

CGIAR Systemwide Livestock Programme Concept Note – Seed Grants 2006

Project title:

Feed production from sweet sorghum residues after extraction of juice for ethanol

Lead centre and address:

International Crops research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

Collaborating institutions (IARC, NARS, ARI, others) and address:

- i) ICRISAT-Agro Business Incubator
- ii) International Livestock Research Institute (ILRI), C/o. ICRISAT, Patancheru 502 324, Andhra Pradesh. India
- iii) Rusni Distillery Enterprise India and Uganda
- iv) JN Agri Tech International Ltd. Uganda
- v) Mariano Marcos State University (MMSU), 16 Quiling Sur, Batac 2906, Ilocos Norte, Philippines

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8. Dr Heraldo Layaoen, Mariano Marcos State University, 16, Quiling Sur, Batac 2906, Ilocos Norte, Philippines

Total cost of Project (SLP Funds, USD):

\$ 40,000.00

Anticipated Start Date and Duration of Project:

March 2007 start, duration 1 year

Background/Justification (Max.300 words)

Sweet sorghum (*Sorghum bicolor*) is well adapted to the Semi-Arid Tropics and one of the most efficient dry land crops to convert atmospheric CO₂ into sugar. This high efficiency sweet sorghum a most promising crop for biofuel production through ethanol (Reddy *et al* 2005). The partner institutions proposing this work have recently set up a pilot ethanol distillery (Rusni Distillery with its head quarters near Hyderabad, India) that can produce 40 000 liter of ethanol daily from the extraction of 800 tons of sweet sorghum stems. The sweet sorghum is supplied by small-scale farmers around the distillery which have been part of the enterprise from the beginning receiving information and training and getting access to improved cultivars. The sweet sorghum based ethanol technique as well as the approach to establish the distillery is being transferred through ICRISAT collaborative project to both the Philippines and Uganda.

A consistent interest of all distilleries is the possibility of using the leaf and sheath strippings and the residues (stillage) from the stems after extraction of juice for ethanol for livestock feed, since feed shortages are severe in all three countries. In preliminary work (ICRISAT 2004, Seetharama *et al* 2006), we investigated 25 fodder sorghum cultivars including sweet sorghum developed by ICRISAT and 37 cultivars (19 varieties and 18 hybrids) of sweet sorghum developed by the National Research Center for Sorghum (NRCS) and ICRISAT through conventional breeding methods, large genotypic variability for grain yields, stover yields, bagasse yields and potentially fodder yield (bagasse plus stripped stover leaves) and fodder nutritional quality were found. For example, bagasse plus leaf residues ranged from 4.5 to 8.1 t/ha (mean 6.6 t/ha) in the varieties and from 3.8 to 7.9 t/ha (mean 5.8 t/ha) in the hybrids. In the varieties *in vitro* digestibility ranged from 42 to 50.4 % (mean 46.6%) and in hybrids from 39.3 to 49.1% (mean 44.6%). Sorghum stover, the residue after harvest of grain - is intensively traded in India. The yearly mean stover prices ranges from 3 Indian Rupees per kg of dry residue (Blümmel and Parthasarathy, 2006).

To summarize, sweet sorghum whole plant utilization can be optimized by an improved choice of cultivars, extraction for ethanol and better utilization of residues for processing for fodder production.

Project purpose (Max. 200 words):

The project when developed and implemented will bring about the coordinated action of researchers (sorghum breeders, livestock nutritionists, and economists), production linkage institutions (Agro-Business Incubator) and entrepreneurs (ethanol distillers and feed industry) to optimize the whole plant utilization of sweet sorghum for food, biofuel and feed in India, the Philippines and Uganda.

Project outputs:

a) List the outputs that will be delivered by the project.

- i) Maps of demand-domains for sweet/forage sorghum with production emphasis for grain or ethanol or fodder in Asia (India and Philippines) and Africa (Uganda) made available
- ii) Inventory of sweet sorghum varieties and hybrids with productivity data pertaining to food (grain), ethanol productivity and fodder values in sweet sorghum bagasse and stover leaf residue developed.
- iii) Information on relationships between laboratory fodder quality traits of unprocessed and processed sweet sorghum bagasse and stover leaf residues and animal performance available.

