



# SWEETFUEL- Sweet sorghum- commercialization and challenges

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# Outline of presentation

- ❑ Introduction to ICRISAT
- ❑ SWEETFUEL
- ❑ Why sweet sorghum?
- ❑ Partnerships for poor
- ❑ Lessons from Brazil, China & Philippines
- ❑ Way forward



# Vision and mission

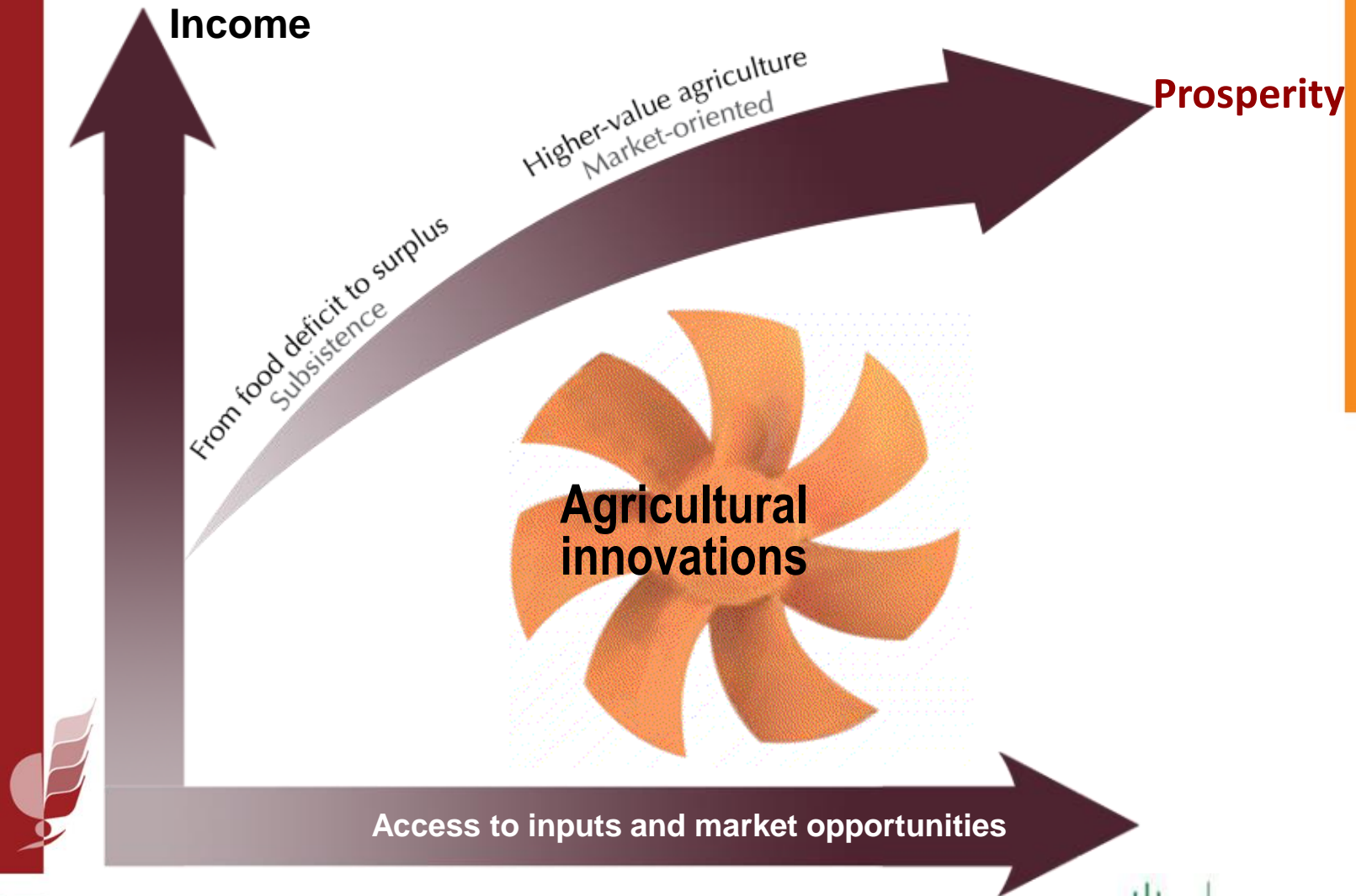
**Vision :** A prosperous, food-secure and resilient dryland tropics

