A project scoping document to SRDC on Harvesting R, D & E.

Project Title: Future Harvest

Background

Mechanical harvesting of sugarcane has been a major success story for the Australian sugar industry. However, the Australian sugarcane industry has suffered a plateau in productivity (Wilson and Leslie 1997) and there is considerable evidence that mechanisation is a component of this plateau in performance.

SRDC has provided significant investment in harvester technology and harvesting operations. This research has been fragmented and has not been carried out within the context of the supply chain or a farming system framework. However, this research has clearly shown the magnitude of harvesting losses and their ultimate effect on productivity is clearly associated with the harvesting system.

Current industry issues of sucrose losses, cane supply quality, alternative farming systems with wider row spacings (1.83–2.0 m) and regional differences in end product requirements (e.g. burnt cane, green cane, whole-of-crop) have further highlighted the limitations with current harvester designs.

These challenges and opportunities have renewed interest at a grower and regional level for improved harvester designs and harvesting practices integrated into a farming systems and supply chain context. SRDC continues to receive requests from industry to support harvester research and development.

New challenges:
The recent review of opportunities to improve the performance of sugarcane harvesters by Davis et al. (2010) highlighted the harvesting issues confronting industry and the rationale for future industry funded harvesting R&D.

There are three major issues facing the Australian sugar industry that will lead to significant changes in harvester design and harvesting systems.

1. new farming systems, adopting wider row spacings and precision farming technologies
2. the cost of harvesting has a major impact on industry productivity
3. the need to reduce environmental impact from harvesting

Each mill area needs a clear vision regarding the purpose of the machine, and the consequent design constraints, to allow targeted investment. For example, machine requirements are different for burnt cane compared with green cane and whole-of-crop harvesting.

A good example of this is the Burdekin region where there is increasing pressure to adopt green cane harvesting and, as such, there will be significant agronomic (e.g. trash residue) and machine (harvesting large crops green, trash separation, reduced bulk density from burnt cane, sugar losses etc) implications associated with this transition. Similarly, NSW is the only area currently committed to whole-of-crop harvesting and there are a number of significant harvesting sector issues which are currently being addressed with SRDC investment.

It is imperative for industry profitability that there is a program of industry support aimed at improved machine performance and harvesting best practice (HBP). In principle, this is due to a number of pending factors. Manufacturers of harvester machines believe the worldwide market for 'chopped cane' sugarcane harvesters to be small, relative to the market for 'mainstream products'. The Australian sugarcane harvester market is very small in comparison with other countries. The Brazilian market, for example, now approaches 1000 machines per year—there were only 9 machines sold into Australia in 2009. Manufacturers, however see the Australian Industry as the world leader in machine performance research, due in no small part to the investment by SRDC and BSES.

John Deere have stated that they have ceased investing in product engineering for trash separation and reduced losses, as the principal markets for machines are in Brazil, which is moving towards whole-of-crop harvesting. It is also known that CNH are focusing on low emission engines and improved cabin controls rather than trash separation.

However, in Australia, trash separation during harvesting is a key requirement in regions from Maryborough to Mossman as the trash residue has significant agronomic value when left in the field. NSW is the only area currently committed to whole-of-crop harvesting and there are a number of important harvesting sector issues which need to be addressed in this system.

Capacity Building:

Davis et al. (2010) also highlighted the decline in industry capacity in harvesting R, D & E. Partnerships in the harvesting sector to enhance learning, undertake change and promote innovation between researchers, extension and industry people, is a core industry requirement. These partnerships will allow the industry to make informed choices on the uptake of new harvesting technology and best practice operation in a variety of farming systems and supply chains.

Machine Testing:

In 1986, the ISSCT released protocols for mechanical cane harvester performance testing. In the late 1990's, a new technique for estimating mass (cane and sugar) loss based on mass balance principles was implemented by Australian researchers. In 2000, SRDC commissioned

BSES Limited and the National Centre for Engineering in Agriculture (NCEA) to review harvester performance analysis systems and refine the 1986 ISSCT protocols.

In the process of developing the performance testing protocol for sugarcane harvesters, the need for an independent review of the literature regarding sugarcane loss measurement became apparent. This review was commissioned by SRDC to concentrate on the methodology of testing. As such, the performance testing protocols were never completed. However, it was demonstrated that the loss process is shown to be complex and the subject is one where the statistical issues surrounding engineering investigation are complex. Great care needs to be taken in trial procedures and analysis to ensure the validity of results (Brotherton 2002).

The review by Brotherton (2002) highlighted major problems with adopted methodologies. There is now a need to develop standardised harvester validation and verification techniques. These standardised techniques would provide a baseline against which future assessments are made. Investigations such as machine comparisons and validating new components/systems across regions, avoid duplication of trials at both a research and/or operational level. The protocols will need to be ratified by the ISSCT Agricultural Engineering & Agronomy Sub-Committee to achieve international status.

