

## Conference

Sustainable Diet for a Healthier and Happier Future  
24 September 2011

### Vegetables for Combating Global Nutrition Problems

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Slide 1



### ► Outline

1. Global nutrition: double burden
2. Vegetable production, consumption and health benefits
3. AVRDC mission and research themes
4. Approaches to food security, diversity and value addition
  - Vegetable germplasm
  - Indigenous vegetables and nutrition properties
  - Breeding for nutrition
  - Agricultural interventions for better nutrition and health
5. Challenges: evidence base and scaling up

Slide 2



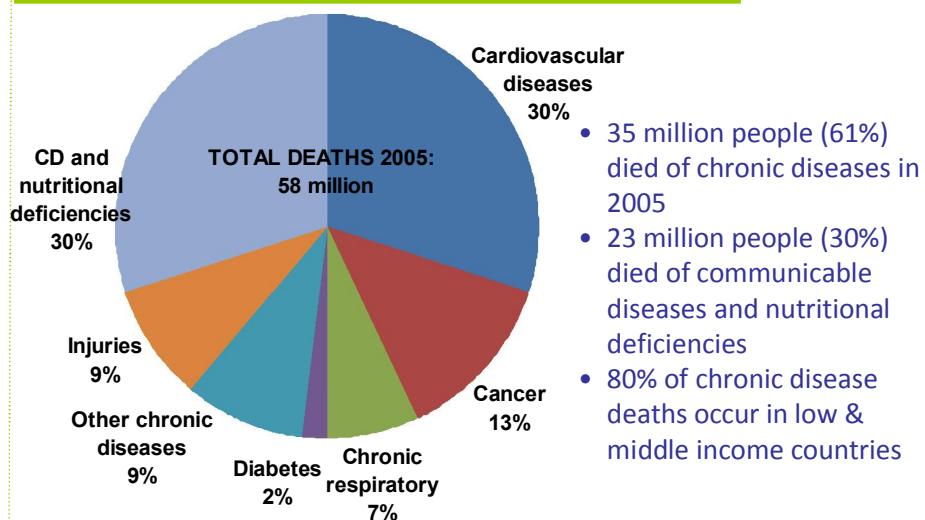


## 1. Global nutrition: double burden



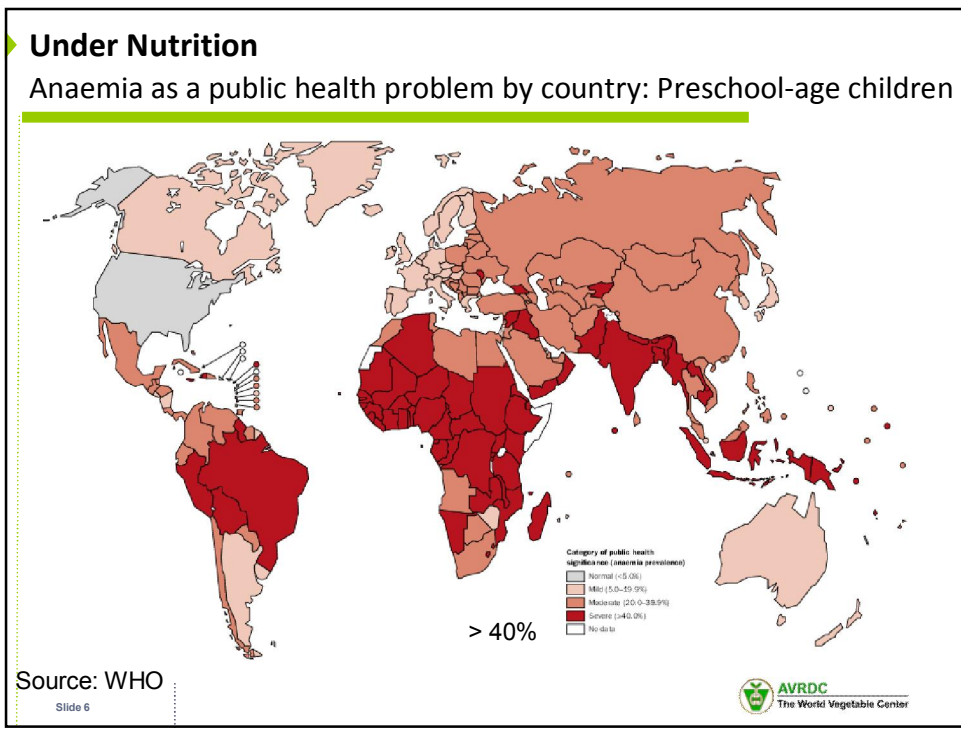
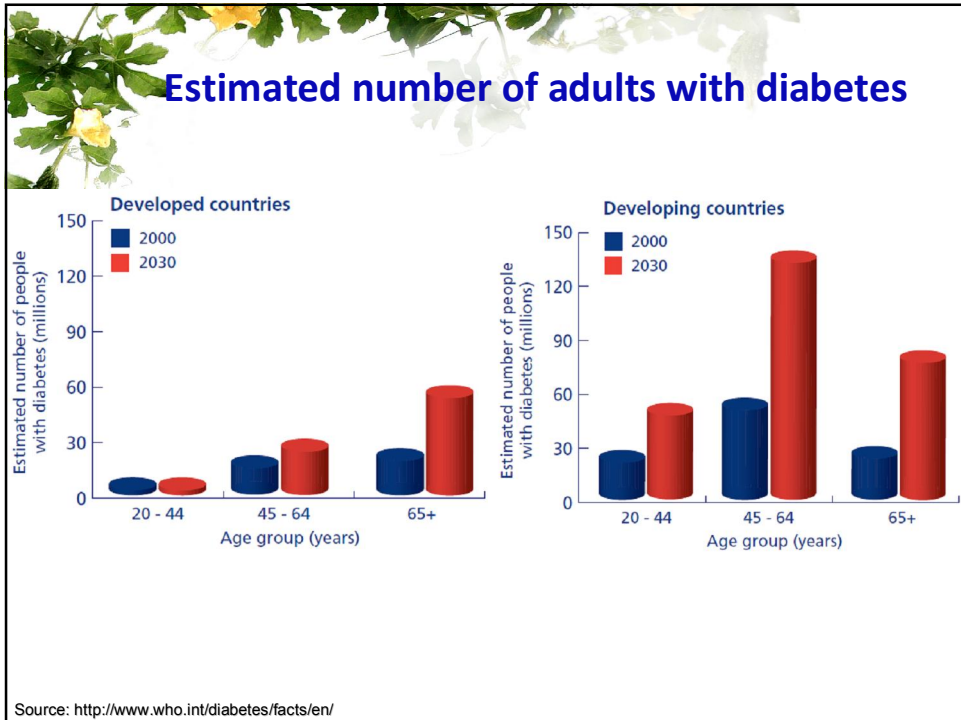
### Global Nutrition and Health: Double Burden

