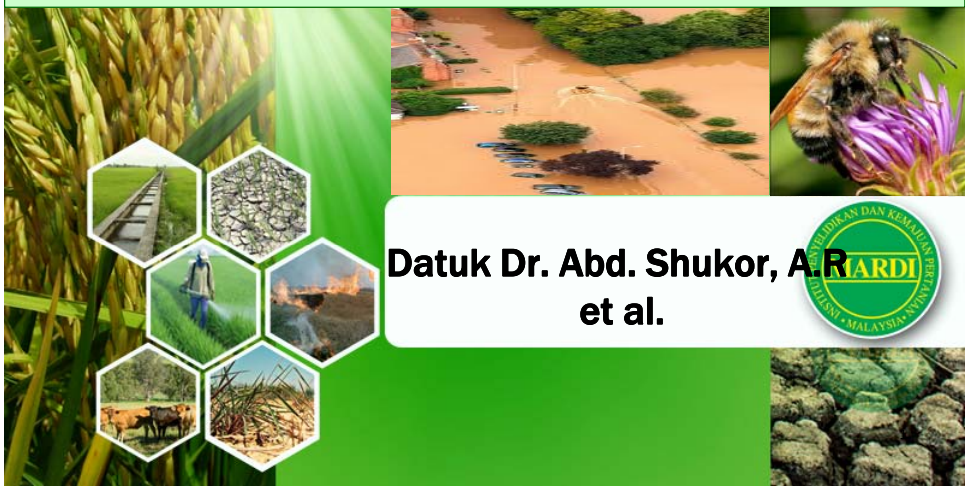
Impacts of Climate Change to Agriculture Biological Diversity



Datuk Dr. Abd. Shukor, A.R
et al.

Outline of presentation

1. Introduction
2. Climate Change In Malaysia
3. Sectoral Vulnerability
4. Climate Change Impacts On Agrobiodiversity
5. Agrobiodiversity As An Adaptive Component to Climate Change
6. Research Gaps, Needs And Way Forward
7. Activities On Agrobiodiversity In MARDI
8. Conclusions

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Climate change: threat facing today's world

- Any change in climate over time that directly and indirectly affects human and their activities as well as natural systems and processes.
  Impacts could:
  - » Undermine development
  - » Affect human well-being
  - » Threaten security of natural resources

- Dry seasons will have less rainfall. There will be an increase in irrigation water demand unless offset by diversification with dry-food crops

Global Scenario of Climate Change

Many species will disappear, many will face problems in surviving.

Frequency of tropical cyclones will increase.


Climate Change in Malaysia
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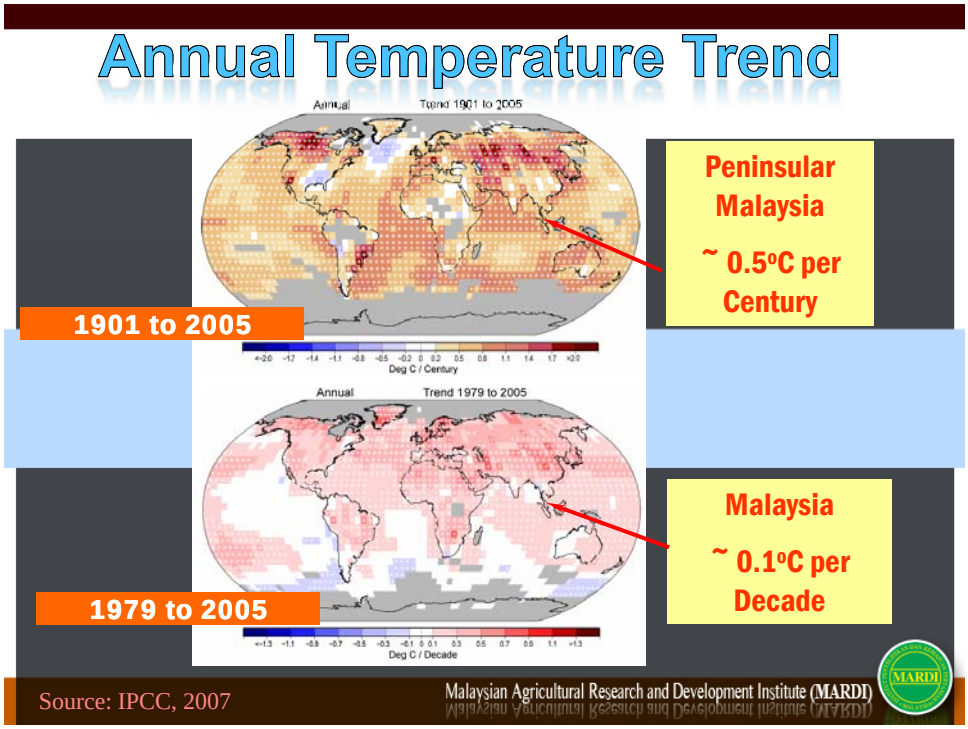
Annual Temperature Trend
Annual
Trend 1901 to 2005
Deg C / Century
1901 to 2005
Peninsular Malaysia
~ 0.5°C per Century
Annual
Trend 1979 to 2005
Deg C / Decade
1979 to 2005
Malaysia
~ 0.1°C per Decade
Source: IPCC, 2007
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Projections by NAHRIM

