

ALBERTA CROP INDUSTRY DEVELOPMENT FUND

Strategic Research Priorities for the Environment and Nutrient Management Initiative

Focussed Discussion Workshop

SUMMARY REPORT

Facilitated by

Marilyn Steers



Convening Strategic Conversations

Box 1707, Jasper, AB TOE 1E0

Telephone: 780 487 5139

780 852 3969 (Jasper)

marilyn@kaleidoscopeconsulting.ca

www.kaleidoscopeconsulting.ca

JUNE 14, 2005

TABLE OF CONTENTS

Introduction and Contexting	1
The Focus Discussion Process	2
The Exploration Questions	2
Discussion Synopsis	3
Key Messages	3
Discussion of the Exploratory Questions.....	4
Research and Development Priorities	6
Conclusion	10
Appendix 1	i
Participants	i
Appendix 2	ii
Poster Questions	ii
What R&D needs to be done? (Worksheet data before grouping).....	v

INTRODUCTION AND CONTEXTING

The Alberta Crop Industry Development Fund (ACIDF) is an independent, not-for-profit company operating under the direction of the Alberta crop industry through a memorandum of understanding between fourteen diverse crop industry organizations. The fund is managed by five elected crop industry representatives. ACIDF funds and supports selected crop related industry development activities including market development, research, and extension.

In June 2005, ACIDF signed a new funding agreement with Alberta Agriculture Food and Rural Development (AAFRD) which will provide \$23,000,000 over the next five years. This money must be invested in meaningful activities generating measurable outcomes before March 31, 2010 for complete disbursement by March 31, 2012.

The new funding agreement defines three crop initiative areas with defined scope for each one:

1. Feed grain quality and supply
2. Environment and nutrient management
3. Bio-products

The environment and nutrient management initiative has been allocated \$8,000,000 with the direction of supporting worthy world-class research and development (R&D) programs and projects that will:

- Develop new technologies that:
 - harvest value from animal input and manure streams before they can impact the environment,
 - optimize nutrient availability and utilization at the animal level and direct them to salable products, and
 - reduce nutrient excretion and gas emissions by domestic livestock
- Reduce the environmental impacts of land application of nutrients in manure by developing technologies to capture nutrients and make them available to crop-based production

Performance measures for the environment and nutrient management initiative are:

Measure	Target				
	2005/6	2006/7	2007/8	2008/9	2009/10
New procedures and products developed and available to industry		2	4	4	4
Adoption of technology (technology transfer events)	1	2	3	3	3

ACIDF's Board has the responsibility of making the funding decisions. However, they operate on the basis that those charged with making the investment decisions need the best possible information. One part of that information is input from the industry and the research community.

On June 14, 2005, twenty-two invited value-chain representatives from agriculture and food industry convened to identify R&D priorities for the environment and nutrient management initiative (see Appendix 1 for Participant List).

This workshop brought together a range of perspectives, insights, experience and knowledge with the goal of creating a comprehensive understanding of the needs, and subsequently, the R&D priorities that would respond to the environment and nutrient management initiative, and moreover provide results for the defined outcomes. The ACIDF Board, AAFRD, Alberta Agricultural Research Institute (AARI) and likely other funding consortium members will use the results to inform their decision process.

THE FOCUS DISCUSSION PROCESS

The driving question for the workshop was, "What R&D needs to be done to achieve the stated outcomes and performance measures?"

Rather than brainstorming ideas for R&D project and programs, participants addressed eight questions (listed below) in their discussion process. The discussion and the responses resulted in a strategic approach to identifying R&D priorities.

The Exploration Questions

1. What is already happening in the area of environment and nutrient management R&D that can be built upon?
2. Who are the major players in environment and nutrient management R&D?
3. Where are there leveraging opportunities for new environment and nutrient management R&D?
4. What is the most pressing issue that needs to be addressed in environment and nutrient management? Why is it pressing?
5. What needs to happen to create momentum in environment and nutrient management R&D and achieving the outcomes?
6. What are the barriers that need to be addressed to achieve the outcomes and measures in the environment and nutrient management initiative?
7. The most significant opportunity in the environment and nutrient management initiative is?
8. What outcomes can realistically be achieved in the next five years?