**Mission:** Reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics



# Roadmap to prosperity

## *Inclusive Market-Oriented Development (IMOD)*





# Strategic thrusts

ST 1 - Resilient Dryland Systems

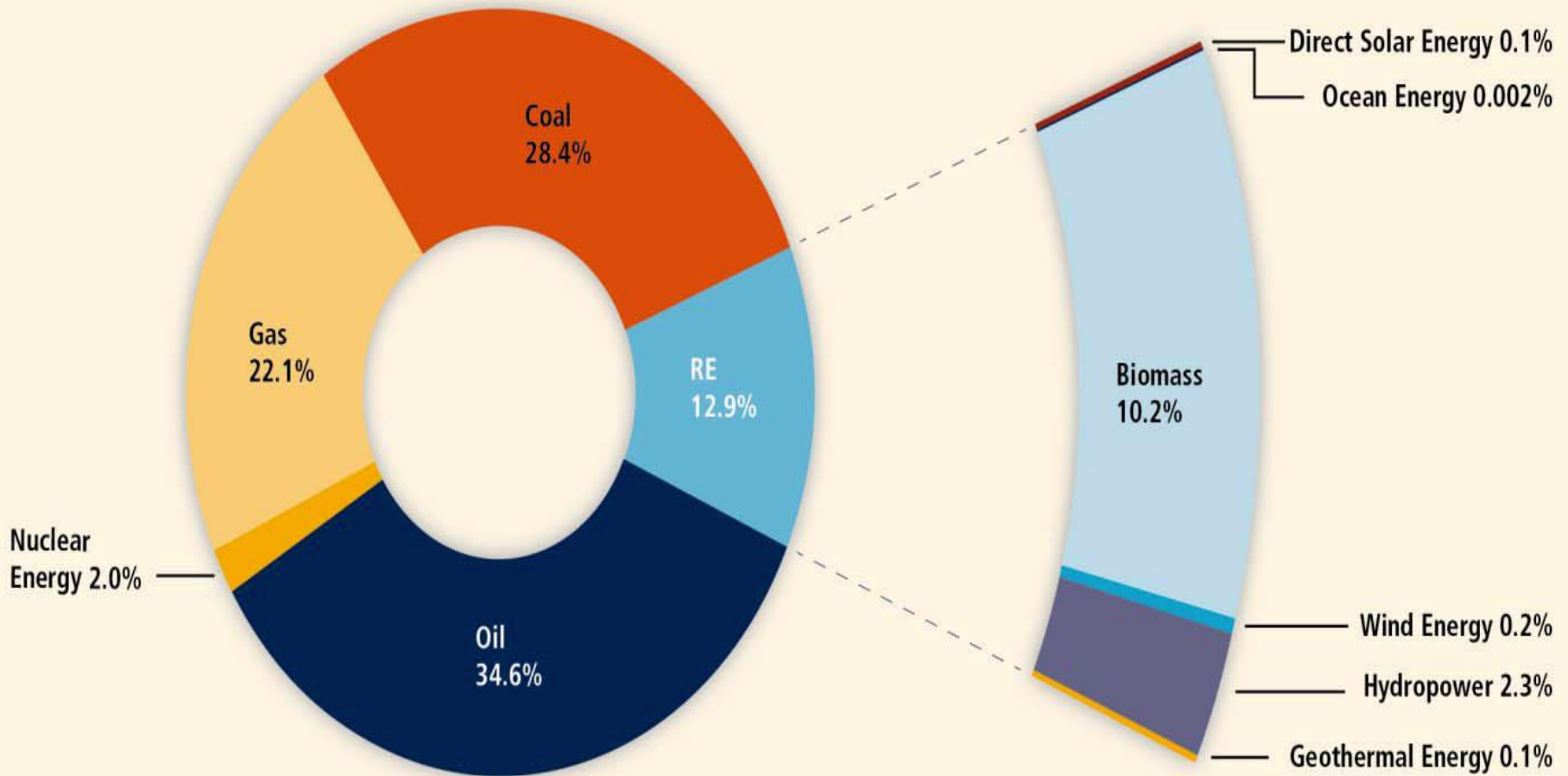
ST 2 - Markets, Institutions & Policies

ST 3 - Dryland Cereals

ST 4 - Grain Legumes



# Share of energy sources in total global primary energy supply in 2008

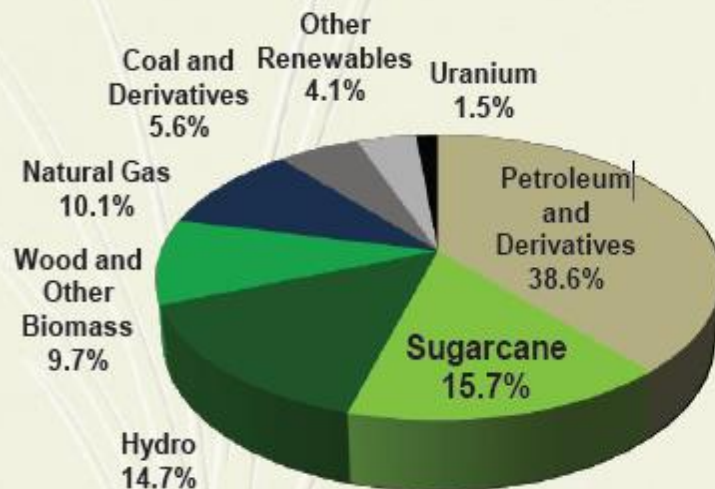


# Ethanol Blending Mandates

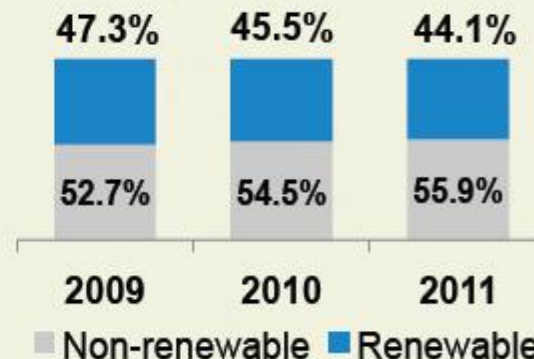
Country/Region	Blending mandate
Argentina	E5 and B7
Australia	E4 and B2 in NSW; E5 Queensland
Brazil	E 18-20 and B7
Canada	E5 and B2
China	E10 in 9 provinces; 10% entire country by 2020
Ethiopia	E5
EU	5.75% currently to be increased to 10% by 2020
India	E5 in metros; E20 by 2017
Indonesia	E3 and B2.5
Kenya	E10
Malaysia	B5
Mexico	E2
Mozambique	E10
Paraguay	E24 and B1
Philippines	E10 and B2
South Africa	E10
South Korea	B2
Sudan	E5
Thailand	B5
USA	15.2 billion gallons renewable fuels; 9.21 percent
Vietnam	E5



# BRAZILIAN ENERGY MATRIX INPUT



**#1 Source of Renewable Energy in BR**



Sources: Balanço Energético Nacional BEN (2011) and International Energy Agency. Key World Statistics 2010. Elaboration: UNICA