- **Annual rainfall in Kelantan, Terengganu, Pahang and N-W coast – increase up to 10%**
- Annual Rainfall in Selangor and Johor – decrease by 5%
- Overall, mean air temperature – increase by 1.2 to 1.4ºC
- Minimum temperature – increase by 0.7-1.4ºC
- Maximum temperature – increase by 1.6-2.0ºC

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Sectoral Vulnerability

Southeast Asia

Sector	Vulnerability	Confidence
Food & Fiber	Highly	High
Water Resource	Moderate	High
Biodiversity	Highly	High
Coastal Ecosystem	Highly	High
Land degradation	Highly	High

IPCC; AR4

Vulnerability; highly, moderately , moderately resilient

Confidence; V. high, **high,** medium , low

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Climate Change Impacts on Agriculture

Positive impacts

- Increased productivity from warmer temperature
- Possibility of growing new crops
- Longer growing season
- Increased productivity from enhanced CO2
- Accelerated maturation rates
- Decreased moisture stress

Projected changes

- Warmer temperature
- Drier or wetter condition
- Increased frequency of extreme climatic events
- Enhanced atmospheric CO2
- Changing market conditions

Negative impacts

- Increased Insect infestations
- Crop damage from extreme heat
- Planning problems due to less reliable forecasts
- Increased weed growth and disease outbreaks
- Decrease herbicide and pesticide efficiency
- Increased moisture stress and drought

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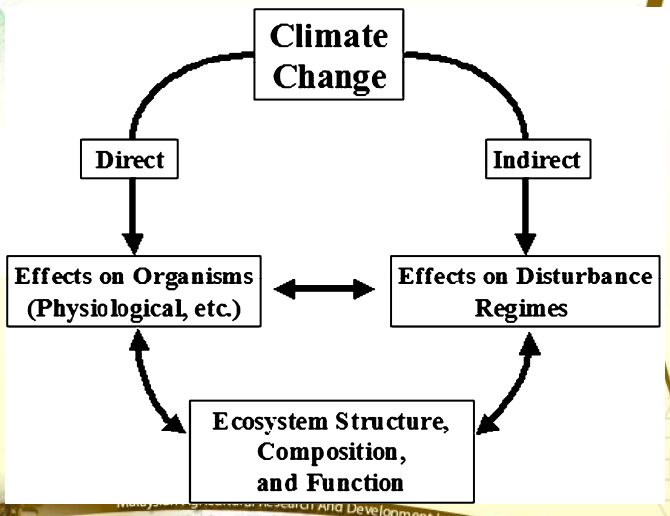
CLIMATE CHANGE IMPACTS ON AGROBIODIVERSITY



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Impacts of Climate Change on PGRFA

- Rain-fed agriculture will be highly affected by total reduction in precipitation.
- Impact on rain-fed rice cultivation from seasonal shift and change in rainfall pattern.
- Impacts on agriculture due to high evaporation loss of moisture from soil
- Frequent and prolonged drought

Rice – climate interaction

- An increase 1°C daily average may result in a 10% yield reduction
- High night T° may cause reduction in CHO reserves and lead to an increase in empty grain
- Current simulation study for MADA area: with a 2ºC rise in temperature, rice yield expected to drop from 8 ton/ha to 7 ton/ha

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Impacts of Climate Change on Arthropods

- Climate change is likely to alter the balance between insect pests, their natural enemies and their hosts
- Under a warmer climate, exotic pests could establish populations in places that it never been found before-such as migration of insect species to higher altitude