DISCUSSION SYNOPSIS

Key Messages

Throughout the discussion a number of consistent themes emerged and became key messages for ACIDF:

- 1. There is a need for an overarching long-term vision for environment and nutrient management in Alberta which is lead by the industry**
There is a feeling the area of manure management is perceived as an issue that needs to be addressed or dealt with as opposed to an area of opportunity. An industry driven vision that speaks to nutrient management and environmental stewardship management practices would be beneficial.
- 2. An R&D life cycle system approach to support management systems which balance nutrient requirements for soil/crop/animal interface**
There was a clear message this initiative is not only about manure management but about the interface between soils, crops, and animals (and some would suggest water). R&D in all of these areas, and balancing the effect of them upon each other, is essential to addressing the issue. This will require collaboration between crop/feed grains and livestock industry.
- 3. The need for efficacy (effectiveness, usefulness, worth, value and efficiency) of R&D**
A challenge cited several times was that R&D, and the technologies and/or products generated had to be realistically affordable by the industry—both crop and livestock. Industry participants stressed that results of any R&D work had to have a direct benefit to and be a practical, affordable application in their operations. Technologies that created a standard or a system that made production cost prohibitive must be avoided.
- 4. Beneficial Management Practices (BMPs)**
The discussion on BMPs ranged from understanding them in the adoption of technology and utilization of improved feed grains to understanding which management practices would have the most significant effect on efficiency. The cost/benefit factor was raised many times as was the inability for producers to implement every BMP identified. The computer modeling technology available provides potential for producers to gain this required knowledge. Education and extension are key components to the effectiveness of BMPs.

Discussion of the Exploratory Questions

Response to the exploratory questions was the tool used to trigger ideas about the R&D required to provide the required outcomes in the environment and nutrient management initiative. In summary:

1. Identifying what is already happening, the major R&D players and leveraging opportunities

Of the three focus areas in the ACIDF R&D funding program, environment and nutrient management definitely had the majority of R&D programs and projects being currently addressed. The current R&D with the potential to be built upon includes:

- Spreading manure on the land—best manure practices
- More efficient water utilization by animals therefore less manure to deal with
- Phosphorous in soil and run off—phosphorous limits project
- Phosphorous recovery
- Diet manipulation
- Feed evaluation
- Life cycle assessment
- Composting
- Gasification
- Antibiotic resistance
- Selection of efficient animals resulting in less manure production
- The work of the funding consortium
- ICM
- IFASA
- Manure composition
- Water quality assessment—AESAWater quality program
- Biodigesters
- Liquid manure injection
- Methane capture (lagoon covers)
- Methane mitigation
- Plant genetics

Because of the scope of basic and applied research, the list of major players and leveraging opportunities was exhaustive and included basically all research performers in the province. The range of existing research work also underlined the need for ACIDF to focus and set clear priorities in its R&D investments.

The concept of capitalizing on leveraging opportunities is consistent with all ACIDF programs. Researchers are expected to find leveraging opportunities at a minimum ratio of 3:1. The key will be to leverage R&D programs that will achieve the specific outcomes of this initiative. Some leveraging opportunities listed were coordination with animal breeding programs, AAFRD technology transfer, watershed groups for watershed evaluation and BMPs, collaborations (European Union, US, Far East), the Rural Development strategy, and carbon credit aggregations.

2. Pressing Issues

Tracking nutrient flows and understanding and balancing the soil/water/plant/animal nutrient interface were identified as key issues. As well the need for development and adoption of technologies to reduce the cost of transporting manure, biodigesters, and developing ways to inject solid manure to reduce run-off were listed. Finally understanding the economic and social impact and benefit of BMPs was identified.

3. Creating momentum toward achieving the outcomes

A “compelling reason for change” was identified as a trigger for creating momentum for the development and adoption of new technologies to reduce the environmental impact and to optimize the nutrient benefit of manure.

The compelling reasons identified ranged from incentives which create demand/reward/recognition for environmental stewardship to a comprehensive system analysis to show cost/benefit (economic, environmental, and social).of BMPs.

Industry awareness and practical solutions were other factors that would determine momentum.

4. Barriers

Reluctant or slow industry adoption of technology due to lack of awareness, cost/benefit or understanding the systemic value was seen as a major barrier achieving the R&D outcomes of this focus area. The cost of transporting manure and human resources were also identified as outcomes barriers.

