



ICRISAT
Science with a human face

Role of ICRISAT in SWEETFUEL Project and Results achieved

**Belum VS Reddy, P Srinivasa Rao
and P Parthasarathy Rao**

Global Theme on Crop Improvement

**International Crops Research Institute for the Semi-Arid Tropics
(ICRISAT), Patancheru 502 324, AP, India**

The New ICRISAT

2004-05

- Fourth King Baudouin Award
- Rated Superior by CGIAR
- US \$ 30 M budget (surplus)
- High staff morale

2006-07

- New vision and strategy to 2015
- Two CGIAR Science Awards
- Fourth year of budget surplus
- High staff morale
- Rated Outstanding by CGIAR

US\$ 56 M budget in 2009

2002-03

- Team ICRISAT
- Third King Baudouin Award
- External reviews
 - Quality science
 - Sound management
- Institutional innovations
- Budget surplus

Mid 90s:

- Financial and human resource challenges
- Declining support

2000-01

- Institutional transformation through Science with a Human Face
- Grey to Green Revolution
- US \$ 22 M budget



International Crops Research Institute for the Semi-Arid Tropics





ICRISAT
Science with a human face

WP 2 and WP 6 Partners



WP 2- Breeding for drought adaptation

<i>Institute</i>	ICRISAT	UANL	ARC-GCI
<i>person months</i>	146	20	10

WP Leader: ICRISAT, Patancheru, India

UANL: Universidad Autonoma de Nuevo Leon , Mexico

ARC-GCI : Agricultural Research Council- Grain Crop Institute, South Africa

WP 6 - Integrated assessment

<i>Institute</i>	IFEU	ICRISAT	WIP	EMBRAPA	KWS	UNIBO
<i>person months</i>	52	12	10	3	1	1

WP Leader: Institute for Energy and Environmental Research (IFEU), Heidelberg, Germany



Tasks- WP2



2.2

Screen sorghum core germplasm accessions and reference collection

- *Identification of potential donors from germplasm*
- *Screening of reference collections*

2.3

Develop promising hybrid parents for high sugar and grain yields

- *Hybrid parents for rainy season adaptation*
- *Postrainy season adapted improved hybrid parents*
- *Develop sweet sorghum hybrids for both the seasons*

2.1

Identify promising sweet sorghum hybrids

- *Seed increase and exchange of germplasm*
- *Multilocation testing to identify promising hybrids*

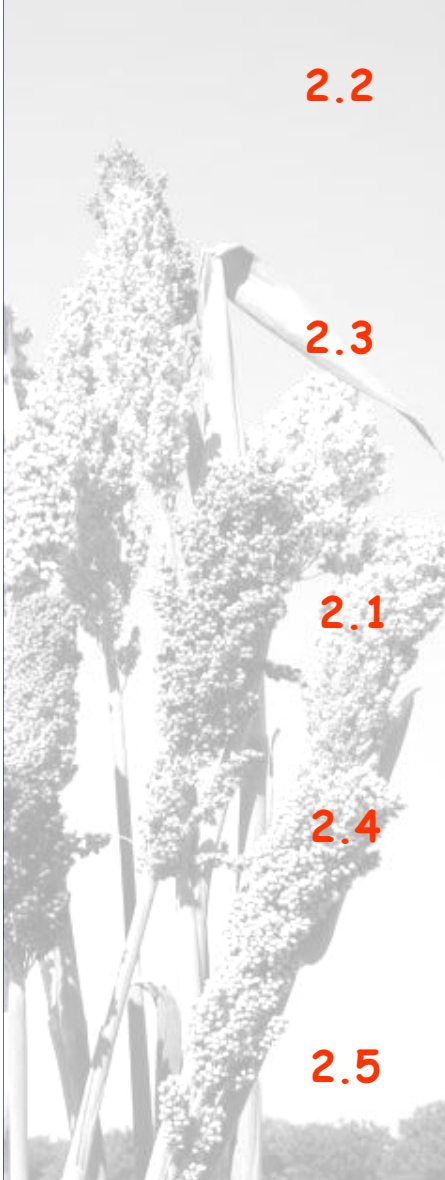
2.4

High biomass yielding brown midrib (*bmr*) hybrid parents

- *Identification of promising donors from germplasm*
- *Develop *bmr* hybrid parents*