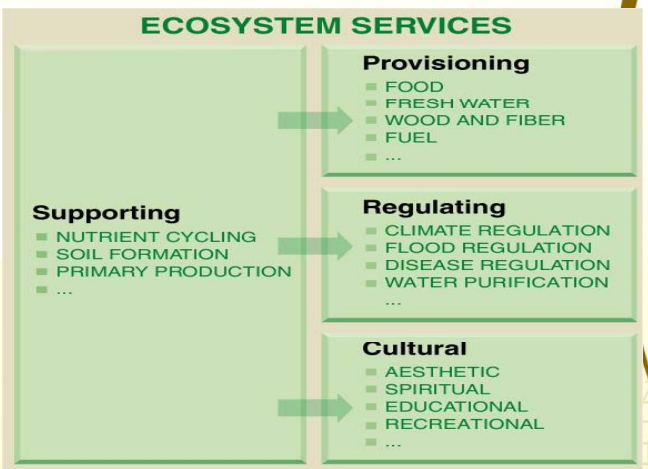
Impacts of Climate Change on Arthropods

- Synchrony between host and insect pest development, the predicted rise in temperature will also generally favour insect development
- Climate change is likely to significantly alter the frequency of insect migrants, including introducing some agricultural pests that are completely new to the place. Invasive species could be a problem too.

Impacts of Climate Change on Microbial Resources

- Reduce microbial activities which affects nutrient and carbon cycle and organic matter decomposition
- Climate change was suspected as a reason why a deadly new version of a tropical fungus is spreading in the temperate climate
- Climate change may lead to discovery of more new fungi or mushroom spesies

Impacts of Climate Change on Ecosystem



Impacts of Climate Change on Ecosystem

- Changes in distribution of species, ecosystems boundaries and biomass
- Changes in phenology of biotic and abiotic processes
- Changes in structure of plants communities
- Increased pests and diseases

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AGROBIODIVERSITY AS AN ADAPTIVE COMPONENT TO CLIMATE CHANGE

Mitigation

- In situ conservation of adapted biodiversity
- On-farm conservation and crop management
- Use IPM options to reduce vulnerability to changes in pathogen distribution
- Better matching of adapted germplasm to climate variability

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AGROBIODIVERSITY AS AN ADAPTIVE COMPONENT TO CLIMATE CHANGE

Adaptation

- Selection of plants and livestock that tolerant to heat & drought
- Cropping system and cropping pattern- Multiple cropping & Agro-forestry
- Species mixtures will provide some insurance against climate change - not all will be affected to the same extent
- Conservation of wild relatives of food crops as insurance for the future

RESEARCH GAPS, NEEDS AND WAY FORWARD

- Lack of information systems for genetic resources especially on climate change related traits
- Lack of support for ex *situ* and *in situ* conservation for genetic diversity resources that could adapt to multiple new stresses (drought, new pest and diseases)
- More International cooperation is needed as part of a long-term strategy to confront climate change.
- Lack of information on effects of climate change on insect pests and diseases

RESEARCH GAPS, NEEDS AND WAY FORWARD

- Conservation, characterization and sustainable use of genetic diversity and plant improvement
- Collection and use of commercially promising and/or underutilized plants
- Dynamics of pests and diseases under changing climates

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RESEARCH GAPS, NEEDS AND WAY FORWARD

- Strong coordination between main global programmes such as UNFCCC, CBD, International Treaty on PGRFA
- Agrobiodiversity conservation to be made a basic component of adaptation strategies to climate change
- Management of agrobiodiversity resorces require re-orientation in their strategies i.e. In-situ conservation must be made a integral part of agricultural development and be supplemented by ex-situ conservation

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Activities On Agrobiodiversity In MARDI

Biological resource management and utilisation

- Bioprospection, utilization and conservation of biodiversity of plants
- Conservation and utilization of arthropod diversity important to agriculture
- Conservation and sustainable utilization of microbial diversity important to agriculture
- Ecosystem approach in agrobiodiversity conservation
- Agrobiodiversity information system