The barriers could be addressed through:

- Education, extension to facilitate technical transfer
- Adaptation of national or global technologies to the Alberta environment
- Increased cooperation and coordination through a systems approach and addressing the full research and development continuum
- Support for policies and incentives to support change in practice

5. The most significant opportunities

Because of the amount of R&D focused on environment and nutrient management, the group had a significant number of suggestions for opportunities that related directly to what is already happening. The opportunities identified included:

- To create/develop/find a crop that has a nutrient profile that more closely meets the nutrient requirements of animals
- Manure replacing commercial fertilizer
- Value added products from manure
- Energy recovery from manure (reduce emissions, energy offset, cashflow and nutrient stabilization)
- BMPs and cost/benefit analysis on production-system scale
- Solid manure injection
- Exporting manure nutrients to deficient soils
- Biofuel
- Composting on a larger scale

6. What is achievable in the next five years?

- Create the collaborative relationships that move the agenda forward
- BMP implementation—focus and conduct cost/benefit analysis to promote adoption

- Identification of local (Alberta) nutrient values for alternate feed stuffs and manure
- Quantify greenhouse gas emissions associated with different manure management technologies
- Changing feeding practices at feedlot/producer level
- Technologies to increase adoption of composting by 40 – 60%
- Technology for injection of solid manure into soil
- Significant reduction of environmental phosphorous load (5% - 50%)
- Harvest value from animal input (energy plus nutrient capture)

Research and Development Priorities

Participants developed and ranked the following R&D priorities as being the most important steps in achieving the outcomes identified in the environment and nutrient management initiative.

The group identified seven R&D priorities, some of which intersect or overlap each other and all of which fall under the umbrella of a life cycle systems approach. Some priorities speak to very specific issues facing manure management and could leverage work already being done by some workshop participants.

Priority One: BMP validation and implementation

The key message relating to this priority is there are an abundance of BMPs which producers could utilize to improve their operation with regards to nutrient management and utilization. The dilemma is about understanding which ones would provide the greatest benefit, be most cost effective and would complement rather than impact other BMPs.

R&D ideas:

- Develop and test BMPs on a watershed scale to assess the impacts on water quality to achieve better water quality and address environmental impacts
- A program to evaluate BMP effectiveness in improving surface water quality resulting in reduced environmental impact
- Get Alberta validation for BMPs found globally for manure application/manure processing to reduce the impacts of manure application
- A program to determine cost efficacy, applicability of nutrient BMPs to Alberta conditions
- Develop a program to implement advances at the farm level
- Find five practices not being done here and try them

Measures, outcomes, activities

- Collaborate with Old Man Watershed Council BMP team
- Apply BMPs at a watershed scale and determine if there is impact at watershed and farm level

- Validating whether individual BMP have impact
- Which BMPs have the best cost/benefit, practicality, effectiveness
- Life cycle assessment of BMP implementation
- Modelling of outcomes of the BMP—computer modeling of impacts

Investment \$20 X 7 \$10 X 2 \$5 X 1 **Total: \$165**

Priority Two: Life cycles systems approach to manure management

The life cycle systems approach was a strong theme throughout the discussion process and seen as the key to reducing the environmental impacts and the nutrient benefits of manure.

R&D ideas

- Provide information on relationships between sources and outputs of nutrients from manure in the environment
- Life cycle assessment of nutrient management BMPs including impact on nutrient flows in production systems resulting in decision support tools that can reduce the environmental impact
- Coordinated group to draw information and team together

Measures, outcomes, activities

- Look at the work being done globally. (computer modeling)
- Adapt an existing model or application to Alberta livestock and crops
- Fill in the research/data gaps to life cycle systems approach identified
- Use the systems approach to identify the relationships of different components—relating each piece of the puzzle.
- Use simple nutrient budgets to find out deficits or surplus across agro-ecosystems
- Deliver a decision support tool producers can use in their management strategy

Investment: \$20 X 2 \$10 X 6 \$5 X 3 **Total: \$115**

Priority Three: Optimize Nutrient utilization in animal/soil/plant systems interface

This priority could well be designated as a subset of the life cycle systems approach but participants identified a number of specific R&D that related to the initiative outcomes.

R&D ideas

- Optimize feed/forage utilization in livestock resulting in reduced production costs and environmental impact by focusing on increased fibre digestibility in forages lowering phytate in feed, forages as a basis of production systems
- Local current nutrient characterization of feed ingredients and manure
- Increase nutrient extraction from feed (diet manipulation) to reduce nutrients in manure
- Manage rations to decrease phosphorous loads

- Improve nutrient balance in manure of minimal nutrient content
- Increase production efficiency per animal unit through genetics, nutrient management and/or animal husbandry

Measures, outcomes, activities

- Nutrient input is matched to nutrient demand—know what the animal needs and characterize the requirements of the animal
- Modified feeds
- Growing crops that are meant to be grown for animal feed.
- Identified alternative management practices for feeding /grazing

