TEMPLE

- Over 1000 old
- Strong wooden beams and post used.
- Joints no nails used



20

M-wave stadium

- Used for winter Olympics
- Inner roofing made of wood reinforced with metal



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KYUSHU UNIVERSITY

- A presentation was made on

Evaluation of drought tolerant Melia volkensii using physiological parameters

- Discussions held on implementation of new project in Kenya
- Objective
  - Evaluation of drought tolerant Melia using physiological parameters
  - Identification of physiological related with drought tolerance of *Melia volkensii* and its application to breeding operations

Activities to achieve objectives

- Studies on Leaf morphology and nutrient characteristics
  - Leaf morphology –Leaf size, specific leaf area, water content, stomata size and density
  - Leaf nutrient- Nitrogen content and chlorophyll content

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Leaf phenology and stem growth phenology

-Leaf flushing, leaf fall and stem growth pattern

- ***Leaf and twig water relations***

-Comparison of water conductance- transpiration

-Comparison of leaf water parameters- Pressure volume curve method

Practical lesson/demonstrations carried out on -

23

- Leaf area measurements
- Photosynthesis measurements
- Water potential measurements


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KYUSHU REGIONAL BREEDING OFFICE

- General outline including development of new varieties for timber, pine wilt resistance
- Area has tropical and subtropical areas
- High Production in forest products of Sugi
- Highest natural distribution of sugi is in Kyusyu-Yakushima island
- 15 permanent staff
- 10-20 temporary staff
- 4 departments- General affairs division, Breeding Division, Genetic resources Division and Technical advice office

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Activities

1.Execution of tree breeding program for timber production

-Selection and propagation of candidate clones for advanced generation

2.Development of pine wilt nematode resistant varieties

3.Development of pollen free or lesser pollen variety of Sugi and Hinoki

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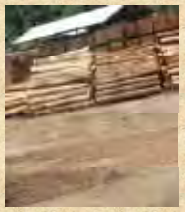
Amakusa cooperative of forest owners

- Membership 7000
- Karimata area not suitable for rice crop farming. Mountanous
- This favour tree seedling production
- Local variety of Sugi planted in shrines
- 3 farmers are producing saplings from root cuttings
- Number of producers is decreasing due low demand and youth not taking up the enterprise.



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Visit within station

- Hedge
- Crossing garden,
- Sugi conservation stand
- Orchard
- Nursery
- Innoculation site

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- NB Large scale farmers producing over 500,000 seedling their children take up the business. Less than 10,000 they refuse
- Price of timber decreasing e.g. 10 yr ago,1m sold at 1000 yen. Today 1m sell at 100yen due to free trade policy of importing cheap timber
- Nursery owners are contracted by forest owners to produce seedlings to plant in cut areas
- Price of resistant pine 400 yen

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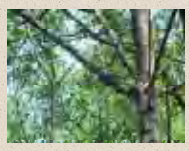
***Melia azaderach* in Minohara area**

- Used for Furniture and indoor work
- $1m^3$ sells at 200,000 yen
- 3 Planting densities – 3000, 5000 and 7000
- Management aims at producing straight stems through
- High density
- Removal of lateral bud
- Pruning. Trees that have poor form are cut to coppice. Best coppice is left to mature
- Annual growth is 5m/yr
- Canker is a major problem on branches and are easily broken by wind



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Iriomote island site

Island is 29,000 ha, forests are 90%, pop 2330 and 350,000 tourists per year

Major component is international cooperation

Theme from 2011 to 2015

- 1- Breeding research about functional trees at amami and sakisima islands
  - Inter- and intraspecific variation of traits concerning *Nothapodytes foetida* and *N. amanianus*
  - Establishment of propagation technology concerning Cinchona
  - Breeding study about wind tolerant calophyllum inophyllum trees II Development of superior Acacia hybrid and promotion of evaluation method
- 2- Examination of pollen storage
  - Comparative test of acquired seedlings between reciprocal crossing
  - Investigation of initial growth of hybrid

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Major Trees grown

- Cinchona planted at Iriomote island 70 years ago
- Cut down when malaria disease spread around the island
- Bark of cinchona trees contains anti-malaria drug
- Eucalyptus spp
- Acacia spp used for timber, Truck flooring and pulp
- Callophylum inophylum
- Casuarinacea

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OKINAWA DISTRICT FOREST OFFICE

- Two main forests-
  - Okinawa-12,000 ha
  - Iriomote-24,000ha. Protected ecosystem and research
- High diversity of flora and fauna
- No direct management of forest
  - rented to US Army for training ground
  - Rented to Okinawa prefec. Governt

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Tropical Dream Centre

- A collection of tropical and subtropical plants planted and conserved here
- A good site for tourism

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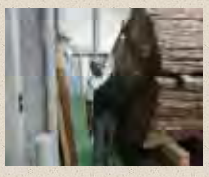
JAPAN HOUSING AND WOOD TECHNOLOGY CENTRE

- Timber strength testing centre for construction industry
- Preservation of very old log of different species.
- Preservation done under controlled conditions – temp and humidity
- Japanese cedar over 500 yrs



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CHUGOKU MOKUZAI WOOD PROCESSING FACTORY

- Largest wood processing company in Japan
- Imports wood from USA
- Factory machines fully automated
- Activities
  - Timber processing
  - Drying kilns
  - Lamination – Douglas fir and Cryptomeria
  - Production of wood chips for pulp and paper
  - Utilization of saw dust and bark for generation of power
  - 60% of wood produces timber
  - 40%chips, bark, saw dust
- **NOTHING GOES TO WASTE**

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A BIG THANK TO DG, VP AND ALL STAFF AT FTBC, PARTICULARLY MR KIMURA-SAN, MIYASHITA-SAN, WATANABE-SAN, ALL OUR TEACHERS AND INSTRUCTOTS

THANK YOU ALL

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