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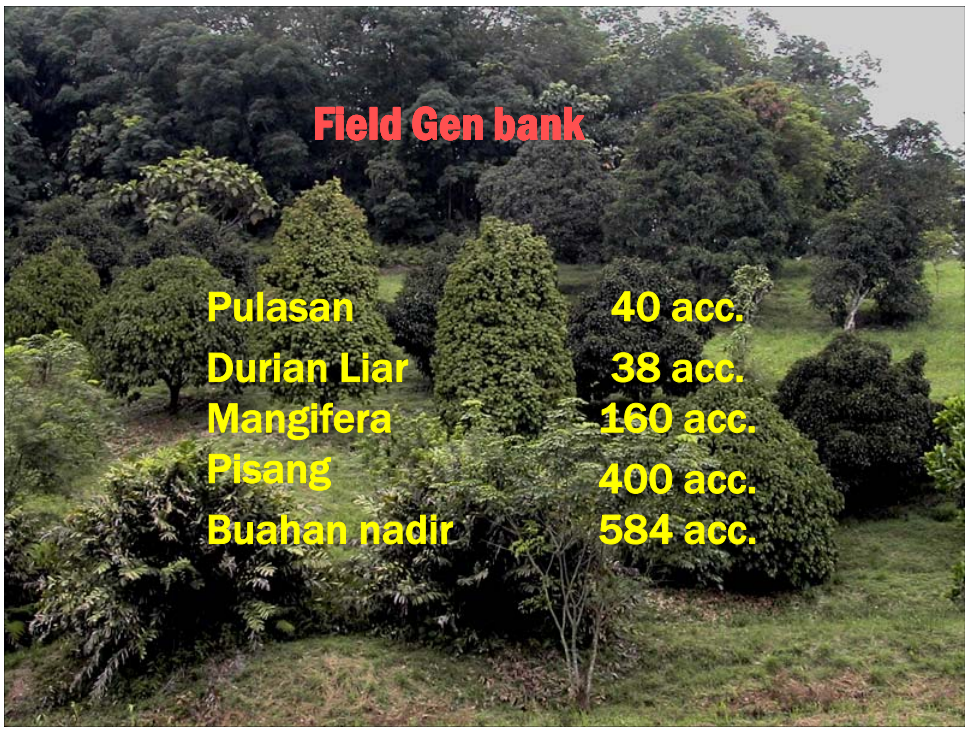
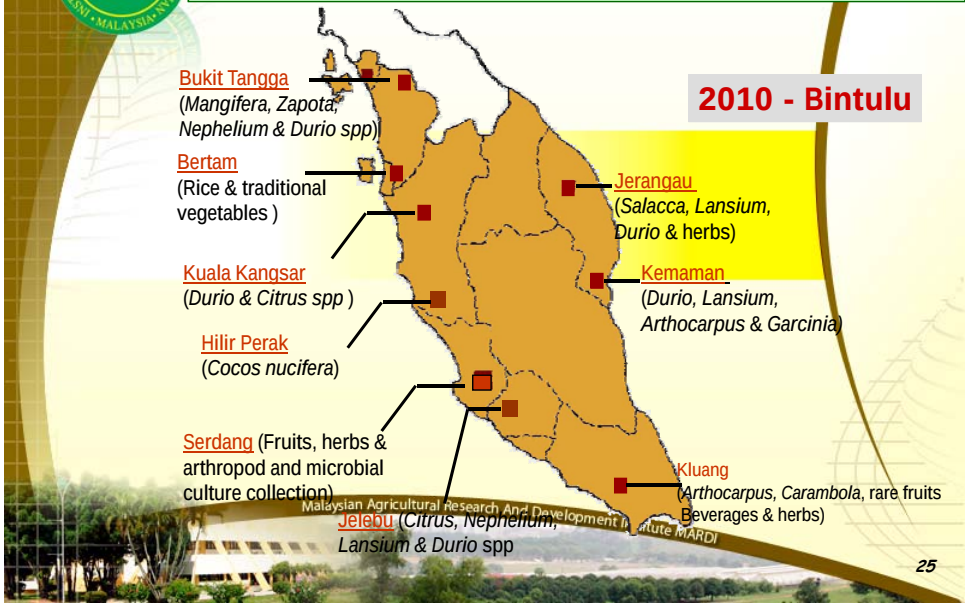
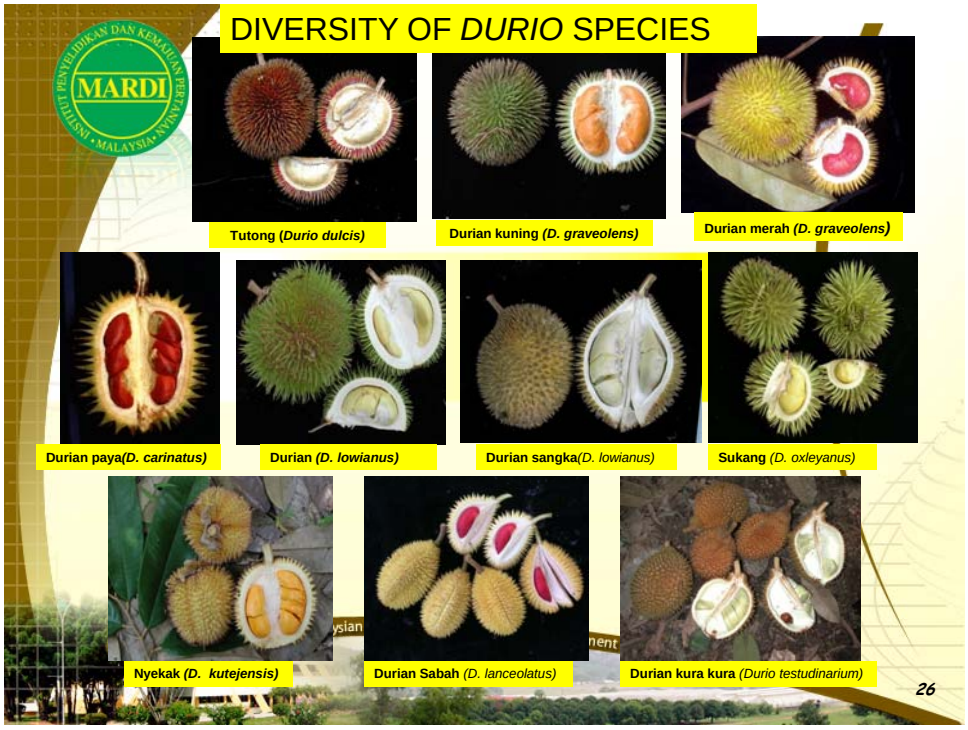