2.5

Stay-green hybrid parents with drought tolerance





ICRISAT
Science with a human face

Breeding for drought-prone environments



Purpose is to develop new lines or hybrids of sweet sorghum with

- (i) juicy stems with high total sugar content (>17%)**
- (ii) high grain yield suitable for human or animal alimentation and high biomass with stem girth >2.5 cm**
- (iii) better resistance to drought with good adaptation to rainy (midseason moisture stress) and/or post rainy season (terminal stress) in India and producing bagasse with a better digestibility, suitable for fodder use including high biomass yielding *bmr* lines**





ICRISAT
Science with a human face

Methodology



- **Selection based on high sugar/biomass yields under normal rainfall and induced drought stress (mid-season/terminal) condition without scarifying grain yield**
- **Screen the germplasm, advance breeding material and hybrid parents available under target environments with all the beneficiaries**
- **Pool the selected material and multiplying the seed for multilocation trials (MLT) and hybrid production**
- **Conduct MLTs in India, South Africa and Mexico involving selected lines and hybrid parents and select 8–10 each of germplasm, breeding material and hybrid parents**
- **Produce hybrids with the selected parents and conduct MLTs**



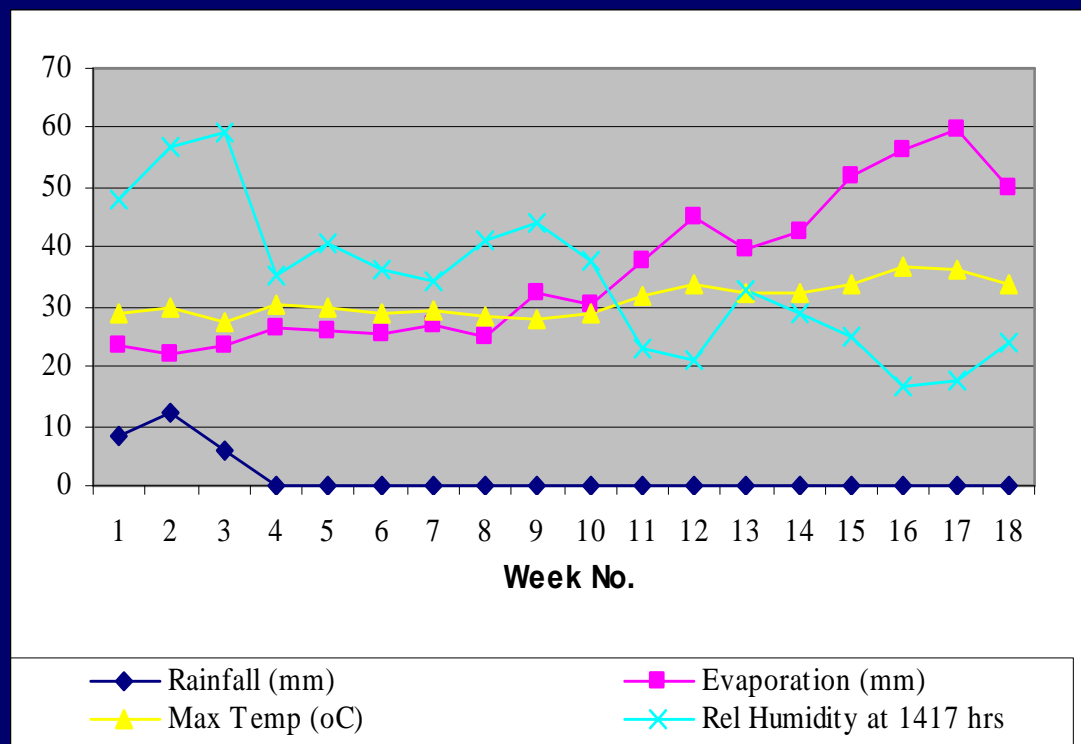


ICRISAT
Science with a human face

Screening of improved sweet sorghum hybrid parental lines, varieties and hybrids for terminal stress (Postrainy 2008-09)



- **182 genotypes evaluated** : (B-lines - 62 and varieties-120)
- **54 genotypes selected** : (B- lines- 19 and varieties/R-lines- 35)
- **Criteria of selection:** sugar yield $>0.20 \text{ t ha}^{-1}$ in B-lines and 0.25 t ha^{-1} in varieties, Brix% > 9 (Checks, ICSB 38: 7.1, 0.04 t ha^{-1} ; SSV 84: 9.9 , 0.19 t ha^{-1})