Projected main causes of death, worldwide, all ages, 2005



Source: WHO 2005

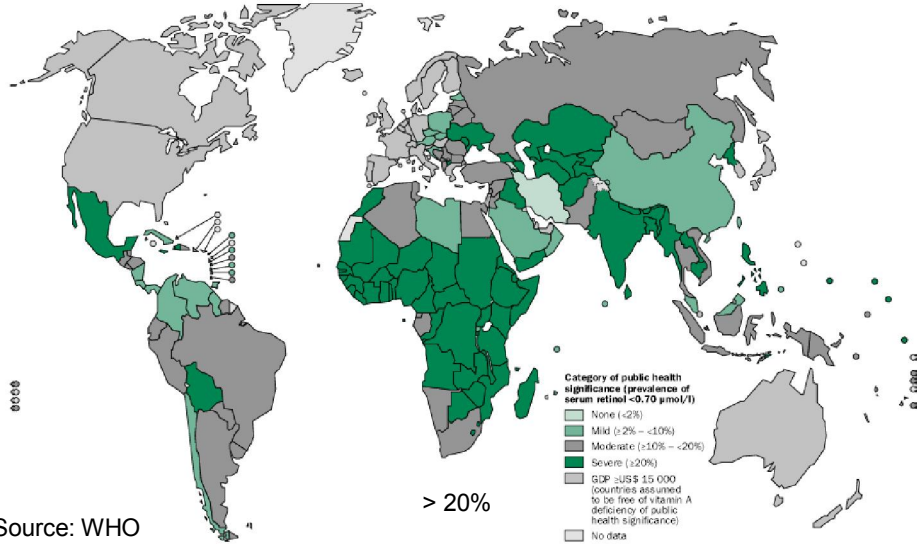
Slide 4



## Under Nutrition

Biochemical vitamin A deficiency (retinol) as a public health problem:

Preschool-age children, 2001 - 2005

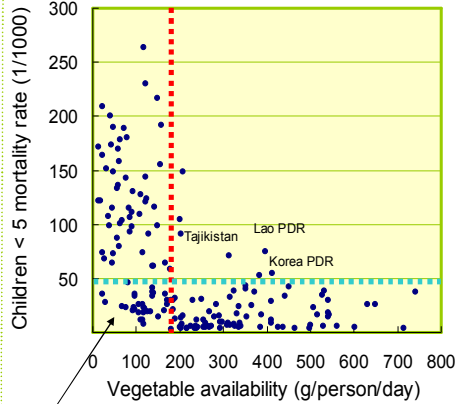


## 2. Vegetable production, consumption and health benefits

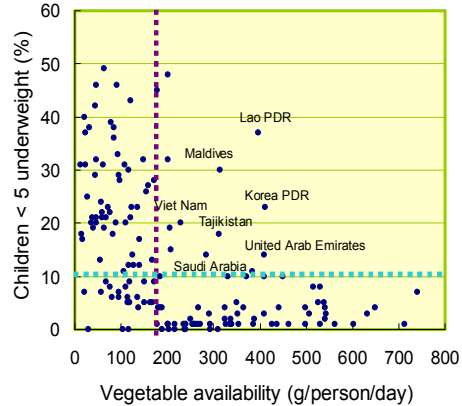


## National vegetable availability vs. health/nutrition status

**Health status indicator:**  
Children under 5 mortality rate



**Nutrition status indicator:**  
Children under 5 underweight



Iceland, Thai, Malaysia, Costa Rica, Fiji, Grenada, Columbia, Peru, Panama, Honduras, Nicaragua

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Data source for the correlation test: FAOSTAT and WHO



## The strength of evidence for obesity, type 2 diabetes, cardiovascular disease (CDV), and cancer

	Obesity	Type 2 diabetes	CVD	Cancer
High intake of energy-dense foods	C ↑			
High intake of NSP (dietary fibre)	C ↓	P ↓	P ↓	
Wholegrain cereals			P ↓	
<b>Fruits and vegetables</b>	<b>C ↓</b>	<b>P ↓</b>	<b>C ↓</b>	<b>P ↓</b>
Whole fresh fruits				
Sugars-sweetened soft drinks and fruit juices	P ↑			
Overweight and obesity		C ↑	C ↑	C ↑
<b>Physical activity, regular</b>	<b>C ↓</b>	<b>C ↓</b>	<b>C ↓</b>	<b>C ↓</b>
Heavy marketing of energy-dense foods, and fast-food outlets	P ↑			



C ↑ : Convincing increasing risk; C ↓ : convincing decreasing risk; P ↑ : Probable increasing risk; P ↓ : Probable decreasing risk; P-NR: Probable, no relationship;

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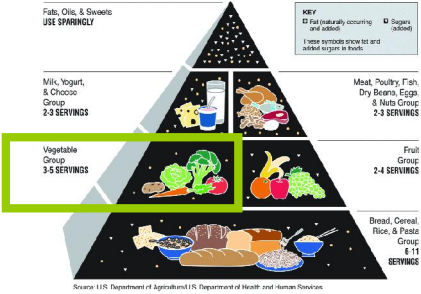
WHO Technical Report Series 916, 2003