Location of Field GenBank



DIVERSITY OF *DURIO* SPECIES



DIVERSITY OF *MANGIFERA* SPECIES

Binjai
(Mangifera caesia)

Kuini
(Mangifera odorata)

Mempelam air
Mangifera laurina

(Mangifera griffithii)

Pauh bemban
(Mangifera pentandra)

Bachang
(Mangifera foetida)

Asam kumbang
(Mangifera quadrifida)

Sepam
(Mangifera longipetiolata)

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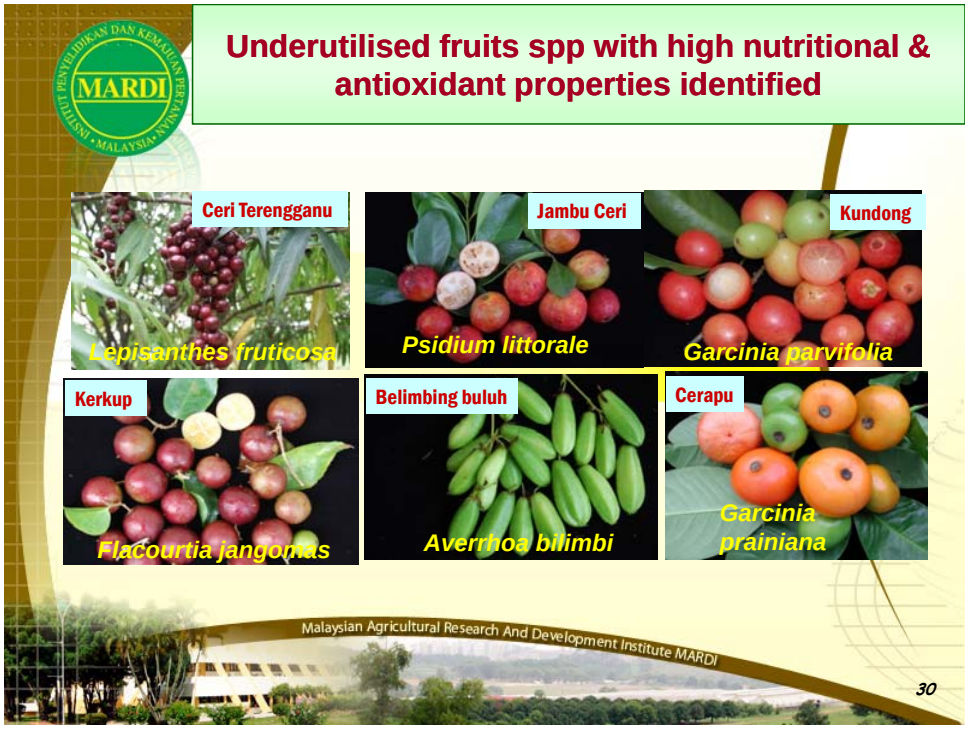
Elite Pulasan Acc.