Date of sowing: 30 Oct 2008

Date of last irrigation: 20 Dec 2008



ICRISAT
Science with a human face

Selection gains from terminal moisture stress screening

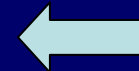


Nursery	Trial Entries (n)	Trial means			Selected entries (n)	Selection means			Selection gain or sugar yield
		Brix%	Sugar Yield (t ha ⁻¹)	Grain yield (t ha ⁻¹)		Brix %	Sugar yield (t ha ⁻¹)	Grain yield (t ha ⁻¹)	
R-lines / varieties	120	9.95	0.19	1.5	5	11.5	0.67	1.67	252.6 %
Parents	62	10.01	0.11	1.10	5	11.8	0.31	1.90	181.8 %
Total	182	9.98	0.15	1.30	10	11.6	0.49	1.78	226.6 %



ICRISAT
Science with a human face

Screening for terminal stress



**Susceptible genotypes
under terminal stress**



**Tolerant genotypes under
terminal stress**





ICRISAT
Science with a human face

Screening of improved sweet sorghum hybrid parental lines, varieties and hybrids for mid season stress

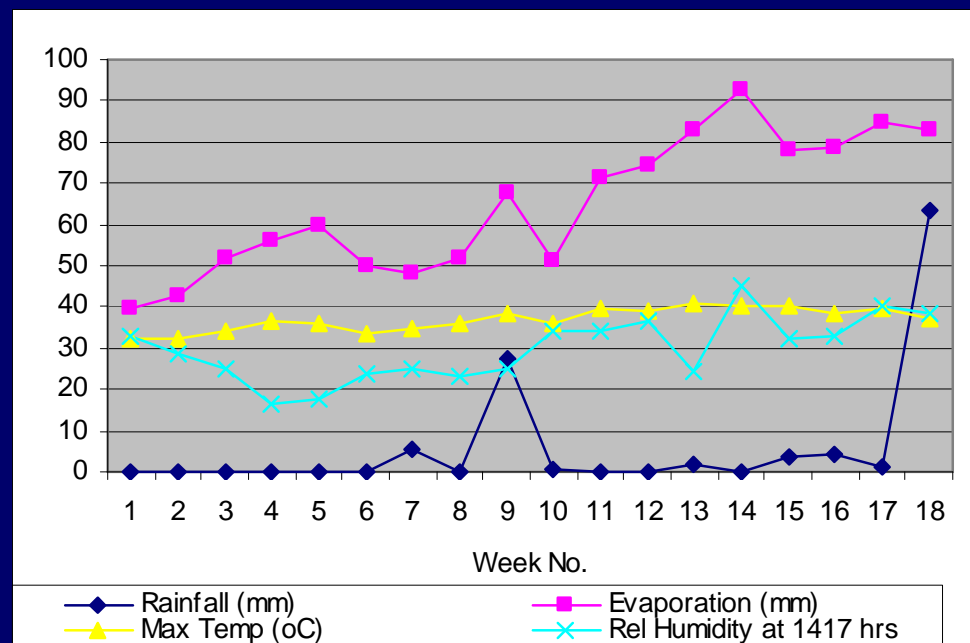
(Summer 2009)



- **393 genotypes evaluated** : (B-lines - 100, varieties/R-lines- 170; hybrids- 65 and germplasm accessions: 58)
- **90 genotypes selected based on Sugar yield and Brix%** : (B-lines - 8, varieties/R-lines- 53; hybrids- 28; germplasm line: 1) Checks: ICSV 112- 0.1 t ha⁻¹, 13.9% ; R 16- 0.3 t ha⁻¹, 14.9% ; B 35-0.1 t ha⁻¹, 15.2% , E 36-1- 0.4 t ha⁻¹, 16.0% and NTJ 2- 0.2 t ha⁻¹, 13.4%
- **Criteria of selection:** sugar yield > 0.66 t ha⁻¹, Brix%> 14.0