- iv) Recommendations for appropriate processing and conversion of distillery residues into marketable feedstuff available
- v) A full detailed project document on Feed production from sweet sorghum residues after extraction of juice for ethanol developed

Financial Summary (Seed Grant - funds requested from the SLP, USD):

Table 1. Cost of the research grants (US\$ '000): Funds requested from SLP by the year			
Line item	ICRISAT - Patancheru	ILRI - Patancheru	Total
	Year 1	Year 1	
Personnel	5	4	9
Services	2	1	3
Supplies	1	1	2
General expenses	2	1	3
Workshops	2	2	4
Travel	4	4	8
Publications & Comm	2	2	4
Total	18	15	33
Indirect costs (@23%)	4	3	7
Grand Total	22	18	40

Matching funds to develop the proposal, if any (USD by source):

Table 2. Matching funds (US\$ '000): Funds requested from ICRISAT and ILRI by the year			
Line item	ICRISAT - Patancheru	ILRI - Patancheru	Total
	Year 1	Year 1	
Salaries	8	5	13
Services	4	3	7
Supplies	3	3	6
General expenses	3	2	5
Workshops	1	1	2
Publications & Comm	2	2	4
Total	21	16	37

Activities and milestones to develop the research proposal:

Activities	Milestones	Timeframe
Synthesis discussion paper from literature review, compilation of own research data and business plan and production statistics of Rusni Distillery in India, Philippines and Uganda	Discussion paper	Four month after funding
Dissemination of discussion paper to wider partners and other stakeholders and incorporation of their feed back into background	Background document for proposal workshop	Fifth and sixth month after funding

paper for proposal workshop		
Workshop	International workshop held and reported	In month seven after funding
Develop and circulate draft proposal	Proposal draft circulated	Eighth and ninth month after funding.
Make final full proposal ready for submission	Target funding agencies contacted and receive full proposal	Tenth months after funding

Project users and beneficiaries:

Users and beneficiaries are researchers who can better target the products (here sweet sorghum) that the sorghum growing smallholder farmers and industries require. Ethanol distillers and feed industry will also benefit from higher whole plant productivity of sweet sorghum. Livestock producers will benefit through increased supply of feed. Sorghum farmers will also benefit from the sales of stalks for ethanol industry, leaf/stillage residues to livestock producers/markets and the grain to food market chains. Thus the project not only contributes to improved livelihoods of the livestock and crop mixed farming community, but also helps sustain the environment and lead to the development and promotion of private-public partnerships.

Project location:

- a) Indicate the countries and agro-ecological zones in which the proposed project will be implemented.

The project will be implemented in India, the SAT environments of the Philippines and Uganda

- b) Explain the criteria to select countries and project sites.

These target countries have large SAT areas with erratic rainfall and temperatures suitable for cultivating sorghum and a lot of smallholder sorghum farmers are looking for expanded market opportunities for sorghum products. Many farmers also depend on livestock to augment their income and fodder is the major limiting factor to enhance livestock productivity and income from the livestock and crop mixed farming in these countries. Finally all three countries are already committed to ethanol distillation from sweet sorghum and these commitments are implemented by the proposed public-private coalition in all three countries.

Research approach and indicative research activities in relation to Outputs (Max. 300 words):

The project will build in, link and integrate ongoing activities in a) sweet sorghum breeding; b) distillation of ethanol from sweet sorghum; and c) improving the utilization of sorghum residues as livestock feed.

- Relationships between morphological, chemical and *in vitro* laboratory traits of unprocessed and processed (bricketed and pelleted) bagasse and stover leaf will be investigated in sweet sorghum cultivars currently used by Rusni Distillery, India, using the feed processing facilities of Sri Venkateshwara Veterinary University, Hyderabad, India and of ICRISAT-Agro-Business Incubator and ILRI animal experimental facilities at ICRISAT. Required inputs (power and machinery) into feed processing will be evaluated together with the feed quality assessments.

- Inventory of sweet sorghum varieties and hybrids will be drafted from searching within and pooling data from the National Research Center for Sorghum and ICRISAT and its associated Hybrid Seed Consortium. This inventory will be used for development of best bet options of sweet sorghum cultivars according to agro-ecological zones and likely demand priorities for grain, ethanol or fodder.
- GIS will be used for overlaying areas of potential sorghum production, existing and planned distilleries, livestock populations and feed demand to map demand-domains for sweet sorghum according to production emphasis that is the preferred traits for example grain or ethanol or fodder.

Scientific impact and International Public Goods expected from the project

(Max. 200 words):

Generally, energy generation from renewable resources is a global effort and proven and systematic approaches that can use dryland crops and at the time improved livelihoods in developing countries are an important IGP. The add-value-chain to sweet sorghum proposed here provides such a systematic approach. In addition the lessons learnt by our public-private coalition in implementing the work in three diverse countries will provide valuable experience for related value addition enterprises. This will lead to more private-public sector partnerships and increase the rate of the delivery of the research products to the farming community.