Herbs & Medicinal Plants Field Genebank; Jerangau
Kacip Fatimah 50 acc.
Zingiber 127 acc.
Limau Purut 20 acc.
Tuba 17 acc.
Tongkat Ali 7 acc.
Other species >1500 acc.


Underutilised fruits spp with high nutritional & antioxidant properties identified
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Ceri Terengganu
Lepisanthes fruticosa
Jambu Ceri
Psidium littorale
Kundong
Garcinia parvifolia
Kerkup
Flacourtia jangomas
Belimbing buluh
Averrhoa bilimbi
Cerapu
Garcinia prainiana
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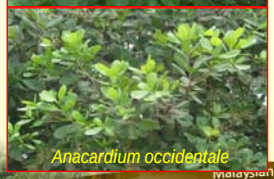
Traditional vegetable and ulam species high in antioxidant, vitamins and iron identified


Premna cordifolia (Peria Pantai)


Pluchea indica


Anacardium occidentale

- Phytochemical content (total phenol, antioxidant activity and iron content) of 10 ulam species analysed
- Bebuas (1/6) acc.,beluntas (7/14) acc., gajus (30/42) acc. showed high antioxidant activity (FRAP assay) more than 70% radical scavenging effect and can be potentially planted for larger scale
- Potential accessions with high antioxidant activity that could be recommended for field planting :
  - Bebuas (EST 07-0201)
  - Beluntas (STN 07-0263, STN 07-0266, EST 07-0287, STN 07-0202)
  - Gajus (25 out of 30 accessions)

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Regeneration


Drying Process


Short-term (3-5yrs): 19-21ºC ºC , RH 50-60%

Seed Genebank Seberang Perai


Medium-term (~15yrs): 3-5ºC , RH 35-45%


Long-term (~30yrs): -20ºC

Seed Genebank Seberang Perai

Rice	**11,940acc.**
Indigenous Vegetables	
Terung	25 acc.
Cili Besar	7 acc.
Cili Api	48 acc.
Amaranth	11 acc.
Petola Ular	9 acc.
Terung Pipit	10 acc.
Terung Bulu	10 acc.
Kacang Botor	12 acc.
Others	368 acc.

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Botanical Pesticides

Evaluation of selected Malaysian plants for potential biopesticide - *Andrographis paniculata* - hempedu bumi, *Cymbopogon spp* .-serai, *Pelargonium radula* -jeremin, *Annona spp.* - durian belanda, *Citrus spp.* limau purut and *Dioscora spp* . - ubi gadung

- Oil formulations from - *Pelargonium radula* (jeremin) & *Cymbopogon citratus* (serai makan) are potential biopesticidal agents.

- Scientific investigation showed the effectiveness of the oil formulations against agricultural pest – *Plutella xylostella* (diamond-back moth) using bioassay method.

Mardi Arthropod Collection

- Established in early 1980's
- Current collection - more than 29,000 specimens from various agroecosystems
- 29,348 specimens ; Pests, biocontrol agents, pollinators and other functional groupings
- Believe to be the largest collections of insects in Malaysia

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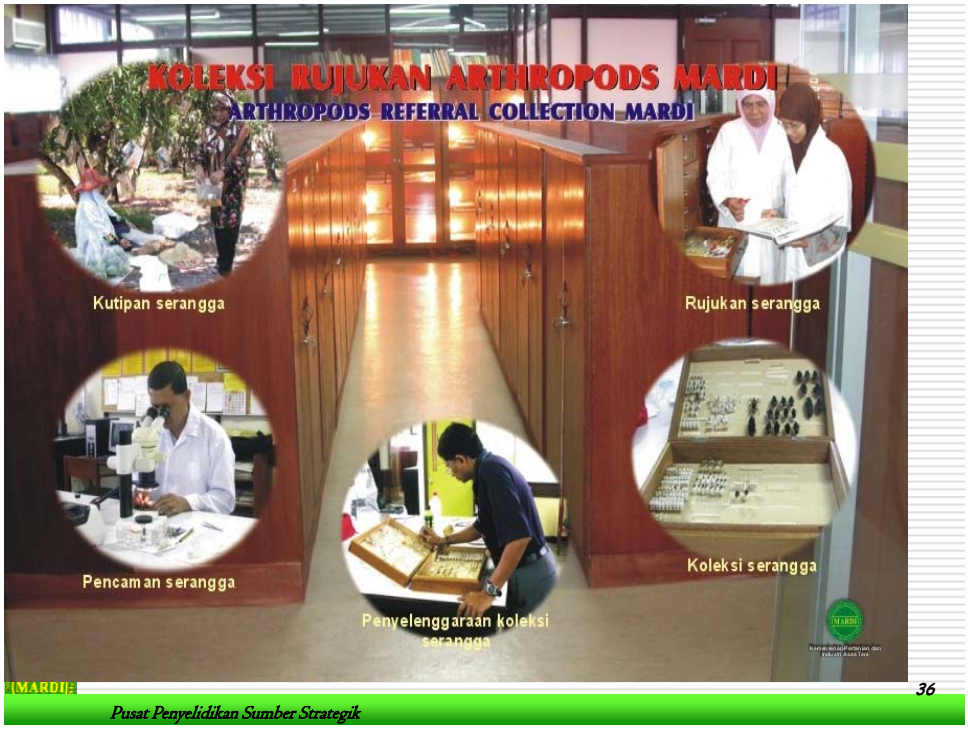