## ▶ Dietary recommendation

### Food Guide Pyramid A Guide to Daily Food Choices



**Vegetables**  
3-5 servings a day  
Min. 200 g per day  
Min. 73 kg per year

Fats, Oils, & Sweets  
**USE SPARINGLY**

Milk, Yogurt, & Cheese Group  
**2-3 SERVINGS**

**Vegetable Group  
3-5 SERVINGS**

Bread, Cereal, Rice, & Pasta Group  
**6-11 SERVINGS**

Meat, Poultry, Fish, Dry Beans, Eggs, & Nuts Group  
**2-3 SERVINGS**





Fruit Group  
**2-4 SERVINGS**

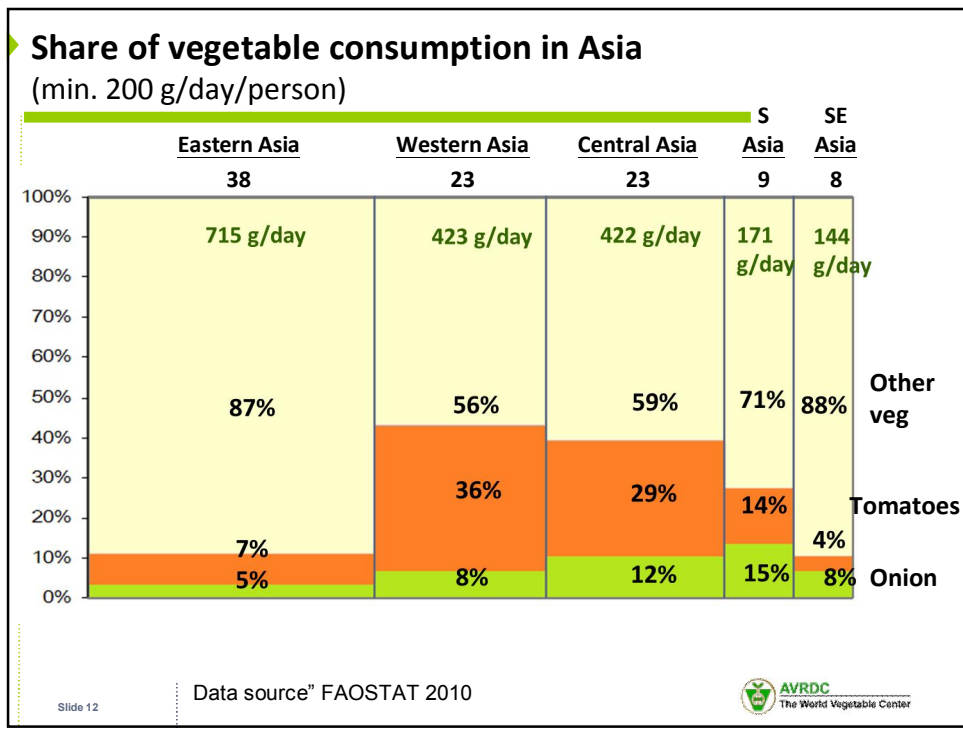
**NOTE:** Fat (naturally occurring and added), Sugars (added), and Fiber (synthetic source and added sugar) are listed.

Source: U.S. Department of Agriculture & U.S. Department of Health and Human Services

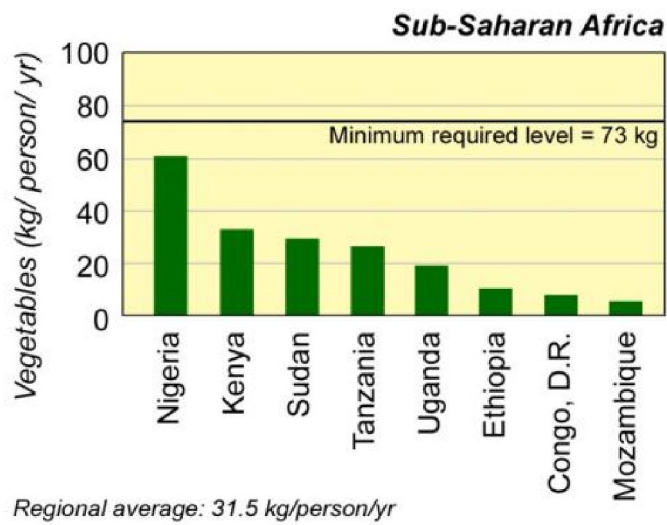
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Source: USDA



## ▶ Vegetable consumption in sub-Saharan African countries



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Source: FAOSTAT data, 2004

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### 3 AVRDC mission and research themes



## Our mission




“Alleviate poverty and malnutrition in the developing world through increased production and consumption of nutritious vegetables”

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## A broader crop portfolio



Bitter melon

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## AVRDC Research Themes

<b>Germplasm</b>	Germplasm conservation, evaluation and gene discovery
<b>Breeding</b>	Genetic enhancement, varietal development and selection of indigenous lines
<b>Production</b>	Safe and sustainable vegetable and seed production systems
<b>Consumption</b>	Nutrition, socio-economic and marketing

Cross-cutting topics: nutrition, socio-economic and marketing



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#### 4. Approaches to food security, diversity and value addition

- Vegetable germplasm
- Indigenous vegetables and nutrition properties
- Breeding for nutrition
- Agricultural interventions for better nutrition



#### ▶ Strategies to address micronutrient malnutrition:

- **Supplementation**
- **Food fortification**
- **Dietary modification**

## ▶ Contribution of vegetables to human nutrition and health

### Consumption

- Increased access, availability, and consumption of vegetables

×

### Nutrient density

- Improved nutrient and bioactive phytochemical contents

×

### Bio-availability

- Enhanced nutrient retention and bioavailability

=

### Nutrition and health outcome

- Assessing the outcomes from the consumption of vegetables on nutrition, public health and overall economic development.

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## ▶ Nutrition approaches

- Improve nutrition and health through food- based and agricultural interventions
- Emphasize direct access to nutritious food
- Link Agriculture – Food – Nutrition – Social science
- Develop R to D pathway

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#### 4. Approaches to food security, diversity and value addition

- **Vegetable germplasm**
- Indigenous vegetables and nutrition properties
- Breeding for nutrition
- Agricultural interventions for better nutrition



#### Germplasm accessions conserved at AVRDC

	Principal crops	Other crops	Total
No. of accessions	42,820	13,310	56,130
No. of genera	7	153	160
No. of species	111	226	337
No. of countries of origin			150





## ► Diversity

- Biodiversity
  - Germplasm collection and conservation
- Crop diversity
  - Breeding for better yield, quality and tropical adaptation
  - Improving farmer's skills in vegetable production
- Food diversity
  - Promotion of greater consumption of vegetables including widely consumed and indigenous/ local vegetables



#### 4. Approaches to food security, diversity and value addition

- Vegetable germplasm
- Indigenous vegetables and nutrition properties
- Breeding for nutrition
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### The Nutritional Treasure of Indigenous Vegetables

**Indigenous vegetables: A growing field**

Indigenous vegetables are highly nutritious and easy to grow. They are an important part of the diets of poor families in Africa and Asia. They can provide up to 50% of daily beta-carotene, potassium, iron, and zinc, and 30% of iron. AVRDC has a collection of over 10,000 accessions of indigenous vegetables. We are developing breeding materials and improving seed supplies and marketing.