Sowing date: 6 Feb 2009

Stress imposed: 3 Mar 2009





ICRISAT
Science with a human face

Selection gains from midseason moisture stress screening



Nursery	Trial Entries (n)	Trial means			Selected entries (n)	Selection means			Selection gain for Sugar yield
		Brix %	Sugar yield (t ha ⁻¹)	Graingrain Yield (t ha ⁻¹)		Brix %	Sugar yield (t ha ⁻¹)	Graingrain Yield (t ha ⁻¹)	
R-lines / varieties	228	14.1	0.5	1.5	53	13.1	0.9	1.8	80.0 %
Hybrids	65	14.4	0.7	1.4	31	14.8	1.0	1.4	42.8 %
Parents	100	15.1	0.4	1.5	9	14.8	0.8	2.3	100 %
Total/Average	393	14.5	0.53	1.46	93	14.23	0.9	1.83	69.8 %



ICRISAT

Science with a human face

Screening for midseason stress



Genotypes showing varied drought tolerance mechanisms

Productive genotypes under drought





ICRISAT
Science with a human face

Correlation between sweet sorghum genotypes evaluated under mid-season and terminal drought conditions

Midseason stress	Terminal stress	Brix%	Sugar yield (t ha ⁻¹)	Grain yield (t ha ⁻¹)
B-lines				
Brix%		0.04	0.05	0.12
Sugar yield (t ha ⁻¹)		0.28**	0.47**	-0.17
Grain yield (t ha ⁻¹)		0.11	0.1	0.12
R-lines/Varieties				
Brix%		0.04	-0.02	0.20**
Sugar yield (t ha ⁻¹)		0.03	0.19**	-0.10
Grain yield (t ha ⁻¹)		-0.15*	-0.06	-0.15*

* significant at $P < 0.05$ and ** significant at $P < 0.01$

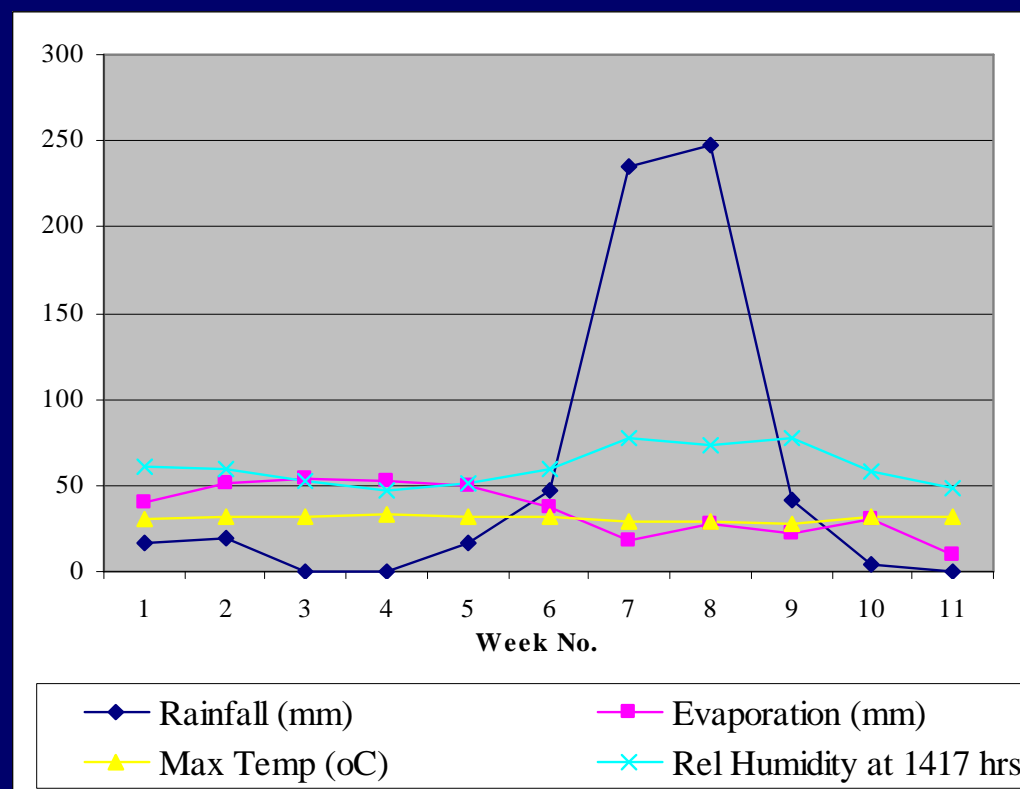


ICRISAT
Science with a human face

Evaluation of improved sweet sorghum hybrid parental lines, varieties and hybrids in SAT conditions (rainy season, 2009)