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Pusat Penyelidikan Sumber Strategik


Tiger moth, Tongkat Ali
Leaf feeder, Kacip Fatimah
Leaf folder, Misai Kucing
Diversity of Arthropod Species on Herbs
Biocontrol Agents
Lace bug, Mengkudu
Mealy bug, Mengkudu
Horn worm, Mengkudu
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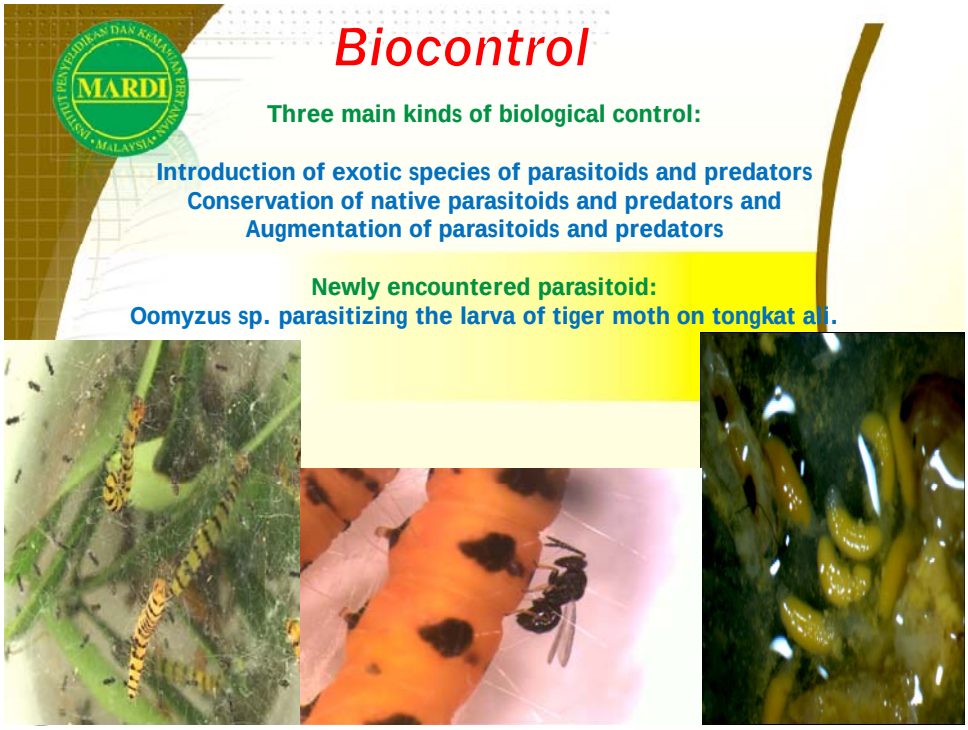
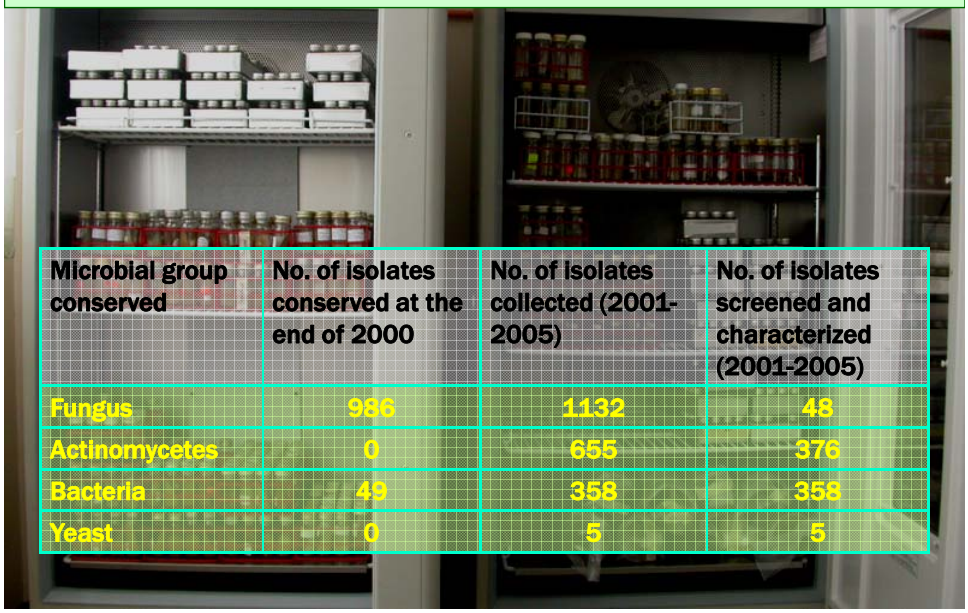