unica



# The Policy Framework for renewable transport fuels

## Fuel Quality Directive

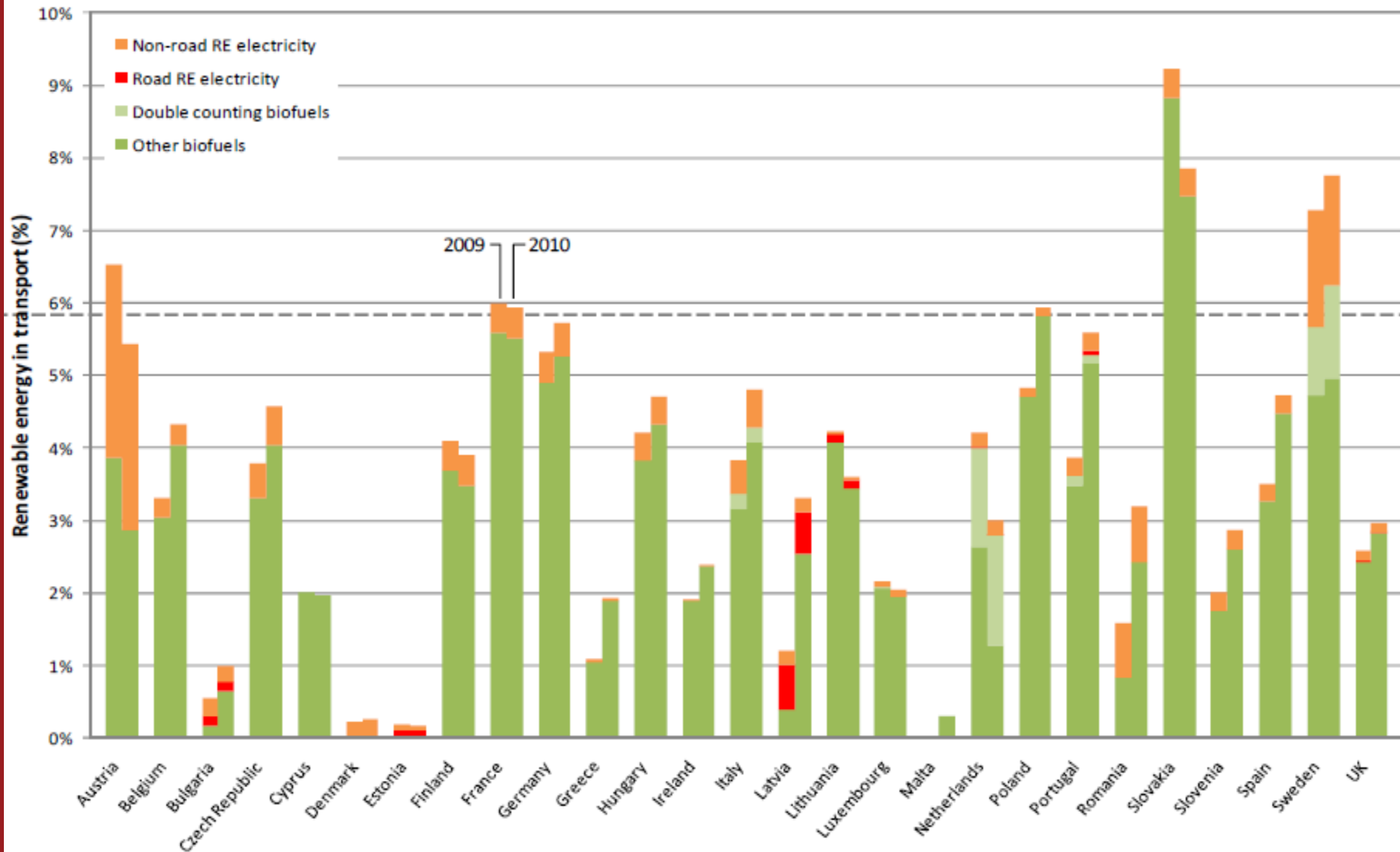
- 6% greenhouse gas reduction target in carbon intensity of road transport fuels in 2020

## Renewable Energy Directive

- 20% share renewable energy by 2020
- 10% renewable energy in transport by 2020

**Significant contribution to both targets expected to come from biofuels**

# Current use of biofuels in the EU



# Indian National Biofuel Policy, 2009

- Non-food feedstocks to be raised on degraded or wastelands that are not suited to agriculture, thus avoiding a possible conflict of fuel vs. food security.
- An indicative target of 20% blending of biofuels, both for bio-diesel and bio-ethanol, by 2017 is proposed.
- The Minimum Purchase Price (MPP) for bio-ethanol, will be based on actual cost of production and import price of bio-ethanol, while for biodiesel it is linked to retail price.
- Feedstocks: Sugars-sugar cane, sugar beet, sweet sorghum; Starch-corn, cassava, algae; Cellulose- residues and wastes
- Government had postponed the deadline for the nationwide roll-out of 5% EBP from December 1, 2012 to June 1, 2013
- 5% EBP requires 1000 million lit.