Expected impact on beneficiaries (poverty reduction, food security, environmental protection - Max. 250 words):

- a) State, preferably in quantitative terms, what development impact might be achieved in the short or medium term.

Each distillery has capacity of producing 40 000 litres of ethanol per day from about 25 ha of sorghum, i.e. pertaining to a total area of about 3000 h for a cycle of 100 days. This provides a tremendous market opportunity for small holder sorghum farmers. Sweet sorghum is a dryland rainfed crop (4000 m³) contrary to sugarcane which is also used for ethanol production but which requires heavy irrigation (36 000 m³).

- b) State what indicators will or can be used to demonstrate impact.

Impact assessment data will be collected on 1) increase in sweet sorghum area and number of growers, 2) feed production from sweet residues and feed sales and 3) overall profitability of sweet sorghum whole plant utilization for entrepreneurs and producers.

Scaling out strategy (Max. 150 words):

- a) Describe the strategy, processes and institutional alliances that can or will be used to upscale findings.

The public-private coalition of the researchers and entrepreneurs proposing this work is currently active (that is having established pilot sweet sorghum distilleries) in India, and Uganda. In addition, the coalition was already approached by the government of the Philippines for setting up pilot distilleries. There is therefore considerable dynamism in demand for adoption of sweet sorghum distillery technology using the research to production philosophy of ICRISAT and its farmer-centric Agro-Business Incubator. There exist, therefore, great scope for converting the findings and outputs of the proposed work into practical development outcomes leading to improved livelihoods, environment sustainability and private and public sector partnerships.

System wide nature of proposed project:

- a) State why this is a systemwide activity and why the SLP is the appropriate mechanism for collaboration and funding

In CGIAR science council priority 2D on ‘Genetic Enhancement of Selected Species to Increase Income Generation by the Poor’, one of the specific goals is to enhance the fodder/forage productivity through genetic manipulations to support mixed crop-livestock systems prevalent in the SAT India to provide options to diversify the farming systems to increase livelihood opportunities and their sustainability. Therefore, the project is a system wide activity as it addresses both the crop and livestock perspectives as evident from the work plans.

- b) State what inter-center and system synergies are expected

ICRISAT is vested with the objective of improving the livelihoods of the poor in SAT areas and therefore carries out research for development and impact. It believes strongly in improving the mixed crop livestock systems and tapping private sector strength for public research and impact. ICRISAT has already a close collaboration with ILRI on multidimensional crop improvement aimed at mitigating feed scarcity through better utilization of crop products. The work proposed here takes this inter-center collaboration a step further by addressing problems of value addition through potent and well-established public-private partnerships.

Contribution to CGIAR goals (Yes/No and if Yes, how). Refer to System Priorities for CGIAR Research 2005-2015, Science Council Secretariat, December 2005):

- a) Sustaining biodiversity: **Yes.** The outputs (improved products) are genetically variable and different from the available ones hither too and will add to diversified cropping opportunities
- b) More and better food through genetic improvement: **Yes.** Genetically improved sweet sorghum will increase be available
- c) Reducing rural poverty through agricultural diversification and high value commodities: **Yes.** Increased productivity means improved incomes and reduced poverty. These products help the farmers to have improved productivity of crop-livestock systems minimizing their vulnerability
- d) Policies and institutional innovations to support sustainable reduction of poverty and hunger: **Yes.** The project promotes new forms of public-private partnerships.

Further, it contributes to the millennium development goals—MDG 1 (livelihood increase), 7 (environment sustainability) and 8 (private and public partnerships/enterprises-globally and regionally)

Approximate cost of project that will be requested from funding agencies (USD '000):

Table 1. Cost of the research grant (US\$ '000): Funds requested from Donor

Line item	ICRISAT, Patancheru					ILRI, Patancheru					G Total
	Y 1	Y 2	Y 3	Y4	Total	Y 1	Y 2	Y 3	Y4	Total	
Salaries	70	73.5	77.2	81.0	301.7	75	78.8	82.7	86.8	323.3	625.0
Services	20	21.0	22.1	23.2	86.2	5	5.3	5.5	5.8	21.6	107.8
Supplies	30	31.5	33.1	34.7	129.3	15	15.8	16.5	17.4	64.7	194.0
General Expenses	35	36.8	38.6	40.5	150.9	25	26.3	27.6	28.9	107.8	258.6
Workshops	2	2.1	2.2	2.3	8.6	15	15.8	16.5	17.4	64.7	73.3