Recommended approaches:
In the SRDC review, Davis et al. (2010) suggested that there be a program of industry investment aimed at; improved machine performance, reduction of harvest losses and uptake of harvesting best practice (HBP) across the diversity of supply chains within the industry. The rationale for this is as follows:

1. it is unlikely that large sums will be invested by harvester manufacturers in new technology and in particular, for Australian requirements
2. the interface between the machine, the agronomic system and the end product desired by millers, will be unique to Australian conditions, and
3. overseas research is unlikely to answer the questions facing the Australian industry.

A number of factors therefore make this project a high priority for industry:

- harvesting is the major cost in sugar cane growing
- losses from harvesting impact directly on farm profitability, production potential and industry competitiveness
- environmental challenges due to sucrose loss from inefficient harvesting need to be addressed, and
- it is unlikely that adequate investment will occur from harvester manufacturers in technology relevant to Australian conditions.

Future Harvest will conduct a research, development and extension program to address productivity, supply chain and environmental issues of the industry. It centres on the SRDC target areas of reducing harvesting

costs, improving the utilisation of capital and other harvesting resources, delivering market based cane products to millers, and reducing the environmental impacts of harvesting systems.

Objectives:

Based on previous reviews, there are three main objectives in this project.

1. Research aimed at finding machine-based solutions to harvest losses

2. Development of regional R, D and E strategies for harvesting best practice

3. Capacity building for key advisors and leading farmers in the harvesting sector

Project Plan:

The project has some innovative principles based on learnings from previous industry funded projects that include:

- Integration of harvester research and development with key agronomic and soil health issues
- Employment of a supply-chain partnership methodology to develop best practice management for different regions, and
- Co-investment from a key harvester manufacturer to ensure uptake of research work into modified harvester designs.

The project plan revolves around two main themes and their outputs:

Theme One: Harvester Research and Development

- define losses in current machine designs,
- develop standardised protocols for measuring machine performance, and
- develop regional solutions to harvest operations relevant to mill requirements in each region.

Theme Two: Building Industry Capacity

- **build** machine and harvesting knowledge based on the interaction of machine operations, with agronomic practice and farming systems,
- **target audiences will be contractors, extension personnel and leading farmers**

Theme One: Harvester Research and Development

Module One: Revised guidelines for standardised harvester performance validation and verification.

The work in this module will include:

- A review of current harvester testing protocols, both in Australia and overseas.

- Develop and gain agreement on guidelines for standardised testing and reporting of harvester performance, including a 'Code of Practice' for undertaking harvester performance verification and validation studies in line with international protocols.
- Disseminate these new guidelines throughout relevant sectors of the industry, both in Australia and overseas for comment and review.

Module Two: To develop and research regional strategies for harvesting best practice

The specific objectives are to:

- Find synergies between regional harvesting best practice issues and assess the practical implications of their roll out across the sugar industry.
- Work collaboratively with existing R&D projects, wherever possible, to avoid duplication of effort and to learn from experience already gained by existing projects.
- Document implementation issues from a regional perspective.
- Build organisational capability and provide assistance to regional industry groups.
- Investigate regional harvesting best practice issues.

One regional key issue has already been identified for immediate funding consideration and is outlined below.

Regional Issue: Impact on Harvesting Best Practice on the transition from burnt to green cane harvesting in the Burdekin Region

The main objective is to directly compare burnt cane and green cane harvesting systems in the Burdekin, with respect to determining the impact on HBP. There are a number of key issues created by a move from burnt to green cane harvesting. These include

- Reduced delivery rate
- Increased cane losses
- Increased harvesting costs
- Increased harvesting fleet and haulout fleet size needed
- Reduced bin weights
- Increased rail fleet
- Difficulties with trash retention on some soils (similar to NSW issues)
- Flood irrigation problems within a green cane trash blanket system
- Milling issues dealing with a higher fibre load

An experimental program will be established to investigate burnt vs green cane harvesting and assess the above issues from a whole-of-system perspective.

This research program will involve undertaking a series of harvester trials. Within each trial, different combinations of harvester ground speed, different

pour rates, primary extractor fan speeds, billet length setting (to increase bin weight) will be tested. Their impact on delivery rates and harvesting costs will be quantified.