Nutrient value (100 g edible part)	
β-carotene	> 2.5 mg
Folic acid	> 19 µg
Iron	> 3 mg
Protein	> 2.5 g
Calcium	> 200 mg
Vitamin C	> 100 mg
Vitamin E	> 3 mg
Anti-cancer activity (Methanol extract)	> 4000 µmole Trolox

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## ▶ Indigenous vegetables

- Native to a particular region
- Long time use in diets
- Important role in biodiversity and diverse diet
- Grown locally on a small scale
- Often tolerant to environmental stress
- Most underutilized
- Limited Information on nutrient values, bioactive compounds, anti-nutrients, and potential health hazards

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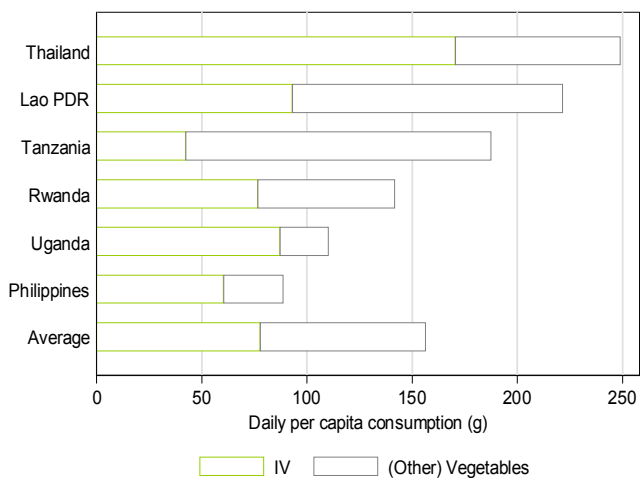
## ▶ Indigenous vegetable species selected for promotion in southeast countries (ADB project, 2000-2006)

Source: LM Engle, AVRDC

1 <i>Abelmoschus esculentus</i>	Okra, smooth and ridged types
2 <i>Amaranthus</i> spp.	Amaranth
3 <i>Basella alba</i>	Malabar spinach/Ceylon spinach
4 <i>Benincasa hispida</i>	Wax gourd
5 <i>Beta vulgaris</i> cvg <i>bengalensis</i>	Swiss chard group
6 <i>Brassica oleracea</i> cvg <i>acephala</i>	Kale group
7 <i>Capsicum</i>	Chillis
8 <i>Coccinia grandis</i>	Ivy gourd
9 <i>Corchorus</i> spp.	Jute
10 <i>Cucurbita moschata</i>	Pumpkin
11 <i>Cucumis sativus</i>	Cucumber
12 <i>Dolichos lablab</i>	Hyacinth bean/ lablab bean
13 <i>Lagenaria siceraria</i>	Bottle gourd
14 <i>Luffa acutangula</i>	Sponge gourd, ridged type
15 <i>Luffa aegyptiaca</i>	Sponge gourd, smooth type
16 <i>Momordica charantia</i>	Bittergourd
17 <i>Solanum melongena</i>	Eggplant
18 <i>Trichosanthes cucumerina</i>	Snakegourd



## Consumption of indigenous vegetables



Source: Surveys conducted by AVRDC in collaboration with NARES in respective countries



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## Priority indigenous vegetables promoted in Africa



African eggplant



Ethiopian mustard



Amaranth



Jute mallow



Okra



Leafy roselle



African nightshade



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## Priority crops in Mali



High beta tomato



African eggplant



Okra



Amaranth



Roselle

## Okra and moringa promoted in Niger



**Cameroon:**  
Okra, African Eggplant,  
Nightshade, Amaranth, Jute  
mallow

Over 5000 varieties of indigenous vegetables are maintained at AVRDC



Ivy Gourd  
*Coccinia grandis*



Tropical violet  
*Asystasia gangetica*



Jute mallow  
*Corchorus olitorius*



Okra  
*Abelmoschus esculentus*



Sweet potato vine  
*Ipomoea batatas*

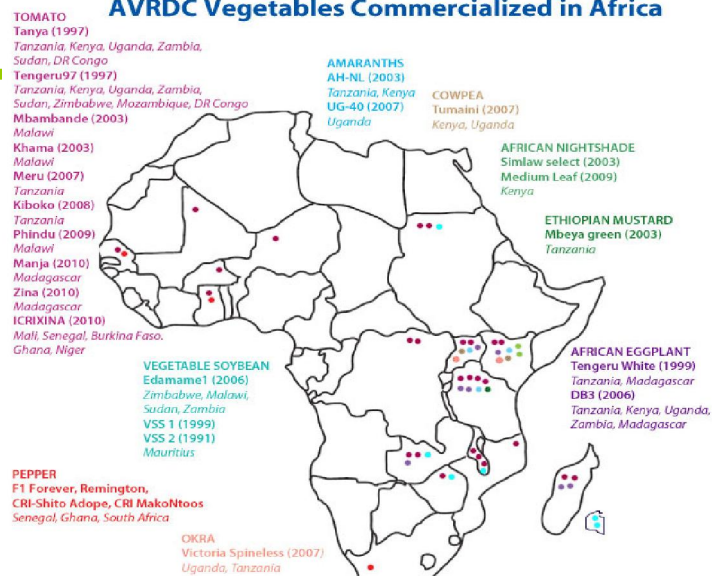


Drumstick tree  
*Moringa oleifera*

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AVRDC Vegetables Commercialized in Africa



Source: Takemore, AVRDC-RCA, Tanzania; Project: vBSS

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## ▶ Indigenous vegetable garden at AVRDC, Taiwan

Southern Taiwan: hot-wet, cool-dry tropical climates



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## ▶ Analytical items

- **Nutritional quality**
  - Protein (AOAC)
  - Vitamins
    - Carotenoids (HPLC)
    - Vitamin C (colorimetric)
    - Tocopherols (HPLC)
    - Folate (Microbial assay)
  - Minerals: (AAS)
    - Calcium, iron, zinc
- **Eating quality**
  - Dry matter, crude fiber
  - Free sugars (reducing sugar)
- **Anti-nutrient factors**
  - Oxalate (HPLC)
  - Polyphenols (Folin)
- **Health promoting properties**
  - Flavonoids (HPLC)
  - Glucosinolates (enzymatic)
  - Antioxidant activities (ABTS, SOS)
  - Anti-microbial activities (diffusion)
  - Anti-inflammation (cell)
  - Anti-diabetes (cell)


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### Nutrient content ranges

In 100 g fw	N	Min	Max	Mean	SD
Protein, g	243	0.2	10	3	1.6
β-carotene, mg	241	0.0	22	3.1	3.3
Vit. C, mg	243	1.1	353	70	77
Vit. E, mg	243	0.0	71	2.6	5.6
Folates, μg	90	2.8	175	51	40
Ca, mg	243	2	744	121	136
Fe, mg	243	0.2	26	2.1	2.6
Zn, mg	27	0.17	1.24	0.49	0.24
Total phenol, mg	241	17	12,070	444	940
AOA, TE	243	0.63	82,170	1383	5648

Specie no.: ~120


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### Micronutrient contents of commonly consumed and indigenous vegetables