Investment \$20 X 4 \$10 X 2 \$5 X 2 **Total: \$110**

Priority Four: Alternative uses of manure

R&D ideas

- Produce value added resources (energy, fertilizers, composts)
- Develop economically viable biodigester systems by capitalizing on rural/urban waste disposal networks resulting in sustainable growth with waste disposal

Measures, outcomes, activities

- Systems that are integrated with rural community
- Gasification
- Production of compost
- Energy recovery and production of saleable products

Investment: \$20 X 4 \$10 X 1 \$5 X 3 **Total: \$105**

Priority Five: Soil/nutrient dynamics

R&D ideas

- A program to determine soil processes under manure conditions which would result in reduced environmental impact

Measures, outcomes, activities

- What is going on with the nitrogen/phosphorous
- Soil ecology
- Plant growth curves—nutrient requirements

Investment \$20 X 0 \$10 X 5 \$5 X 6 **Total: \$80**

Priority Six: Determine nutrient values of feed grains and manures

R&D ideas

- Determine local, current nutrient characterization of feed ingredients and manure

Measures, outcomes, activities

- Decreased nutrient load in manure and optimized nutrient availability
- Decision support tools and models which would optimize the utilization and reduce excretion

Investment \$20 X 2 \$10 X 3 \$5 X 2 **Total: \$75**

Priority Seven: Improve economics associated with manure transportation and incorporation

R&D ideas

- Develop technologies to reduce transportation costs/improve incorporation costs of manure resulting in reduced nutrient concentration and movement
- Improved manure application equipment resulting in improved efficiency
- Address manure transportation costs and methods which would result in surplus nutrients available in nutrient deficient areas
- Extracting phosphorous and nitrogen and making it economically transportable resulting in harvesting value from manure streams
- Reduce manure volumes while maintaining nutrient content resulting in reduced transportation costs

Measures, outcomes, activities

- Application technology:
 - On the go rate applicators
 - Monitoring nutrient content as it is applied
 - Applicators that can put on low rates consistently and evenly
- Identify what is being used elsewhere and can it be applied
- Transportation technologies
 - Systems to transport manure or nutrients
 - Dehydration potential
 - Composting, compaction
 - Pelletizing, trucking, pipeline

Investment \$20 X 2 \$10 X 2 \$5 X 3 **Total: \$75**

CONCLUSION

The significant amount of R&D being conducted in the environmental and nutrient management area set the tone for this discussion from the outset and framed the resulting priorities.

The performance measures for this initiative focus on technology development, transfer and adoption. The industry, and ACIDF through its research funding, needs to take a systemic and strategic approach focusing on the efficacy and benefits of specific technology and management practices. Education and training within the context of the systems approach is critical.

ACIDF committed to summarizing the discussion results into a report, testing it for validity and completeness, and then using the results to round out the business plan and the granting process. They will share it with their partners in the funding consortium and with the workshop participants.

This is the first step in this process. While the results probably reflect the important priorities right now, ACIDF has learned this is a generative process and it is committed to a continuous review, learning and adaptation process to ensure the work the organization funds responds to an evolving industry.

ACIDF also realizes some key R&D projects or programs may require coordination and facilitation through solicited proposal calls and are open to that possibility.

Participants

Grant	Clark	U of A	grant.clark@ualberta.ca
Erasmus	Okine	U of A	erasmus.okine@ualberta.ca
Frank	Larney	AAFC	larney@agr.gc.ca
Jim	Miller	AAFC	millerji@agr.gc.ca
Barb	Shackel-Hardman	AAFRD	barb.shackel.hardman@gov.ab.ca
David	Chanasyk	U of A	david.chanasyk@ualberta.ca
Brent	Paterson	AAFRD	brent.paterson@gov.ab.ca
Trevor	Wallace	AAFRD	trevor.wallace@gov.ab.ca
Dale	Clark	AVAC	dclark@avacltd.com
Jim	Helm	AAFRD-FCDC	jamas.helm@gov.ab.ca
Allen	Good	U of A	allen.good@ualberta.ca
Bruce	Beattie	AESA	westhawk@telus.net
Vern	Baron	AAFC	baronv@agr.gc.ca
Tim	McAllister	AAFC	mcallister@agr.gc.ca
Ron	Alexson	ACFA	ron.axelson@cattlefeeder.ab.ca
Abimbola	Abiola	Olds College	aabiola@oldscollege.ca
Darcy	Fitzgerald	ALIDF	darcy.fitzgerald@alidf.ca
Freda	Molenkamp	AARI	freda.molenkamp@gov.ab.ca
Soenke	Moehn	U of A	soenke.moehn@ualberta.ca
Cam	Klapstein	ACIDF	cam@acidf.ca
Tom	Machacek	ACIDF	tom@acidf.ca
Bonnie	Spragg	ACIDF	bonnie@acidf.ca