Biocontrol
MARDI
Three main kinds of biological control:
Introduction of exotic species of parasitoids and predators
Conservation of native parasitoids and predators and
Augmentation of parasitoids and predators
Newly encountered parasitoid:
Oomyzus sp. parasitizing the larva of tiger moth on tongkat ali.

Microbial Resources Conservation and Utilization



Microbial group conserved	No. of isolates conserved at the end of 2000	No. of isolates collected (2001-2005)	No. of isolates screened and characterized (2001-2005)
Fungus	986	1132	48
Actinomycetes	0	655	376
Bacteria	49	358	358
Yeast	0	5	5

BIOPROSPECTION OF BENEFICIAL MICROBES

Application	Microbial Group	Isolates
Biofertilizer	N-Fixing Bacteria.	59
	P-Solubilizing Bacteria	55
Biopesticide & Bio herbicide	Exsehilum spp.	83
	Actinomycetes	16
Volatile Fatty Acid degrader	Bacteria	74
	Actinomycetes	50
Cellulose degrader	Fungus	59
	Bacteria	44
	Actinomycetes	500

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VIRUS BASED; BIOPESTICIDES

Environmental Friendly Virus based Biopesticide for controlling Armyworm, *Spodoptera litura*

Crude/Semipurified NPV *S. litura*

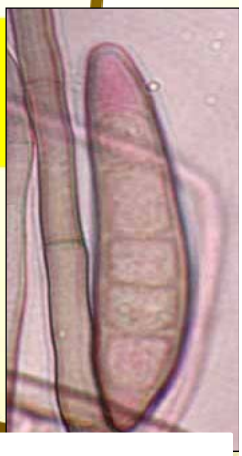
Formulated NPV *S. litura*

- ❑ Novelty: Stable NPV
- ❑ Advantages:
  - Room' Temp. storage
  - Longer shelf life
  - Added with UV protectant

FUNGUS BASED BIOHERBICIDE

To control rumput sambau (*Echinochloa* spp.) in Rice

The utilization of indigenous fungus isolated from naturally infected barnyard grass and the usage of recycled oil palm product as the ingredients in the formulation.



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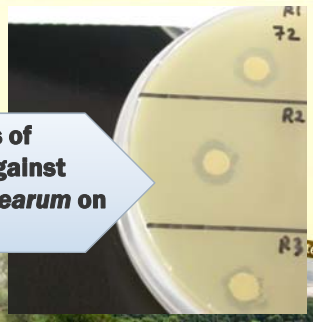
Bacteriophage Based Biopesticide

- 12 isolates of phage (P36, P45, P47, P71, P72, P630, P631, P482, P483, P459, P535 and P536) caused inhibition growth of *R. solanacaerum*

Tomato plants inoculated with bacteriophages



The lysis activities of bacteriophages against *Ralstonia solanacearum* on agar plate

Wilting of tomato plants without inoculation with bacteriophages

Agrobiodiversity Information System

Conclusions

- Genetic resources are crucial to cope with climate change
- Conservation of agricultural biodiversity is a key option for the adaptation to climate change
- Maximum of genetic resources has to be conserved as the future needs for human survival
- Association between climate change and loss of biodiversity required more holistic framework and approaches to solve common problems
- Combination of mitigation and adaptation need to be addressed simultaneously

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