

TECHNICAL REVIEWERS' RATING SUMMARY

R024-D

Developing a Biomass Industry in North Dakota

NDSU

Principal Investigator: Nancy Hodur

Request for \$364,158; Total Project Costs \$728,316

| <u>Rating Category</u> | <u>Weighting Factor</u> | <u>Technical Reviewer</u> | | | <u>Average Weighted Score</u> |
|-------------------------------|-------------------------|---------------------------|-----------|-----------|-------------------------------|
| | | <u>1D</u> | <u>2D</u> | <u>3D</u> | |
| 1. Objectives | 9 | 4 | 4 | 5 | 39.00 |
| 2. Achievability | 9 | 4 | 4 | 5 | 39.00 |
| 3. Methodology | 7 | 4 | 3 | 4 | 25.67 |
| 4. Contribution | 7 | 4 | 4 | 5 | 30.33 |
| 5. Awareness | 5 | 4 | 5 | 3 | 20.00 |
| 6. Background | 5 | 3 | 5 | 3 | 18.33 |
| 7. Project Management | 2 | 4 | 4 | 4 | 8.00 |
| 8. Equipment Purchase | 2 | 5 | 5 | 5 | 10.00 |
| 9. Facilities | 2 | 5 | 4 | 5 | 9.33 |
| 10. Budget | 2 | 4 | 4 | 3 | 7.33 |
| Average Weighted Score | | 199 | 205 | 217 | 207.00 |
| Maximum Weighted Score | | | | | 250.00 |

OVERALL RECOMMENDATION

FUND

x

x

x

FUNDING MAY BE CONSIDERED

DO NOT FUND

R024-D
Developing a Biomass Industry in North Dakota
Submitted by NDSU
Principal Investigator: Nancy Hodur
Request for \$364,158; Total Project Costs \$728,316

- 1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Renewable Energy Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.**

Reviewer 1D (Rating: 4)

The proposal's main objective, to prepare a plan for establishment of an AFEX "depot" to densify and reduce the recalcitrance of low-cost / high-volume NDak biomass (particularly corn stover), for its potential use as a feedstock, for animal feed and biofuels and bioproducts as secondary markets, fits within NDIC/REC goals. The AFEX process presents a low impact on the environment and is versatile in adapting to different scales.

Reviewer 2D (Rating: 4)

Report very clearly lays out the goals of the project – FEED work to create a viable waste biomass to value industry in ND through the use of distributed plants. More work can be provided to quantify overall scale of impact. It's clearly early in the process, but even some back-of-the-envelope numbers to quantify cost savings potential of x number of plants in ND would be helpful.

Reviewer 3D (Rating: 5)

This project will assess the economic feasibility of constructing regional AFEX depots in North Dakota to provide a higher value, pretreated and densified feedstock from biomass. This will create new market opportunities for these resources, as well as a feedstock that can be used initially in cattle feeding operations, and later in biorefineries. The objectives match strongly to NDIC goals.

- 2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.**

Reviewer 1D (Rating: 4)

The applicants are likely to fulfill their proposed deliverables: a plant design and cost analysis for the AFEX depot, and a list of potential sites for establishing the depot

Reviewer 2D (Rating: 4)

It's a very reasonable, well thought-out plan to reach a very achievable milestone at the end of the work. It's specifically worth calling out and commending the go/no-go decision that occurs between each of the FEL phases. If granted funding, perhaps actual disbursement should be tied to these stage-gates. If the viability of the overall model is realized to be limited for whatever

cause at any phase in the process (more on that in following sections), then no more work should be done.

On the actual order of work besides the FEED report, the customer research / focus-groups should be front-loaded, along with the databasing and market research required to identify appropriate feedstock providers. This is work that can be done by grad students very cheaply, but is paramount to the overall likelihood of success. If customers won't buy it, or there's not enough available supply, then what's the point of building the plant??

Reviewer 3D (Rating: 5)

This is a straightforward economic feasibility analysis that could be conducted within 1 year. Much supporting information from prior projects is available that will aid in this project. The participants are aware of this information

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 1D (Rating: 4)

The methodology for Objective 1, the Front End Engineering and Design (to be conducted mainly by partner MBI) is well described in the proposal, and appears feasible. Objectives 2 and 3 will be achieved by interviews, presentations, and focus groups aimed at biomass producers and potential users of animal feed.

Reviewer 2D (Rating: 3)

I always think of any waste-to-value opportunity in three phases: feedstock, black box and offtake. This proposal does a tremendous job describing the black box – in this case the small-scale AFEX depot. The methodology to develop a FEED report is sound, the partners are well-established and strongly positioned to execute, and a 100x scale-up from pilot to commercial, while difficult, is certainly achievable. What is not as robust in this report, though, are steps 1 and 3. There is reference to the availability of the biomass necessary, as well as a brief discussion regarding prior limitations of related approaches (biomass handling, logistics, transportation costs), but just because there is biomass availability does not mean that farmers would be willing to actually give-up their waste biomass. What hurdles are there? What competing applications would you have to overcome (as mentioned: land application. Also, bedding)? At what price point could you acquire the waste biomass, or in potential better scenario, what would the farmers pay you to take it off of their hands? It's this idea of price/economics that ties into phase #3 – at what price would potential customers be willing to buy the AFEX pellets? Would they be willing to buy them at any price? Research has indicated that AFEX pellet replacement didn't impact cattle growth, but what other concerns would there be?