Specific objectives are:
1. Demonstrate that a green cane harvesting system is a viable option within the Burdekin
2. Provide a pathway for implementing green cane harvesting and trash blanketing
3. Increase the ability of growers to undertake on-farm evaluations of green cane trash blanket farming systems

Theme Two: Building Industry Capacity

Module one: Training of harvesting system knowledge providers

This module is specifically targeted at industry technical personnel involved with daily coordination of harvesting operations and service providers (extension officers, productivity officers, etc**)** rather than harvesting operators and growers, per se. The objective of this module is to increase knowledge of service providers who can pass this information on to harvesting operators and growers as well as provide direct input to the design of regional issue studies in Theme One, Module Two.

The work in this module will consist of the following activities:

- Facilitated workshops across five regions in QLD.
- Machine operation and machine/crop interaction.
- The interface between machines and farming systems.
- Practical training with machines on farm to teach attendees machine setup & operating, limitations and performance
- Updates on the latest research on harvesting systems research.
- Facilitated discussion with attendees on:
    - ways to reduce cane and sucrose losses
    - dealing with the issues of time, cane feed rates, harvest quantity and quality
- The workshops will build joint knowledge on:
    - Machine operation and machine/crop interaction.
    - The interaction between machine and farming system
    - Ways to deal with optimisation of harvest performance for different sectors of the supply chain.
    - Ways to reduce cane and sucrose losses

Timelines:

Suggested timelines for work in this project is as follows. Milestone report dates have not been included but would be by negotiation with SRDC. They could correspond with key decision times relating to design of harvester trials, workshop design and location, and review of workshops outcomes.

The outcomes from the regional training workshops in March- April 2011 will guide the design of harvester experiments in 2011 and beyond.

2010-11

Month	What task	Who	Where
July	Contract signed	SRDC-FSA Consulting	Brisbane
August	Team meeting	Key personnel	Toowoomba
Sept- Dec	Testing protocols developed – theme one, module one. Seek and employ NCEA Ag. Engineer	Rod Davis, NCEA	Desktop
Dec-Feb	Prepare for regional training workshops	Davis, Garside, Jensen, Davison, John Deere	Desktop
Mar-Apr	Deliver workshops – target contractors, extension personnel	Davis, Garside, Jensen, Davison, John Deere	5 workshops in agreement with SRDC
Feb - June	Prepare for harvester trials	Davis, NCEA - New Engineer	Toowoomba Burdekin

2011-12

Month	What	Who	Where
July - Sept	Harvester experiments	FSA Consulting/NCEA/John Deere	Burdekin
Sept- Dec	Analyse trial results	FSA Consulting/NCEA	Toowoomba
Sept - Jan	Prepare for workshops	Garside, Jensen, Davis, Davison	Desk top
Feb- April	Deliver capacity building workshops – target – leading farmers and extension personnel	Garside, Jensen, Davis, Davison, New Engineer.	5 regional workshops
Feb- June	Prepare for harvester trials	Davis, NCEA	Toowoomba

2012-13

Month	What	Who	Where
July - Sept	Harvester experiments	FSA Consulting/NCEA/John Deere	To be decided
Sept- Dec	Analyse trial results	FSA Consulting/NCEA	Toowoomba
Sept - Jan	Prepare for workshops	Garside, Jensen, Davis, Davison	Desk top
Feb- April	Deliver results of experimental program and HBP to contractors, leading farmers, and extension personnel	Garside, Jensen, Davis, Davison, New Engineer.	5 regional workshops
May - June	Prepare final report	FSA Consulting	Toowoomba

IP

The project will be using intellectual property that is owned by SRDC from previous studies funded by SRDC. New information gained through this project will become the property of SRDC.

Personnel

Future Harvest integrates harvester research and development with key agronomic and soil health issues. Hence, a multidisciplinary team has been formed with experts in relevant areas. Dr Alan Garside will bring extensive farming system experience to the project and Dr Troy Jensen from NCEA will provide linkages to Precision Agriculture. The employment of an agricultural engineer will provide industry with an additional human resource for this arena.

We are committed to a multi-disciplinary approach to dealing with raising the productivity of harvesting operations in Australia. So in our workshops with industry technical and extension personnel we will deal with the interaction of harvesting operations with the farming system, agronomic considerations, impacts on soil health and precision farming techniques.

Project Coordinator: Dr Tom Davison (FSA Consulting)

Theme One:
Leader: Rod Davis (FSA Consulting)
Team members: Agricultural Engineer (NCEA), Chris Norris (Expert review provided in-kind)

Theme Two
Leader: Dr Tom Davison (FSA Consulting)
Team members: Dr Alan Garside (Consultant), Dr Troy Jensen (NCEA), Rod Davis (FSA Consulting).

To build industry capacity in the harvesting arena, the project will appoint an agricultural engineer to develop, coordinate and conduct the R&D program. This Research Officer will:

- Establish the program of trials to investigate the respective regional strategies for harvesting best practice.
- Coordinate and undertake the trial program.
- Provide data collation and review of progress after the first R&D harvest season.