	Ranges	Tomato	Cabbage	Moringa	Amaranth	Aibika	Sweet potato leaf
β-Carotene,mg	0.0 - 22	0.40	0.00	15.28	9.23	5.11	6.82
Vit C, mg	1.1 - 353	19	22	459	113	82	81
Vit E, mg	0.0 - 71	1.16	0.05	25.25	3.44	4.51	4.69
Iron, mg	0.2 – 26	0.54	0.30	10.09	5.54	1.40	1.88
Folates, μg	2.8 – 175	5	ND	93	78	177	39
Antioxidant activity, TE	0.6 - 82,000	323	496	2858	394	560	870

Data source: AVRDC Nutrition Lab  
 Ranges: including >100 vegetable species

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#### 4. Approaches to food security, diversity and value addition

- Vegetable germplasm
- Indigenous vegetables and nutrition properties
- **Breeding for nutrition**
- Agricultural interventions for better nutrition



#### Breeding for better nutrition and health in the tropic (Biofortification)



- **For widely consumed vegetables crops such as tomato and pepper, modest improvements in micronutrient density would benefit human health**
- **Tomato:** Breeding for high beta-carotene, high lycopene, high rutin content
- **Pepper:** Breeding for high antioxidant and carotenoid paprika
- **Pumpkin:** Selection for high  $\alpha$ - and  $\beta$ -carotenes
- **Bitter gourd:** Selection for antioxidant vitamins and anti-diabetic activities
- **Leafy crucifer:** selection for higher glucosinolates
- **Indigenous vegetables:** selection for high nutrient and low anti-nutrient content

## ► Evaluation of germplasm for breeding materials



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## ► High beta-carotene, high lycopene tomato

- AVRDC high beta-carotene tomato lines in fresh market and cherry market types
- Orange color a challenge for consumer acceptance
- Piggyback with diseases resistant and heat tolerant genes



High beta cherry  
tropical type



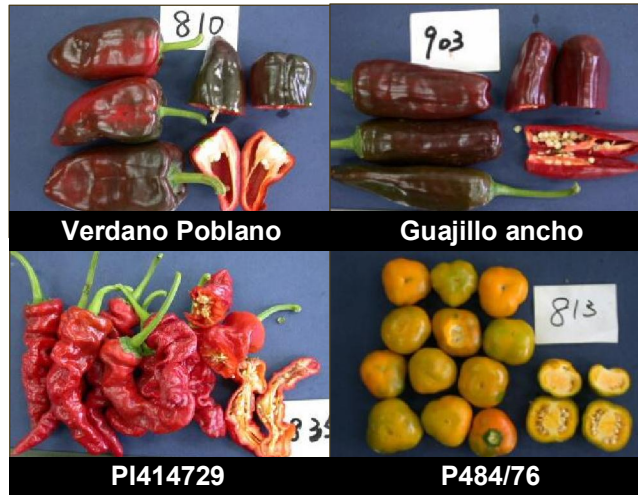
High beta-fresh, tropical type



High lycopene, disease  
resistant, heat tolerant,  
fresh type

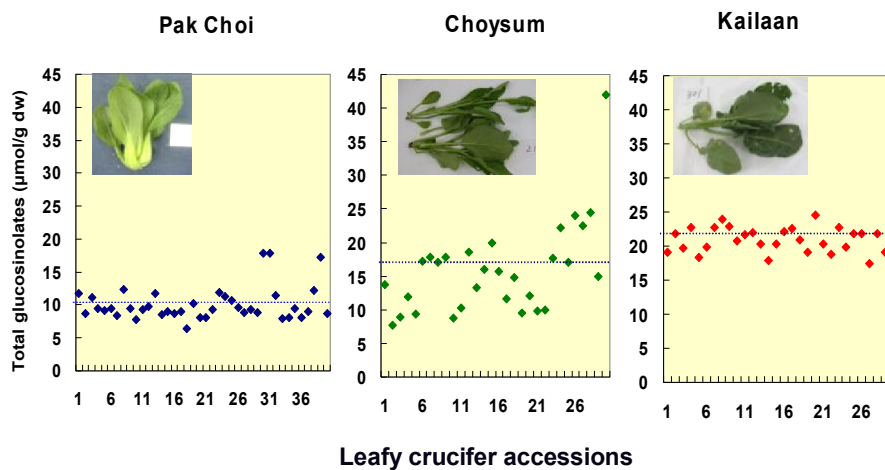
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## High antioxidant Capsicum accessions



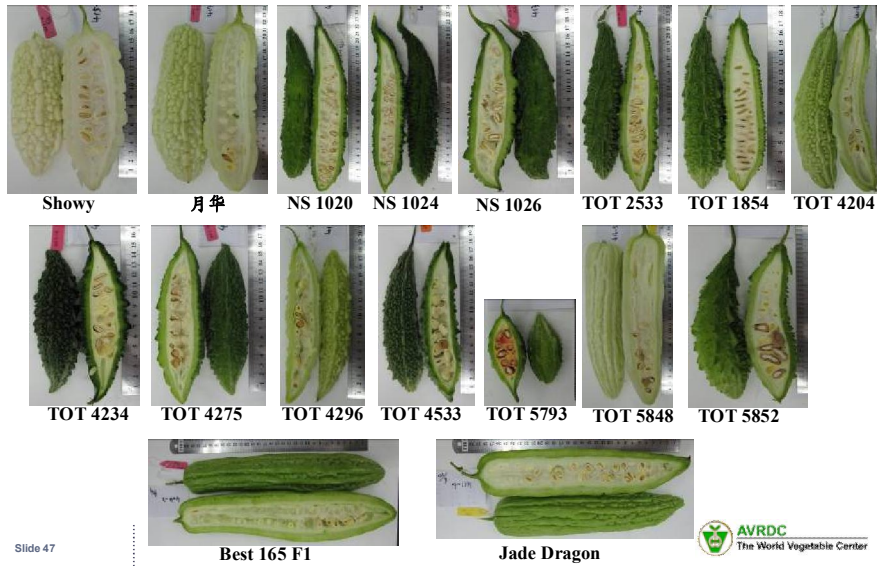
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## Variation for total glucosinolates in leafy crucifer germplasm



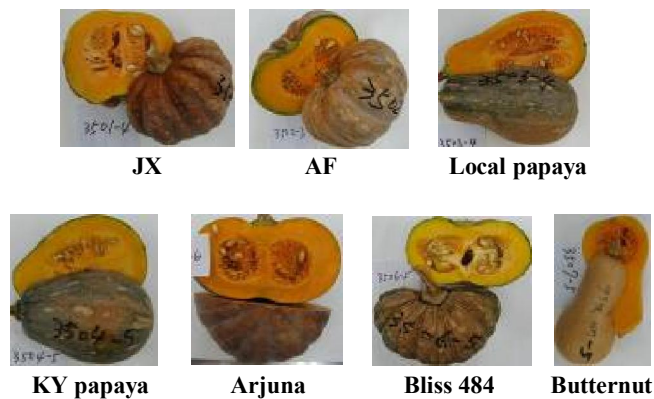
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## Bitter gourd accessions to be evaluated for vitamins and anti-diabetic properties



## Pumpkin accession for evaluation of carotenoids

Selection for high  $\alpha$ - and  $\beta$ -carotene contents



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#### 4. Approaches to food security, diversity and value addition

- Vegetable germplasm
- Indigenous vegetables and nutrition properties
- Breeding for nutrition
- Agricultural interventions for better nutrition and health



#### ► Challenges

##### The complex of food and nutrition security

- All people, at all times, have access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active healthy life. (FAO)
- Food should be available, accessible, and consumed to meet nutritional needs.