Preliminary answers to the questions above could and should be prioritized before any engineering design work is done. If the proverbial dog won't eat the dog food (or in this case, the cow not eating the cow food...sorry, I had to), then what's the point of designing a plant that doesn't produce products that are in demand? The same questions can be answered for the proposed secondary applications like ethanol production. This can be done very cheaply by a

grad student. I recommend them specifically because most people are more willing to speak with students – we've all been there before and it's my experience (both as a student doing this type of research myself, as well as having them do it on my behalf) that people generally want to help.

Regarding the question of price above, this should also be addressed sooner rather than later. I know that it's difficult without the FEED report, but even some back-of-the-envelope numbers would be helpful. Would the AFEX pellets be sold at a discount, par or premium to incumbent products? That makes a world of difference...

Reviewer 3D (Rating: 4)

Standard methodologies are employed. The economics work is straightforward. MBI is the world expert in AFEX and understand the technology thoroughly.

- 4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Renewable Energy Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.**

Reviewer 1D (Rating: 4)

AFEX is a proven technological approach for densification and pretreatment of biomass. The proposed work will compliment ongoing R&D efforts by MBI to adapt the technology to pilot scale, and from an emphasis on bioethanol to animal feed from corn stover, converting NDak's abundant supply of biomass into a form that possesses long shelf life.

Reviewer 2D (Rating: 4)

As stated in the report, what's caused many other agriculture waste-to-value projects to have trouble getting off the ground are the pure logistics of securing, collecting and transporting biomass over long distances. If the group can successfully create a smaller, more distributed treatment and production facility, then that could open up this yet-untapped opportunity at scale.

Of course, so much of this does come down to cost. It's great if you can create a smaller facility that alleviates some of the feedstock issues, but can you do it economically?

Reviewer 3D (Rating: 5)

The AFEX process has been around for decades, but has yet to be commercially applied. This has been somewhat of a red flag, but understandably, the first generation players in lignocellulosic ethanol have chosen to start with simpler and lower cost methods such as dilute acid pretreatment.

In the meantime the AFEX developers have continued to progress with optimizing the technology, scaling to the pilot level, and evaluating alternative uses (such as proposed herein) as livestock feed. This application is the lowest risk and offers the quickest to market opportunity. If successful it would demonstrate to biofuel facilities that the technology works. They could become additional customers for the AFEX pretreated pellets.

Thus the AFEX “team” has been progressing at a solid pace on a logical development timeline. The project proposed herein is the logical next step, and if the economic and market data looks promising could lead to investments to construct the initial deployed facility. If this facility succeeds, it could lead to a rapid expansion throughout ND, as well as surrounding states.

5. The principal investigator’s awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1D (Rating: 4)

Partner MBI is the leader in the R&D of AFEX, a novel and robust technological approach to pretreatment of lignocellulosics, developed several years ago by Bruce Dale of Michigan State University. Hodar and Bangsund of NDSU appear knowledgeable on the potential applications of AFEX, and their applicability in NDak.

Reviewer 2D (Rating: 5)

Very well versed in available research, and overall a strong understanding of what it will take to be successful in the space. Now get out there and actually talk to your potential suppliers and customers! That feedback will be worth twice as much as you think, I promise.

Reviewer 3D (Rating: 3)

The project involves collaboration with MBI and the lead developer of the technology, Bruce Dale at Michigan State. Thus the knowledge of the technology is obviously sufficient. The project builds upon prior crop/biomass production and use information that was supported by NDIC. In the discussion on NDIC project R010-022 I would have like to have seen information pertaining to estimated biomass values, as this is one important factor to producers.

In the discussion on the feeding value of AFEX-treated corn stover it would have been helpful to provide an economic value of this material if it can replace 30% of the corn in beef rations. Based on this return, one could have deducted estimated feedstock costs, logistic costs, and processing costs to provide a high level estimate of potential feasibility. I would have liked to have seen this preliminary analysis in the proposal.

The PI indicates that AFEX depots could provide feedstock to corn ethanol plants. This is true only if the corn ethanol plant were to bolt-on a lignocellulosic capability. Separate saccharification enzymes are required for biomass, as well as a separate fermentation train that uses a glucose/xylose fermenting yeast. Thus, it is not as simple as just mixing AFEX treated pellets and corn grain as the PI seems to suggest.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1D (Rating: 3)

Although the expertise of Hodar and Bangsund, and MBI, is very good, this proposal would be greatly strengthened if an expert in rural sociology, particularly relating to technology adoption,

were added to the team. The use of AFEX-treated corn stover as a source of animal feed is a new notion that remains in the testing and evaluation stage. There are a lot of unknowns relating to its long-term impact on animal health. Will a lower price be enough of a motivator for farmers to adopt the new animal feed? Are there barriers and bridges to adoption?