**Partner 1**  
**Coordinator**  
**WP4 and WP8 leader**



Centre de coopération internationale en  
recherche agronomique pour le développement  
(CIRAD / France)

**Partner 2**  
**WP2 leader**



International Crops Research Institute for Semi-Arid  
Tropics (ICRISAT / India)

**Partner 3**  
**WP3 leader**



EMBRAPA Maize and Sorghum (Brazil)

**Partner 4**  
**WP1 leader**



KWS SAAT AG (Germany)

**Partner 5**  
**WP6 leader**



IFEU - Institute for Energy and Environmental  
Research Heidelberg, Germany

**Partner 6**  
**WP5 leader**



**Alma Mater Studiorum – Università di Bologna  
(UNIBO / Italy)**

**Partner 7**



**Università Cattolica del Sacro Cuore (UCSC / Italy)**

**Partner 8**



**Agricultural Research Council – Grain Crop Institute  
(ARC-GCI / South Africa)**

**Partner 9**



**Universidad Autónoma de Nuevo León  
(UANL / Mexico)**

**Partner 10**  
**WP7 leader**



**WIP - Renewable Energies (WIP / Germany)**

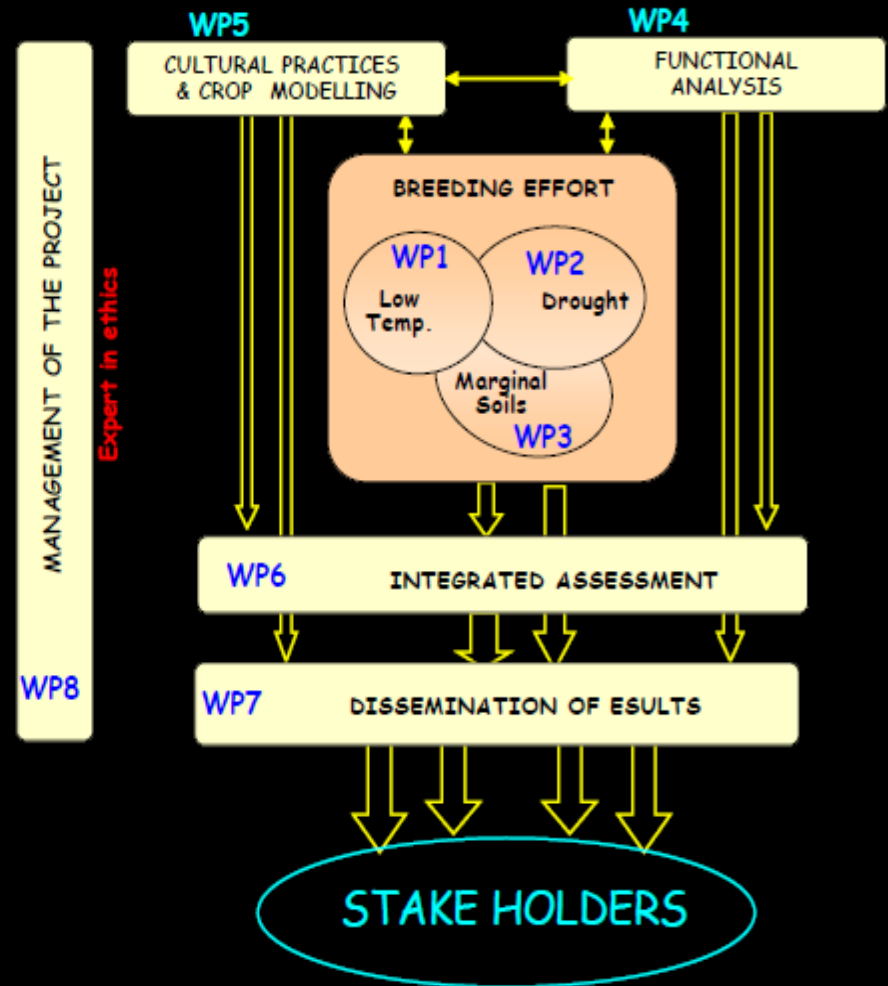


# Budget and organisation of WPs

## Distribution of the total budget

(Total budget = 4 950 937 €)

Breeding effort:	WP1 = 20%
	WP2 = 12%
	WP3 = 14%
Func. Analysis & ...	WP4 = 15%
Cult. Pract. &...	WP5 = 13%
Integrated assess.	WP6 = 12%
Dissemination...	WP7 = 6%
Management...	WP8 = 8%



# Grain-sweet-energy sorghum



# ICRISAT's BioPower strategy

- BioPower empowers the dryland poor to benefit from emerging bioenergy opportunities
- Ensures both food and energy security
- Focuses on biomass, juice and grain yields
- Greater smallholder incomes
- Sustaining environments



# Why sweet sorghum?

## Drivers: Population, Energy and Climate Change

As crop	As ethanol source	As bagasse