Poster Questions

1. What is already happening in this area that we can build upon?

- Spreading manure on the land—best manure practices
- More efficient water utilization by animals therefore less manure to deal with
- Phosphorous in soil and run off—phosphorous limits project
- Phosphorous recovery
- Diet manipulation
- Feed evaluation
- Life cycle assessment
- Composting
- Gasification
- Antibiotic resistance
- Selection of efficient animals resulting in less manure production
- The work of the funding consortium
- ICM
- IFASA
- Manure composition
- Water quality assessment—AESA water quality program
- Biodigesters
- Liquid manure injection
- Methane capture (lagoon covers)
- Methane mitigation
- Plant genetics

2. What is the most pressing issue that needs to be addressed through new technology? Why?

- Tracking nutrient flows through the system
- Concentration of nutrients within farm environment
- Balance nutrient requirement in soil/plant/animal interface
- Reduce/adjust nutrient content in manure to meet plant requirements
- Adjust nutrient content in plants to meet manure content
- Incorporation of dairy/beef manure into soil profile to reduce nutrient run off—technologies to reduce
- Technologies to reduce the cost of manure transport
- Biodigesters
- Phosphorous/nitrogen limits—the basis for establishing them
- Pathogens and vermins
- Air emissions and green house gasses
- Soil salinity and sodicity (Na)
- Veterinarian and pharmaceutical residues in manure
- Odour
- Environmental economic value (Social value, \$\$)

3. What needs to happen to create momentum in this area?

- Network needs to focus on nutrient management from feed to animal to soil (value added) to plan
- Create demand/reward/recognition for environmental stewardship
- Need a (quick) win
- Industry embracing change

- Focus
- Leaders/leadership
 - Leader can not be “feathering the nest”
 - Acceptable to all groups (industry, government, ACIDF)
 - Fair, knowledgeable and respected
- Re: Harvest value need an economic driver (a compelling reason for change, i.e. money)
- Optimize nutrient excretion
- Initiate funding in a timely manner (minimize bureaucratic bottlenecks)
- System analysis to show cost/benefit of practices (economic, environmental, social) BMP, technology
- Industry awareness
- Working together better (Industry R&D and government pulling in the same direction –this meeting is a start)
- More focus on identified problems versus random grant lottery
- Solutions that are practical/economic now or in the future and environmentally sound

4. What outcomes can realistically be achieved in the next five years?

- BMP implementation—focus and conduct cost/benefit analysis to promote adoption
- Identification of local (Alberta) nutrient values for alternate feed stuffs and manure
- Quantify greenhouse gas emissions associated with different manure management technologies
- Changing feeding practices at feedlot/producer level
- Technologies to increase adoption of composting by 40 – 60%
- Technology for injection of solid manure into soil (reduce run off)
- Create the collaborative relationships that move the agenda forward
- Significant reduction of environmental phosphorous load (5% - 50%)
- Harvest value from animal input (energy plus nutrient capture)

5. What are the barriers that need to be addressed?

- Transfer of technology to farm—payback on adoption is not known
- Imbalance of nitrogen to phosphorous in cattle manure
- Economic
- What are the barriers to developing and implementing technology(ies) –time and money
- Are we reinventing the wheel? Shouldn't we look at what Europe has done and learn from them, adopt their technologies –need to validate them specific to Alberta
- Imbalance in feed
- Policy and or incentives to encourage change
- Understanding issues –education and awareness
- Funding for a systems approach
- People management skills
- Transportation costs
- Equipment available and utilized for precision application of manure treatments
- Access to research technology (e.g. biodigesters)

- Economic barriers to adaptation
- Time constraints on research and development
- Instability in industry, uncertainty about future
- Slow policy response
- Lack of government and interagency coordination
- Is the research continuum model basic research to adoption working ?
- Don't get hung up on technology—does technology solve everything? There is no silver bullet