# SIR RATAN TATA TRUST

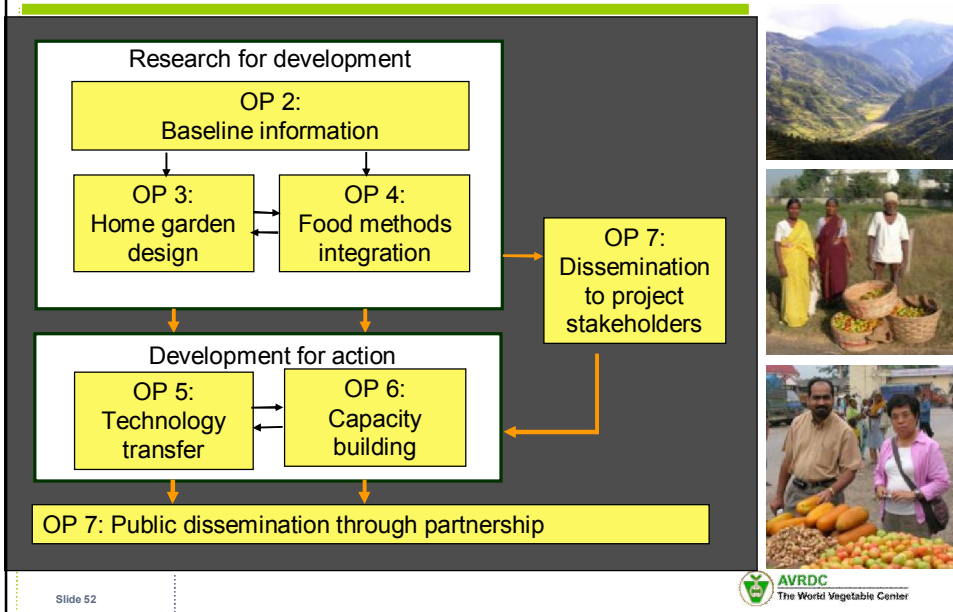


- **Title:** Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India
- **Subproject 2:** Home gardens for diet diversification and better health
  - **Goal:** To contribute to increased diet diversification and improved household nutrition of rural population in India.
  - **Objective:** To expand improved home garden practices in the targeted areas of Jharkhand and Punjab

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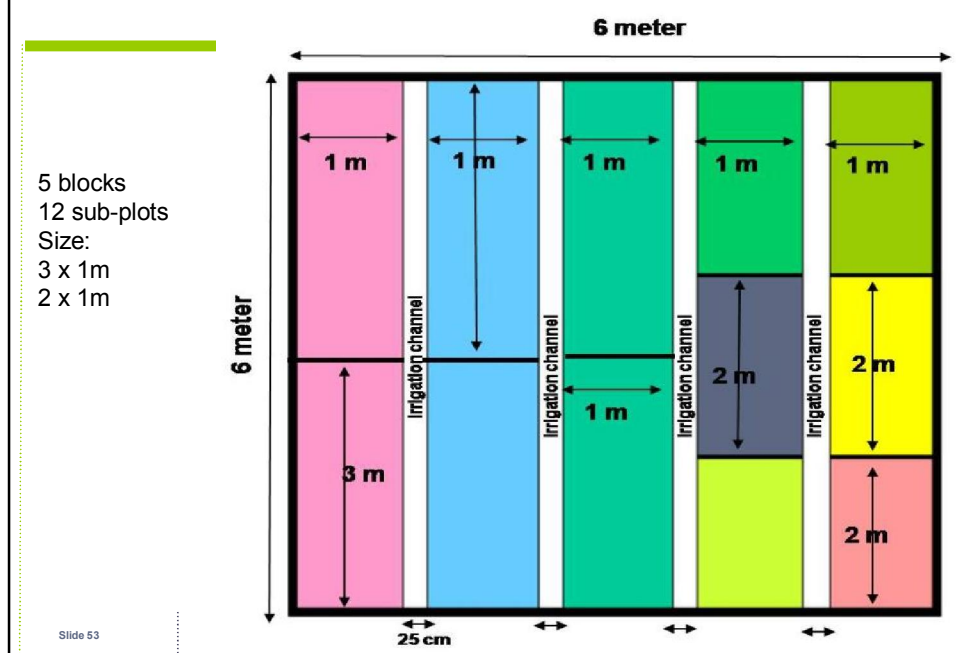
## Major output (op) and operation pathway



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## Garden layout



## Finalized home garden model for Jharkhand

	Block A	Block B	Block C	Block D	Block E
6m	Bitter gourd July-October	Brinjal July-December	Bottle gourd July-October	Bottle gourd July-October	Lablab July-February
	Onion October-March	Kasuri methi January-March	Garlic November-March	Chilli July-June Round the year	Ridge gourd March-June
3m	Amaranthus April-June	Bottle gourd April-June	Sponge gourd April-June	Okra July-October	Cowpea July-September
	Kangkong July-September	Tomato July-December	Amaranthus July-September	Tomato November-March	Chenopodium October-January
3m	Spinach October-February	Lettuce January-February	French bean September-January	Kangkong April-June	Basella February-June
	Tomato March-June	Brinjal March-June	Okra February-June	Coriander July-January February-March	Basella July-November
				Mint	Radish December-February
					Cowpea March-June
	1m				1m
	6m				

## Home garden design for Jharkhand at AVRDC



Home garden model design at AVRDC, Hyderabad, India

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## Home garden adopted in Jharkhand



Home garden model at research station



Home garden model in villages

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## ► Daily vegetable and nutrient availability of garden produce harvested from 6x6 m home garden models