- **Ninety genotypes being evaluated** : B-lines - 8, varieties/R-lines- 53; hybrids- 28 and germplasm line: 1
- **Checks**: CSH 22 SS, SSV 74, ICSV 112, R 16, B 35, E 36-1, NTJ 2
- **Evaluation traits to be recorded**:
Juice yield,
Grain yield,
Brix%, Biomass





ICRISAT
Science with a human face

Evaluation of selected improved sweet sorghum hybrid parental lines, varieties and hybrids for terminalia (postrainy 2009-10)

- **No. of genotypes to be evaluated :** B- lines - 19
, varieties/R-lines- 35
- **Evaluation traits to be recorded:** Juice yield,
Brix%, Grain yield, Biomass





ICRISAT
Science with a human face

Screening of selected improved sweet sorghum hybrid parental lines, varieties and hybrids for terminalia (postrainy 2009-10)

- **No. of genotypes to be evaluated :**
 - B- lines - 19
 - Varieties/R-lines- 35
- **Screening traits to be recorded:** Leaf firing, Leaf rolling, Recovery, Juice yield, Brix%, Grain yield, Biomass





Science with a human face

Evaluation of B-35 derivatives with stay green QTLs for high Brix% and sugar yield



- No. of entries evaluated : 40
- Six lines (S35SG 06019, S35SG 06002, 111SG 06025, S35SG 06015, S35SG 06014, 111SG 06041) are found to be rich in sugars (13.25 - 18.50 % Brix)
- Seed multiplication is being undertaken in 2009-10.





ICRISAT
Science with a human face

Crossing of *bmr* 6 and 12 with high biomass selected from germplasm



- No. of crosses to be made: 10



X





ICRISAT

Science with a human face

Seed multiplication of drought tolerant h



- **ICSA 324 x SSV 74**
- **ICSA 675 x ICSV 700**
- **ICSA 749 x ICSV 93046**
- **ICSA 502 x SP 4481-1**
- **ICSA 702 x SSV 84**

(Ten Kg each)



ICRISAT
Science with a human face

Seed supplied to UANL, Mexico



S.No	Name	Pedigree
1	ICSV 25275 (SP 4495)	(IS 19587 x B 24)-2-1-1-1
2	ICSV 25279 (SP 4511-2)	(ICSV 93046 x SSV 84)-7-2-1-2
3	ICSSH 20	ICSA 52 x SPV 1411
4	ICSSH 31	ICSA 38 x ICSV 700
5	ICSSH 50	ICSA 84 x E 36-1
7	ICSB 38	[(BTx 623 x MR 862)B lines bulk]-5-1-3-5
6	ICSB 52	Ind. Syn. 422-1
8	ICSB 84	(Ind. Syn. 89-1 x US/R-20-682)-5-1-3
9	SPV 1411	Parbani moti
10	ICSV 93046	(((IS 1082 x SC 108-3)-1-1-1-1-1) x (((IS 5622 x CS 3541)-20-1-1-1-1-1 x (UCh V2 x Bulk Y-55)-1-5-1)-5-2-5-1-1))-9-1-3-1-1-1
11	E 36-1	E 36-1
12	ICSV 700	(IS 1082 x SC 108-3)-1-1-1-1-1



Science with a human face

WP 6: Integrated Assessment



Goal

Multicriteria evaluation of sustainability of sweet sorghum production and use routes for biomaterial, food, fibres and biofuel.

Task 6.1 Technological Assessment

Task 6.2 Environmental Assessment

→ Task 6.3 Economic Assessment

Task 6.4 SWOT Analysis

Task 6.5 Integrated Assessment



ICRISAT
Science with a human face

WP 6- Task description



- **Determination of the environmental implications of the sweet sorghum systems**
 - **Definition of the economy-specific system boundaries**
 - **Cost analysis of sweet sorghum systems compared to that of conventional production systems and reference systems**
 - **Investigation of several subscenarios taking into account future opportunities for optimisation**
 - **Generation of different scenarios for sweet sorghum and conventional production and use lines using different revenue levels**
 - **Determination of areas where sweet sorghum production would have a comparative advantage over traditional systems**