<ul style="list-style-type: none"><li>▪ Multipurpose 'smart' crop</li><li>▪ Efficient in photosynthesis</li><li>▪ High RUE, WUE, NUE</li><li>▪ Short duration dryland crop</li><li>▪ Greater resilience</li><li>▪ Non-invasive species</li><li>▪ Seed propagated</li></ul>	<ul style="list-style-type: none"><li>▪ Eco-friendly process</li><li>▪ Superior quality (low sulphur and lead)</li><li>▪ Automobile friendly (up to 85% blend)</li></ul>	<ul style="list-style-type: none"><li>▪ Higher biological value</li><li>▪ Rich in micro-nutrients</li><li>▪ Use as feed/for power co-generation/bio-compost</li></ul>

RUE: Radiation use efficiency; WUE: Water-use efficiency; NUE: Nutrient use efficiency



# Tradeoff between food and fuel

Season	Variety/ hybrid	Sugar yield (t ha <sup>-1</sup> )			Grain yield (t ha <sup>-1</sup> )		
		Sweet stalks (SS)	Non-sweet stalks	% gain of SS	Sweet stalks (SS)	Non-sweet stalks	% gain / loss in SS
Rainy season	Varieties	6.0 (6) <sup>1</sup>	3.9 (11)	54	3.0 (6)	3.3 (11)	-9
	Hybrids	6.2 (5)	5.6 (4)	11	6.2 (5)	5.9 (4)	5
Post rainy season	Varieties	1.7 (11)	0.9 (6)	89	4.6 (11)	4.7 (6)	-2
	Hybrids	1.5 (6)	1.0 (3)	50	6.4 (6)	8.5 (3)	-25





# Sweet sorghum (ICSV 93046) in India



# Sweet sorghum value chain (SSVC)

SSVC consists of two models:

1. Centralized model (Rusni, AP & TCL, Maharashtra) 1 t stalks → 350-500 kg juice → 44 L ethanol (Lab); 45 L (Rusni); 50 L (Praj); 50 L (DA-BAR)
2. Decentralized model (Ibrahimbad, AP & Parbhani, Maharashtra) 1 t stalks → 280-400 kg juice → 50-80 kg syrup → 16-26 L ethanol





# Partnerships for the poor



# Sweet Realty 2007-08

S.S. Pet  
K.C.