The research officer would be initially be located at the NCEA under the supervision of Rod Davis, Erik Schmidt and Craig Baillie. After an initial training period the officer would be located in a regional area.

Experience and background of key personnel:
Dr Tom Davison, FSA Consulting.

- Extensive experience in large project management with the Qld Department of Primary Industries, Dairy Australia, LWA, MLA and RIRDC.
- Knowledge of extension methodology and facilitation skills in national projects
- National coordinator of the Healthy Soils program with Land and Water Australia
- Extensive scientific publication record.

Rod Davis, Senior Agricultural Engineer, FSA Consulting.

- Work experience with BSES, FSA Consulting as a research engineer and consultant
- Expertise and track record over 10 years in sugarcane harvester and machine component R&D.
- Established reputation and publication record in both scientific literature and industry.

Dr Alan Garside (Consultant)

- Former Team Leader (Sugar Yield Decline Joint Venture).
- 20 years experience in sugarcane farming systems research
- Extensive publication record

Dr Troy Jensen, Senior Agricultural Engineer (National Centre for Engineering in Agriculture)

- 21 years R&D experience in applying engineering technologies to agriculture.
- USQ Lecturer in Precision and Smart Technologies in Agriculture.
- Extensive experience in yield and quality monitoring in grain
- Currently evaluating sugar yield monitors on the SRDC project CSE022

Research Officer (Agricultural Engineer)

- Responsibility for day to day activities directed through the project leader.
- Skills in machinery modifications and sugar cane harvesting and working closely with harvester operators and farmers to develop solutions to harvesting best practice

Budget

This budget represents costs requested of SRDC. The project will also seek funding support (a combination of cash and in-kind) from John Deere, who have indicated support for this work.

Theme One:

Salaries – All costs exclusive of GST
Salaries include time input by project personnel and take account of NCEA and the agricultural engineer's input into the project. Note, Chris Norris will provide time as in-kind.

Person	**2010-2011**	**2011-2012**	**2012-2013**	***Total***
Rod Davis	55,500	33,250	25,000	113,750
Agricultural Engineer (NCEA)	15,000	32,000	34,000	81,000

Operating - All costs exclusive of GST
Allowance has been made for support staff salaries, trial consumables and vehicle costs for conducting trials. Travel includes an annual project team meeting in Brisbane.

Item	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
Printing	750	250	250	1,250
Travel and accommodation*	3,000	12,000	12,000	27,000
Trial Program Consumables**	na	30,000	30,000	60,000

* Includes vehicle hire for trials
** Includes casual labour

Summary - All costs exclusive of GST

Item	**2010-2011**	**2011-2012**	**2012-2013**	Total
Salaries	70,500	65,250	59,000	194,750
Operating	3,750	42,250	42,250	88,250
Total	74,250	107,500	101,250	283,000

Theme Two:

Salaries - All costs exclusive of GST
Salaries include time inputs by project personnel and take account of NCEA input to the project.

Person	2010-11	2011-12	2012-13	Total
FSA Consulting*	45,000	26,000	20,000	91,000
Alan Garside	15,000	5,000	5,000	25,000
NCEA**	12,000	6,000	6,000	24,000
Total	72,000	37,000	31,000	140,000

* Tom Davison and Rod Davis
** Troy Jensen

Operating - All costs exclusive of GST
Operating costs include printing of workshop notes, venue hire and lunch costs for workshops. Allowance has been made for a return air travel and accommodation for Alan Garside, Rod Davis, Tom Davison and Troy Jensen to attend five regional workshops from their respective bases during the project. Travel for team members to an annual team meeting in Brisbane..

Item	2010-11	2011-12	2012-13	Total
Printing	1,000	500	500	2,000
Travel and accommodation	10,000	4,000	4,000	18,000
Venue costs	1,500	500	500	2,500
Total	12,500	5,000	5,000	22,500

Summary - All costs exclusive of GST

Item	2010-2011	2011-2012	2012-2013	Total
Salaries	72,000	37,000	31,000	140,000
Operating	12,500	5,000	5,000	22,500
Total	84,500	42,000	36,000	162,500

Overall Budget Costs - All costs exclusive of GST

	2010-2011	**2011-2012**	**2012-2013**	Total
Theme One	74,500	107,250	101,250	283,000
Theme Two	84,500	42,000	36,000	162,500
Total	159,000	149,250	137,250	445,500

References:

Brotherton, GA, 2002, Harvester Performance Testing - Literature Review: Loss Measurement in Sugarcane Harvesting. Bureau of Sugar Experiment Stations Publication CD02008, Brisbane, Australia.

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