ICRISAT

Science with a human face

Milestones for Task 6.3

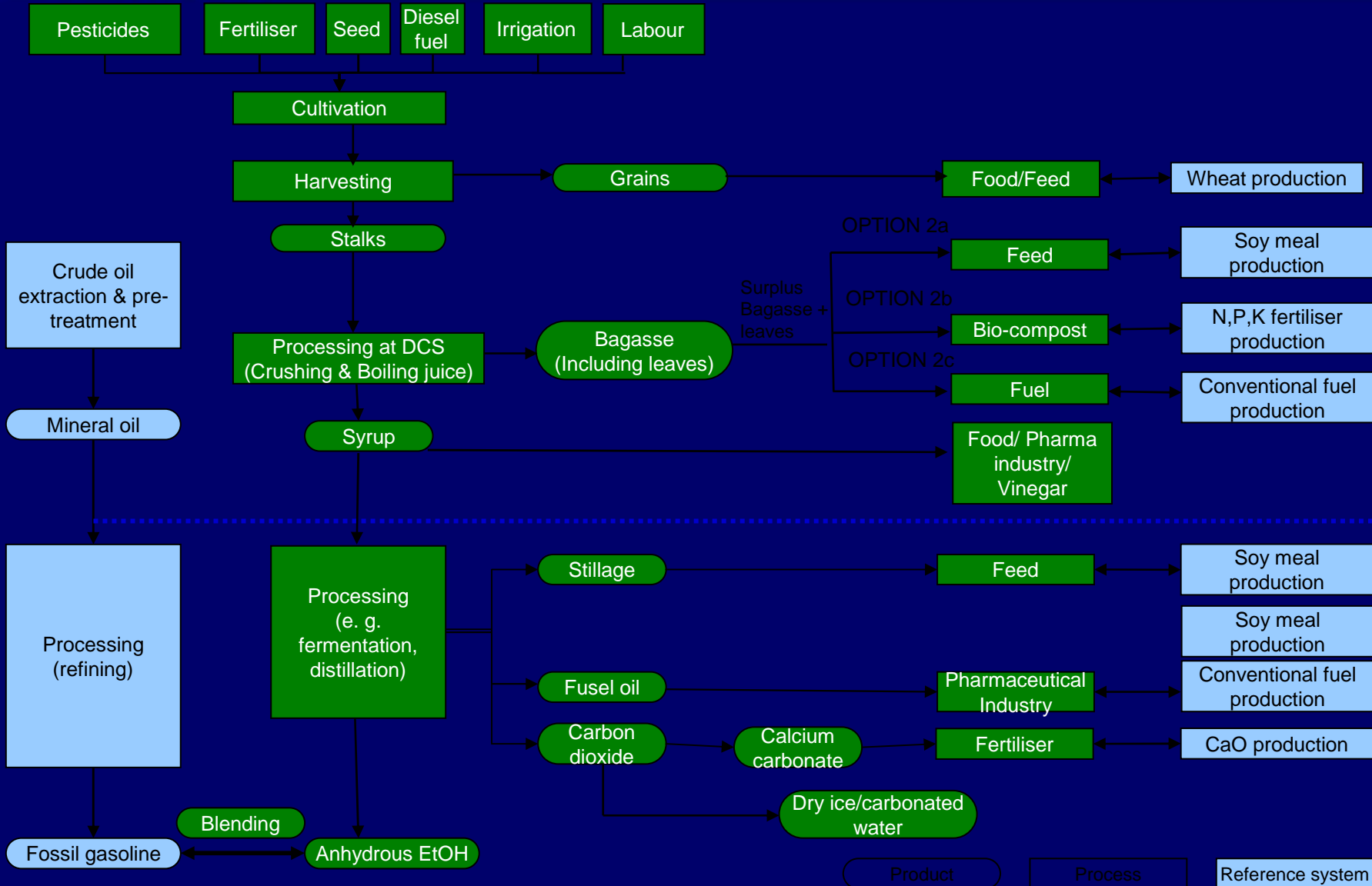


- 6.2.1 Ex-ante analysis of sweet sorghum and grain sorghum cultivation in rainy and post rainy seasons for Centralized unit (TCL/ Rusini)
- 6.2.2 Ex-ante analysis of sweet sorghum and grain sorghum cultivation in rainy and post rainy seasons for Decentralized unit
- 6.2.3 Break even analysis for ascertaining the viability of unit/ sweet sorghum cultivation vis-à-vis other feedstock's
- 6.2.4 Valuation of other non-tangible benefits due to sweet sorghum cultivation for addressing sustainability, equity and welfare concerns
- 6.2.5 Scenario/ Sensitivity Analysis of sweet sorghum cultivation for price fixation and policy advocacy