RUSNI DISTILLERIES (P) LTD.  
FARMER BILL

Farmer Name :- కె. రమేశ్ రావు

Father Name :- వెంకటేశ్వర రావు

Village :- గుంతపల్లి Mandal :- కందుకూరు

Stalk Received Date :- 26/9-07 S. No.:-

Stalk Net Weight :- 49790 kg Tractor No.:- AP234-32524 AP2341951

Rate Per Ton :- 600/- Total Amount :- 29,874/-

SPED Qty :- 8 kg (2Acres) SPED Price :-

DAP Qty :- 100 kg (2 bags) DAP Price :- 970/-

UREA Qty :- 100 kg (2 bags) UREA Price:- 502/-

WEEDSIDE Qty :- WEEDSIDE Price :-

Net Payable :- 28402/-

Payment Mode By cash/ Cheque No. :- SYNDICATE BANK CHQ. NO. 623142

Payment Date :- 10.10.07

Authorized Signature

Farmer / Receiver Signature

Farmer Name: Ramesh Rao

Village Name: Gunthapally

Acreage: 2 Acres

Stalk supplied: 49.7 tonnes

Total Income: Rs. 29,874 (US\$747)

Input cost: Rs. 1874 (US\$47)

Net gain: Rs. 28000 (US\$700)