Reviewer 2D (Rating: 5)

Very well positioned. All involved have been so for a very long time and are clearly dedicated to the technology and approach. I particularly like the interaction and collaboration with multiple different entities – government, academic, private – all perspectives bring something important to the table.

Reviewer 3D (Rating: 3)

The proposal fails to clearly identify the participants from NDSU and MBI, other than listing Nancy Hodur as the PI and point of contact. There are no resumes or any indication of the background of the investigators and their abilities to conduct this project. However the methodology is relatively straightforward and I would imagine that any competent economist could do the project. As the project comes from NDSU I'm wondering why David Riplinger wasn't involved in some capacity, at least as a consultant.

- 7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.**

Reviewer 1D (Rating: 4)

The applicants will hold weekly teleconferences, and have included travel expenses to enable face-to-face meetings between MBI and NDSU co-investigators. The milestones and a Gantt Chart for their achievement have been well laid out.

Reviewer 2D (Rating: 4)

Again, it's a very reasonable and conservative plan to get to the intended milestone in the time allotted. Where I would ding them, though, is on the aforementioned need to front-load the market / supplier / customer research. That should be step #1.

Reviewer 3D (Rating: 4)

The plan outlines appropriate coordination between the team, a logical set of milestones and stage gates, and an effective communication plan.

- 8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)**

Reviewer 1D (Rating: 5)

No equipment is to be purchased

Reviewer 2D (Rating: 5)

Even though there's no equipment purchased, the money allocated to the FEED report itself seems reasonable.

Reviewer 3D (Rating: 5)

No equipment is requested

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 1D (Rating: 5)

MBI possesses the facilities required to complete the process and equipment design.

Reviewer 2D (Rating: 4)

Not much discussion here, but less relevant given the scope of the proposal.

Reviewer 3D (Rating: 5)

MBI has all necessary equipment and facilities for any testing of the process. The economic work involves surveys and data analysis.

10. The proposed budget “value”¹ relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 1D (Rating: 4)

I equate the value of the deliverables (depot design and assessment, site location, etc) to be commensurate with the investment by NDIC/REC, with the exception of 45% Indirect Costs (\$43K) by NDSU, which seems a high rate to charge a state government agency by the state's land grant flagship campus.

Reviewer 2D (Rating: 4)

As mentioned previously, very reasonable budget. I would look for some more info on MBI, though. Who are they? How big is their organization? Can they provide pricing for previous contracts that are similar in scope to ensure that expectations are realistic?

Reviewer 3D (Rating: 3)

It would have been helpful to identify the people involved and the percent time they will be devoting to the project. The amounts are just lumped into NDSU vs MBI with no details provided, either on the direct or matching funds. The NDSU budget request is reasonable, but it is difficult to assess the “value” from the \$250K MBI subaward with such little detail provided.

¹ “Value” – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

²Financial commitment from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Higher priority is to be given if the application has private industry investment equal to or at least 50% or more of total cost.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 1D (Fund)

The proposal would partner a potentially strong marriage between AFEX, a robust, scalable, and environmentally benign pretreatment for lignocellulosics to open up their structure for saccharification and/or (bio-)chemical conversion and provide densification (thereby reducing transportation costs and increasing storage life), and the abundant supply of biomass (particularly corn stover) that is available in NDak. The applicants at NDSU and MBI possess the expertise to deliver on the “supply side”: plant design for a pilot-scale depot (which makes sense as an operating scale for NDak), the economic assessment, site location (in NDak), and outreach. My only concern is for the “demand side”. Although the utilization of AFEX-treated corn stover as an inexpensive animal feed possesses scientific merit, and preliminary results are encouraging, this reviewer is a little concerned that the new application is not sufficiently established to drive adoption by NDak ranchers in their operation. Expertise on the team with technology adoption rural sociological models would address many of these concerns. The short-term viability of many of the secondary products described in the proposal is also of concern, due to the recent price decreases and increased supply of petroleum and natural gas. Yet, despite of the concern, this proposal possesses significant scientific merit and potential economic impact to be considered for funding.

Reviewer 2D (Fund)

No general comments provided.

Reviewer 3D (Fund)

The project is straightforward, builds upon prior work, and can easily be completed. The project will provide the information needed to decide on whether to move forward with deployment or not. If deployed and successful, this technology could rapidly spread throughout the region and provide a new source of income for producers, a new feed ingredient for cattle producers, and a feedstock for biofuel facilities. My biggest disappointment with the proposal was the lack of information on participants at NDSU and MBI and the amount of time they will be spending on the project.