6. The most significant opportunity in the Environment and Nutrient Management Initiative is:

- To create/develop/find a crop that has a nutrient profile that more closely meets the nutrient requirements of animals
- Value added products from manure
- Energy recovery from manure (reduce emissions, energy offset, cashflow and nutrient stabilization)
- BMP and cost/benefit analysis on production-system scale
- Solid manure injection
- Exporting manure nutrients to deficient soils
- Biofuel
- Composting on a larger scale
- Manure replacing commercial fertilizer
- Develop management system which balances nutrient requirements for soil/crop/animal
- Collaboration between crop/feed grains/ and livestock industry

7. Who are the major players?

- Industry—equipment manufacturers, technology developers, energy companies, feed companies, fertilizer companies
- Agriculture and Agri Food Canada
- Environment Canada
- Health Canada
- Environmental movement (NGOs)
- Industry Associations
- Universities: Guelph, Lethbridge, Edmonton and Calgary
- Government departments
- Funders: NSERC, Funding consortium, Biocap, follow on investors for commercialization
- International players (USDA, EU, Netherlands)
- Olds College
- Municipalities
- NRCB

8. Where are there leveraging opportunities?

- Government programs
- WEBS—watershed evaluation and BMP
- NAESI (environmental committee)
- Sustainable Technology Development Canada

- Provincial and Federal Funds and research
- Industry—producers
- NSERC: Strategic Grants—Greenhouse Gas mitigation
- Animal breeding programs, AAFRD technology transfer, watershed groups, collaborations (EU, US, Far East), Rural Development strategy, Carbon credit aggregations

What R&D needs to be done? (Worksheet data before grouping)

What programs or projects would contribute to achieving the identified outcomes?	How?
Local current nutrient characterization of feed ingredients and manure	Current data for management decisions and technology adoption and modeling
Life cycle assessment of nutrient flows in production systems	Models and data for management decisions
Life cycle system approach to manure management	Would identify deficiencies and or excesses in nutrients in the environment
There needs to be a systems approach	Coordinated group to draw information and team together
Basic research on nutrient dynamics (nitrogen and phosphorous) in soils	Knowledge to optimize plant uptake, reduce leaching and run-off
Evaluation of (cost/benefit, environmental impact) of BMP (life-cycle approach)	Information to encourage and inform adoption of BMP
Biodigestion nutrient recovery, etc. (integrated manure utilization)	Energy recovery and production of saleable products
Cheaper, effective technology for manure transport and incorporation	Better manure utilization, reduced volumes, stable nutrients
Nutrient values in Alberta feed grains	Ration changes to reduce phosphorous loads
Policy to encourage change	
Overarching long-term vision lead by industry with strategies to encourage adoptions	
Crops to utilize more nutrients	
Manure and nutrient transportation to required areas	Composting, palletizing, trucking, pipeline
Alternate uses of manure	Bio-energy (biodigesters, gasification and methane) Fertilizers Pyrolysis Nutrient extraction
A process in place to implement at the farm level	Clear system to bring the knowledge to the farmer

What programs or projects would contribute to achieving the identified outcomes?	How?
Municipal agricultural waste management integration program	Identify models (Quebec, Netherlands) Identify pilot projects Assist to remove barriers
Increase fibre digestability in forages	Develop and test protocols Select forages for fibre digestability
Compare lowering of phytate in feed with addition of enzymes lowering phytate in grains	Genetics Animal feeding studies
Develop production systems and varieties to use forage as the feed stock	
A program to determine soil processes under manured conditions	Determine crop yield curves Mitigate nutrient less processes
A program to determine cost efficacy, applicability of nutrient BMP to Alberta conditions	
Optimize nutrient utilization in animal/soil/plant systems	Systems research in nutrient flows
Develop an economically viable biodigester system by capitalizing on rural/urban waste disposal networks	PR programs Meeting the needs of communities and farm waste disposal
Reduce volumes while maintaining nutrient content	Reduce transportation costs for moving manure
Selection of efficient animals	Physiological and genetic research
Reduce nutrient content and improve nutrient balance in manure	Nutrient management Nutrient extraction from manure Plant genetics
Develop technology to reduce transportation costs of manure	Composting, dehydration, pipeline
Develop technology to better incorporate solid manure with the soil profile	Injection equipment, slurries
Increase production efficiency per animal unit	Genetics Nutrient management Animal husbandry
Development and testing of BMP on a watershed scale to assess impacts on water quality	Small watershed scale Cooperative and innovative producers (cooperation) Water quality monitoring
Reduce impacts of manure application through Alberta validation for worldwide mitigation Best Practices	Find five practices not being done here and try them