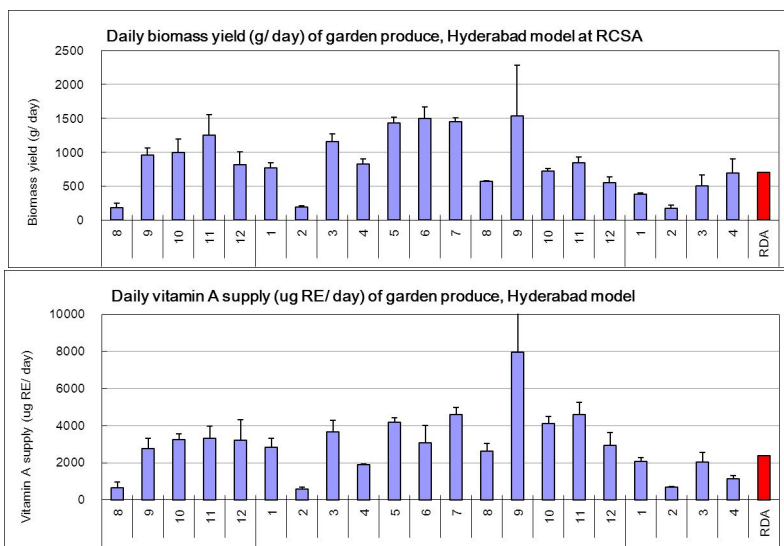
Nutrient	RDA*	Andhra Pradesh	Punjab	Jharkhand
		-----% RDA-----		
Vegetables, g/d	750	111	60	72
Energy, kcal/d	8980	3	2	2
Protein, g/d	196	10	8	7
Vitamin A, ug RE/d	2400	123	93	69
Vitamin C, mg/d	160	239	95	127
Folate, ug DFE/d	670	118	65	56
Iron, mg/d	81	16	9	9
Zinc, mg/d	41	12	6	9

- RDA: Values were the sum of RDA of 4 household members including one adult male and one adult female both with moderate physical work, one child of 7-9 year old, and one 14-15 year-old girl. RDA data source: NIN (2010)
- Weekly harvest data provided by Easdown et al., SRTT project

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## ► Nutritional yields (amount per day) by month: fulfill daily nutrient requirements for a 4-person household in India

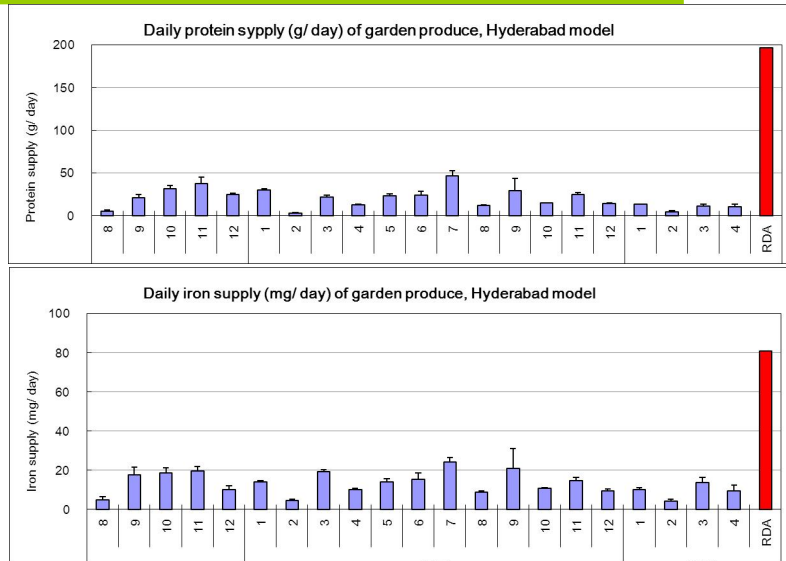


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Weekly harvest data: provided by Eastown et al., SRTT project



► **Nutritional yields (amount per day) by month: failure to meet daily nutrient requirements for a 4-person household in India**



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Weekly harvest data: provided by Easdown et al., SRTT project



**Improved recipes for Jharkhand**



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► **Women's group in Tanzania trained by AVRDC staff for home gardening**



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► **Home garden produce for home consumption and local market**



Veggie grown in home garden and sold at local market



Dried vegetable for sale

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## ► Hospital gardens in Rwanda



High adoption of improved lines of nightshade, Amaranth, celosia and African eggplant



Gikondo District Hospital, Kigali

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## ► Improved food methods, nutrient retention and accessibility; participatory recipe design and promotion



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▶ Village women group leaders, agricultural extension people and AVRDC staff



▶ School garden in the Philippines



■ Project: Promoting utilization of indigenous vegetables for improved nutrition of resource-poor households in Asia (ADB RETA 6067 2003-2006)

## ▶ Gardening and physical activity

- Compare energy expenditure, nutritional and environmental effects of working in a 6 x 6 m<sup>2</sup> vegetable garden versus exercise in a wellness center



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## ▶ Vegetable seed kits for disaster response, rehabilitation, and nutrition relief

- To produce and make appropriate vegetable seed kits available and alleviate nutritional crises and respond to immediate rehabilitation of vegetable production in the most vulnerable farming communities in disaster-affected regions



Threshing



Packing



Seed packets

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# Bitter Gourd Project

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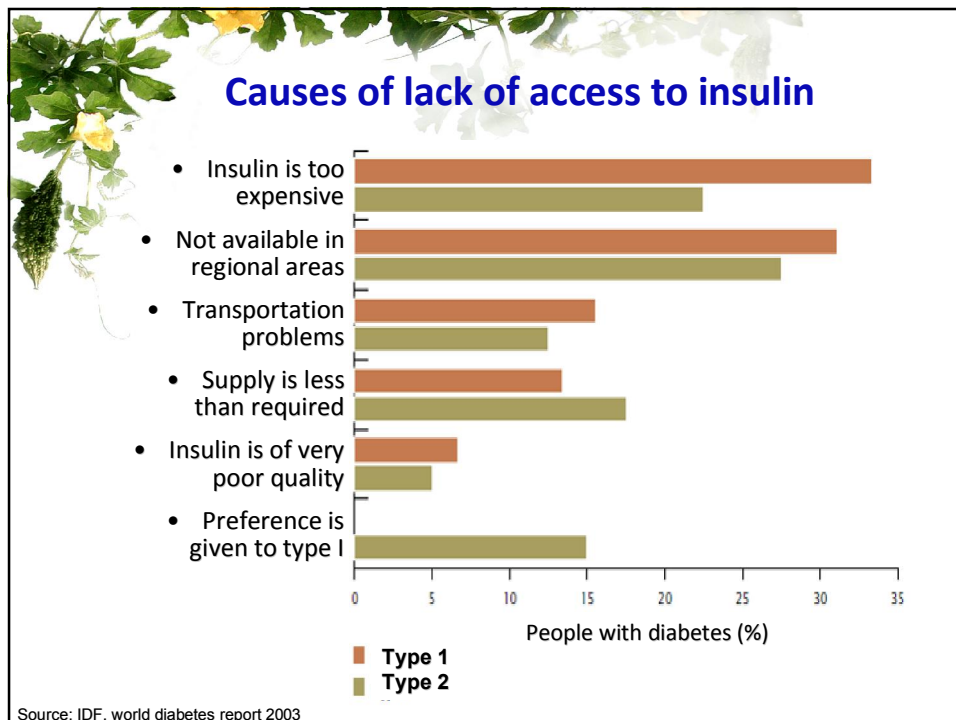
PHOTO GALLERY