ICRISAT
Science with a human face

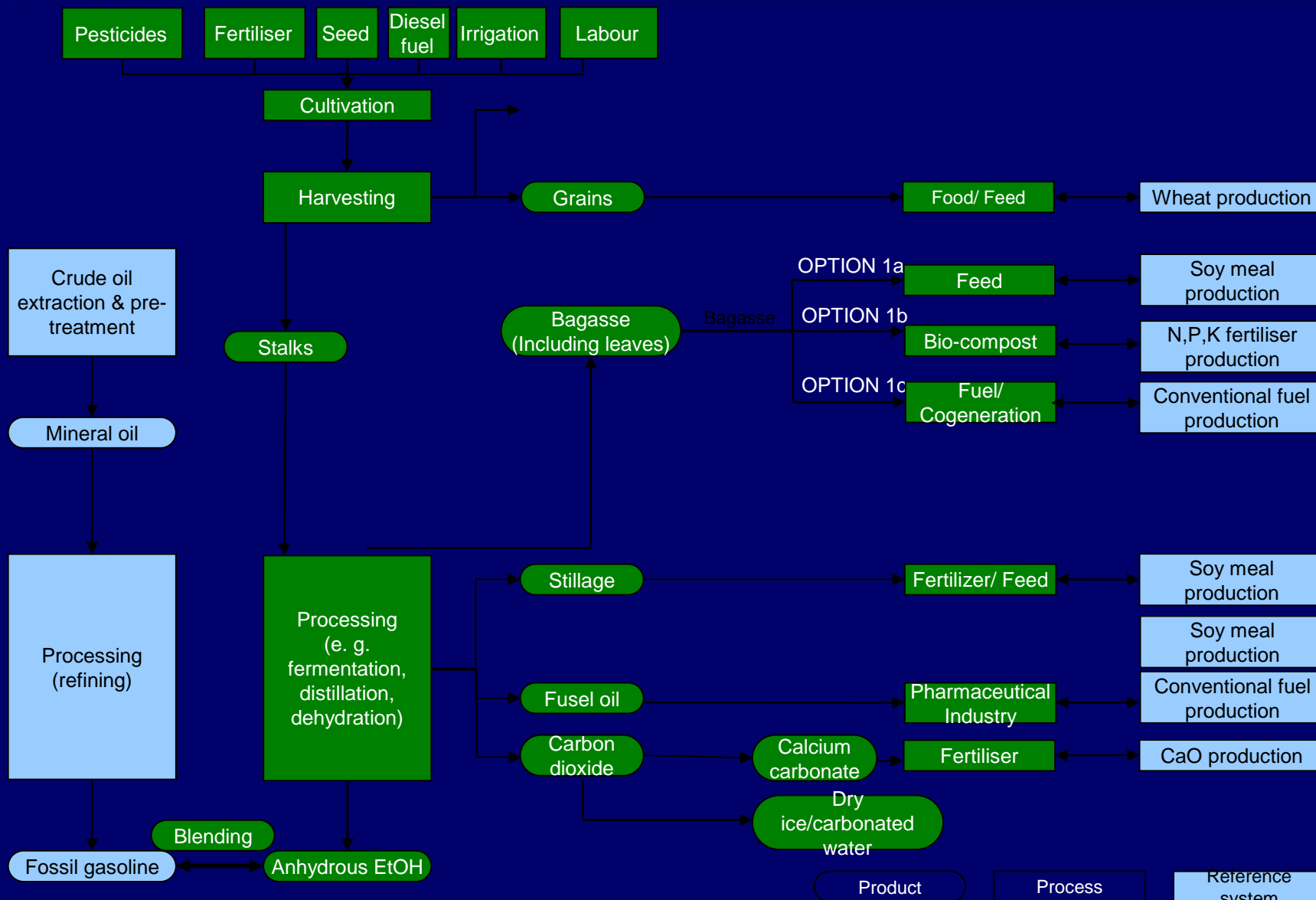
Scenario 2: Decentralised system in SAT areas





ICRISAT
Science with a human face

Scenario 1: Centralised system in SAT areas





ICRISAT

Science with a human face

Centralised Sweet sorghum distilleries in India- Rusni and TCL



Thank you