Training	2	2.1	2.2	2.3	8.6	15	15.8	16.5	17.4	64.7	73.3
Equipment	5	5.3	5.5	5.8	21.6	20	21.0	22.1	23.2	86.2	107.8
Travel	5	5.3	5.5	5.8	21.6	10	10.5	11.0	11.6	43.1	64.7
Publications & Comm	10	10.5	11.0	11.6	43.1	10	10.5	11.0	11.6	43.1	86.2
Total	179	188	197.3	207.21	771.5	190	199.5	209	219.9	818.9	1590.44
Indirect costs (23%)	41.2	43.2	45.4	47.7	177.4	43.7	45.9	48.2	50.6	188.4	365.8
Total	220.2	231.2	242.7	254.9	949.0	233.7	245.4	257.7	270.5	1007.3	1956.2

Approximate research matching funds from partner institutions (USD'000):

Table 2. Matching funds (US\$ '000): Funds requested from ICRISAT and ILRI by the year

Line item	ICRISAT, Patancheru					ILRI, Patancheru					G Total
	Y 1	Y 2	Y 3	Y4	Total	Y 1	Y 2	Y 3	Y4	Total	
Salaries	24.5	25.7	27.0	28.4	105.6	24.5	25.7	27.0	28.4	105.6	211.2
Services	20	21.0	22.1	23.2	86.2	10	10.5	11.0	11.6	43.1	129.3
Supplies	3	3.2	3.3	3.5	12.9	3	3.2	3.3	3.5	12.9	25.9
General Expenses	5	5.3	5.5	5.8	21.6	5	5.3	5.5	5.8	21.6	43.1
Workshops	2	2.1	2.2	2.3	8.6	2	2.1	2.2	2.3	8.6	17.2
Training	2	2.1	2.2	2.3	8.6	2	2.1	2.2	2.3	8.6	17.2
Publications & Communications	3	3.2	3.3	3.5	12.9	3	3.2	3.3	3.5	12.9	25.9
Travel	1	1.1	1.1	1.2	4.3	1	1.1	1.1	1.2	4.3	8.6
Total	60.5	63.53	66.7	70.036	260.8	50.5	53.03	55.7	58.46	217.7	478.4

Funding strategy:

a) Indicate which major funding agency is being targeted by the seed money period and the amount of funds sought per source.

- i) IFAD
- ii) Melinda and Bill Gates Foundation

b) Indicate if official contact with these agencies has been initiated and the outcome of this contact, if any.

We are already in touch with both organizations.

c) Explain why this proposed Concept Note has a good chance of success in being turned into a major project proposal.

This concept note is a very good example of successful inter-center public-private partnerships where value addition in an important crop – sweet sorghum – can be even further increased by converting residues from ethanol distillation into transportable and tradable feedstuffs. The final project will address three developmental issues that are important to donors: a) improving profitability in dry land crops, b) opportunities for production of renewable energy and c) mitigation of feed shortages to improve livestock productivity. The final project will convincingly address these issues in Asia and Africa and should therefore be very attractive to donors.

Specific capabilities of partner institutions and key staff (Max.300 words):

1. Belum VS Reddy, Principal Scientist, ICRISAT: Has the expertise in conventional sorghum breeding procedures and phenotyping. The location where he works has good

facilities and qualified supporting staff for phenotyping and conventional breeding. ICRISAT is well known to receive funding support to the projects targeted to small holders farmers` livelihoods improvement.

2. Michael Blümmel, Principal Scientist, ILRI animal nutritionist with extensive experience in food-feed aspects of crops and feeding systems.
3. P Parthasarathy Rao, Principal Scientist, ICRISAT: Has the expertise in socioeconomics and marketing. The location has excellent support staff and good computing facility
4. A Ashok Kumar, Scientist (Sorghum breeding), ICRISAT has the expertise in conventional breeding procedures and phenotyping. The location where he works has good facilities and qualified supporting staff for phenotyping and conventional breeding.
5. Mr S.M. Karuppanchetty, Deputy Chief Operating Officer, Agri Business Incubator, ICRISAT has expertise in building production linkages and enterprises.
6. Mr A R Palaniswamy, Rusni Distilleries, Hyderabad has expertise in sweet sorghum based ethanol technology and erection of the distillery units
7. Dr Venku Reddy, JN Agri Tech International Ltd., Kampala, Uganda has experience in organizing the farmers and seed production on a commercial scale
8. Dr Heraldo Layaoen, Mariano Marcos State University, 16,Quiling Sur, Batac 2906, Ilocos Norte, Philippines is an experienced plant scientist and has gained experience in sweet sorghum crop cultivation and ethanol technology

References:

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