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BMZ German Development Cooperation  
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## Bitter gourd

- **A vegetable**
  - Popular in India, China, the Philippines, Taiwan, and Japan
  - Consumed worldwide, particularly in Chinese and India communities
- **A medicinal plant**
  - Anti-hyperglycemia
  - Anti-hyperlipidemia
  - Anti-oxidation
  - Anti-inflammation
  - Anti-microbial pathogens



## BMZ-AVRDC Bitter Gourd Project

- **Project title**
  - **A better bitter gourd: Exploiting bitter gourd (*Momordica charantia* L.) to increase incomes, manage type 2 diabetes, and promote health in developing countries**
- **Funded by BMZ**
  - **BMZ: Federal Ministry for Economic Cooperation and Development, Germany**
- **Project duration:**
  - **2011.03.01 – 2014.02.28**

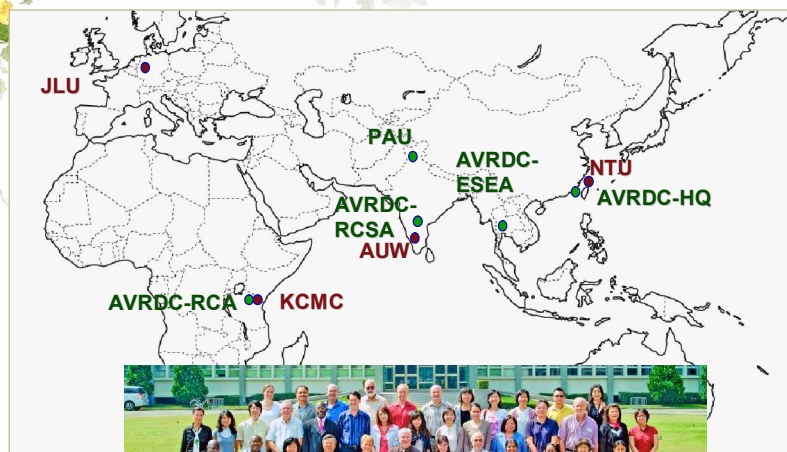
## Project goal and objectives

- **Goal**
  - Improved income and quality of life of diabetics in developing countries
- **Objectives**
  - Optimize production of anti-diabetic compounds in bitter gourd through varietal selection, postharvest practices, and preparation methods
  - Develop evidence-based dietary strategies using bitter gourd to reduce hyperglycemia (high blood sugar) in type 2 diabetic populations in Asia and Africa

2011/9/26

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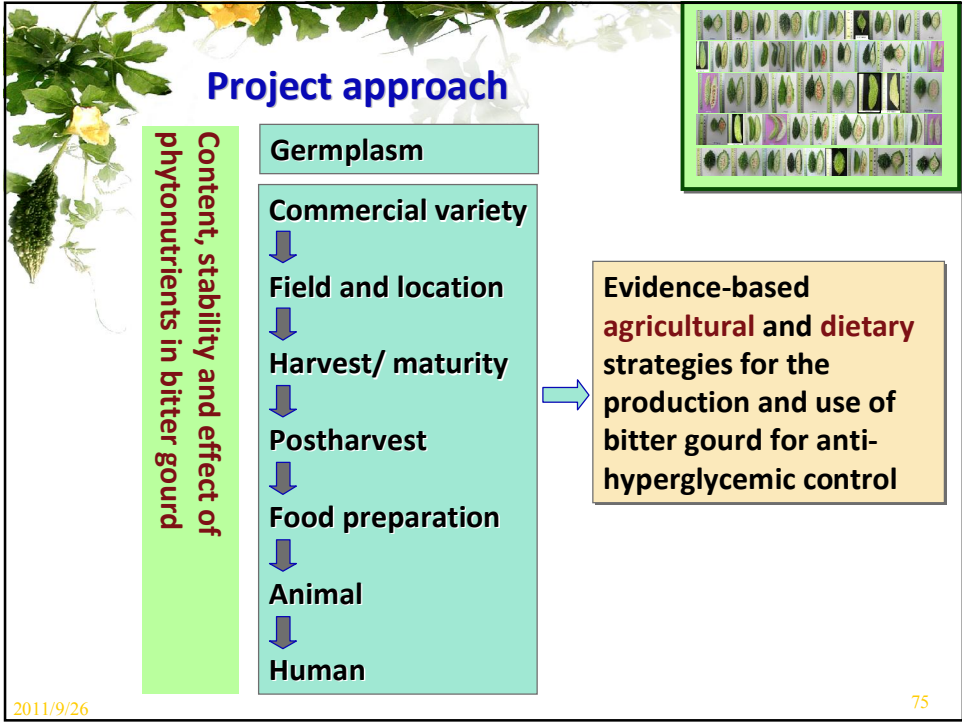
## Project partners and study sites



PAU: Punjab Agricultural Univ.  
AUW: Avinashilingam Univ. for Women  
KCMC: Kilimanjaro Christian Medical Center  
JLU: Justus-Liebig Giessen University  
NTU: National Taiwan University

Project planning workshop, 3-6 May 2011, AVRDC

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**Bitter Gourd Project**

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PHOTO GALLERY

[www.Bitter-Gourd.org](http://www.Bitter-Gourd.org)

Bitter Gourd Project is a project of AVRDC-The World Vegetable Center. This project is funded by the German Ministry for Economic Cooperation and Development, Germany.

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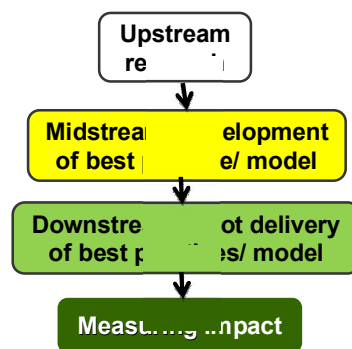


## 5. Challenges



### Challenges

- Evidence-based interventions
  - Intervention packages, efficacy tested
  - Experimental design
  - Measuring nutritional efficacy and cost-effectiveness
- Delivery pathway and scaling up
  - Delivery strategies
  - Scaling up strategies



Thank you



Source: SL Lu, AVRDC



 AVRDC  
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