Promised Less Delivered More



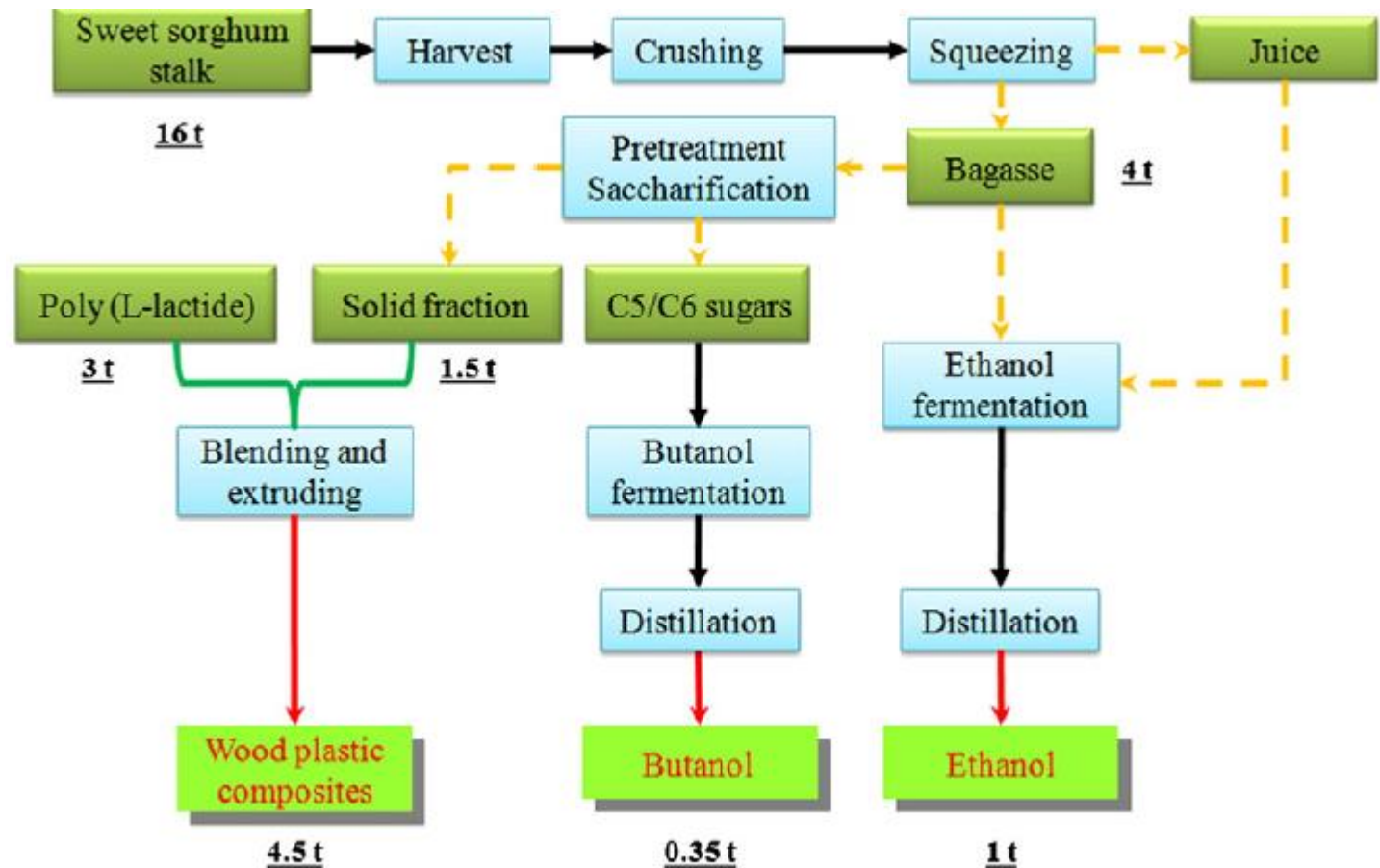
# Partnerships for the poor

ICRISAT, Rusni Distilleries & TC L tie-up through ABI





# Model Sweet sorghum value chain (SSVC)



# Lessons from Brazil

- **PROALCOOL (*Programa Nacional do Alcool*) Program initiated in 1975**
  - Government initially extended support, now self sustainable
  - Brazil currently largest exporter of ethanol (sugarcane)
- **EMBRAPA sweet sorghum variety, BRS 506, recorded 2500 l ha<sup>-1</sup> in 1500-ha pilot study in 2011**
  - 1.8 M ha identified for sweet sorghum cultivation
  - Government actively supporting sweet sorghum cultivation
- **Ceres identified sweet sorghum hybrids from ethanol pilot studies**
- **EMBRAPA seed production for 2013: 20,000 tons**



# Lessons from Philippines

- SPV 422 - popular as “Sweet Philippines Variety” and grown in 80 ha in Cabiao and Ilocos Norte (2010)
- SPV 422 average stalk productivity: 65 t ha<sup>-1</sup>  
Grain: 4.5 t ha<sup>-1</sup> in Cabiao
- Bapamin Enterprises (Engr. Antonio Arcangel) sells 1000 L per month of sweet sorghum vinegar
- SCBI produced 14 KL ethanol from sweet sorghum in 2012



Pemdas Energy Corp, Candaba



San Carlos Bio-Energy Inc,  
Negros



Green Future Innovations  
Inc, San Mariano, Isabela



# Lessons from China

- Sweet sorghum promoted as non-food feedstock
- Fuxin distillery (Liaoning province) and ZTE distillery (inner Mongolia) in commercial operation since 2011
- Government cash incentives
  - Farmer, 180 yuan/mu (15 mu = 1 ha)
  - Distillery, 1350 yuan /t of ethanol
  - VAT and consumer tax refunds to distillery
- Sweet sorghum ethanol production cost: 7000 yuan/t
- Ethanol sale price: 9000 yuan/t  
(at par with gasoline)
- Excellent R4D and seed production systems established
- More than 10 upcoming firms to operate soon



Inclusive Market-Oriented Development (IMOD)



# What makes SSVC sustainable ?

- Use of multi-feed stocks (year-round operation) and production of multiple products and by-products
- Focused target area instead of dispersed
- Strong agricultural R&D set-up and supply-chain management
- Mechanized crop production and harvesting
- Customized crushers and processing
- Favorable policy environment





# Lignocellulosic ethanol

?



- **Feedstock**
  - Photo-thermo sensitivity
  - Lignin content
  - Food- feed-fodder-fuel security ?
  - Biotic and abiotic stress tolerance
  - Adaptation to marginal environments (WUE, NUE, salinity, lodging)
- **Pretreatment technologies**
- **Enzyme costs**
- **Co-fermentation (C5 and C6)**





*Thank you!*



*ICRISAT is a member of the CGIAR Consortium*



**International Crops Research Institute  
for the Semi-Arid Tropics**

**Inclusive Market-Oriented Development (IMOD)**



RESEARCH  
PROGRAM ON  
DrylandCereals