

TECHNICAL REVIEWERS' RATING SUMMARY

BM001-A

Developing a Biomaterials Industry in North Dakota

Submitted by North Dakota Agricultural Experiment Station

Principal Investigators: Dr. F. Larry Leistritz

Request for \$800,000; Total Project Costs \$1,503,000

<u>Rating Category</u>	<u>Weighting Factor</u>	<u>Technical Reviewer</u>		<u>Average Weighted Score</u>
		<u>21</u>	<u>22</u>	
Objectives	9	3	4	31.50
Achievability	9	3	3	27.00
Methodology	7	3	3	21.00
Contribution	7	4	3	24.50
Awareness	5	3	2	12.50
Background	5	4	2	15.00
Project Management	2	3	3	6.00
Equipment Purchase	2	2	2	4.00
Facilities	2	3	3	6.00
Budget	2	3	3	6.00
Average Weighted Score		160	147	153.50
Maximum Weighted Score				250.00

OVERALL RECOMMENDATION

Fund		
Funding May Be Considered	X	X
Do Not Fund		

BM001-A
Developing a Biomaterials Industry in North Dakota
Submitted by North Dakota Agricultural Experiment Station
Principal Investigators: Dr. F. Larry Leistritz
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- 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 21 (Rating: 3)

The stated objective of the project to complete a front end engineering and design study for a pilot scale plant to demonstrate the commercial potential of the CNF technology is consistent with the Council goals to generate information that helps bring renewable energy companies and investment to North Dakota, create renewable energy jobs, develop technologies not presently used in North Dakota, and maximize market potential for renewable energy resources.

Reviewer 22 (Rating: 4)

The goal of this project is to conduct a study for a pilot plant to demonstrate the commercial potential of a technology for producing cellulose nanofibers from biomass feedstock in North Dakota. Additionally, the technology will be integrated with fermentation to produce ethanol (which could further result in the generation of electricity). The produced cellulose nanofibers will be morphologically and structurally characterized/evaluated for making bio-composites that could (potentially and/or partially) substitute the glass fiber reinforced composites. The cellulose nanofibers are, therefore, made from renewable sources, completely biodegradable, less toxic than glass fibers, just as strong as glass fibers with half the weight, and cost less to produce. The cellulose nanofiber bio-composites, on the other hand, may not be completely biodegradable, because the matrix materials of the composites are usually petroleum based so that they may not be biodegradable. The project will also conduct the “Refining the Initial Investment Analysis” for the business, as well as prepare a strategic business plan for integration of public and private sectors. This reviewer considers the objectives/goals of the proposed project are very clear.

- 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 21 (Rating: 3)

Without more technical details about what has been achieved thus far, and what specific obstacles remain, it is difficult to judge the achievability of the objectives, particularly with regard to objective 1. The suggested approach provides a logical methodology for advancing knowledge about the CNF technology in objective 1 which should provide the information needed for objectives 2 and 3. The budget and time available appear to be adequate to complete objectives 2 and 3 contingent upon how much progress is made with objective 1.

Reviewer 22 (Rating: 3)

The hypothesis of the project is that cellulose nanofibers for production of bio-composites can be

a value-added byproduct in a cellulose to ethanol bio-refinery. The project will conduct the researches in the following areas including (1) investigation of the “Ammonia Fiber Expansion (AFEX)” process for efficient conversion of wheat straw cellulose and hemi-cellulose to fermentable sugars, (2) determination of the best extraction methods for refining cellulose nanofibers from wheat straw fermentation residues, (3) investigation on the production of bio-composites from cellulose nanofibers, and (4) development of a strategic business plan that details the likely nature of operations and corporate organization for a commercial entity as well as examine potential markets, capitalization requirements, and projected financial performance. The goal is to achieve commitments from investors that will provide for the long-term implementation of the plan, construction of a commercial bio-refinery in the State of North Dakota.

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 21 (Rating: 3)

The proposed methodology provides only a general description of what will be done. Difficult to judge the quality of the methodology without more information.

Reviewer 22 (Rating: 3)

As described in the previous item, the hypothesis of the project is that cellulose nanofibers for production of bio-composites can be a value-added byproduct in a cellulose to ethanol bio-refinery. And the project will conduct several researches. Nonetheless, some proposed activities including “the scalability of a continuous AFEX process design”, “AFEX processing conditions (e.g., temperature, pressure, ammonia loading, and retention times)”, “Enzyme hydrolysis conditions”, “production of bio-composites from cellulose nanofibers” and others, have been well-studied and the results could be easily accessed in public literatures. This reviewer, however, does believe the activities relevant to the development of a business entity in North Dakota such as “economic modeling” and “strategic business plan” are important.

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 21 (Rating: 4)

The work is likely to make a significant scientific/technical contribution toward bringing a new bioenergy industry to North Dakota by increasing knowledge about CNF technology and evaluating the economic potential of this technology.

Reviewer 22 (Rating: 3)

Although the scientific/technical merits of research efforts on fermentation of bio-based products, production of cellulose nanofibers, and preparation/evaluation of cellulose nanofiber bio-composites

are minimum (since they have been well-studied and well-known), the exploration for developing a business entity in North Dakota to utilize its large supplies of agriculture biomass may be important.

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 21 (Rating: 3)

No published literature was referenced; however, PIs appear to have a good scientific awareness of the technology. Some mention about other work in this area would be helpful to demonstrate the originality and the feasibility of this project.

Reviewer 22 (Rating: 2)

Fermentation of bio-based products, production of cellulose nanofibers, as well as preparation/evaluation of cellulose nanofiber bio-composites have been well-studied and well-known. This reviewer wish to know what is the difference(s) of the proposed research to the previously conducted ones (which could easily be found in published literatures). The inclusion of those literatures and a clear explanation of the differences in the proposed research are needed. Additionally, regarding economic modelings and strategic plans for developing a comprehensive bio-refinery, other states (such as Kansas and Pennsylvania) have conducted studies. A comparison of those studies to the proposed one and a clear explanation of the uniqueness and (potential) advantages of the proposed plan are also needed.

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 21 (Rating: 4)

Based on their previous accomplishments and areas of expertise, the investigators are well qualified for this project.

Reviewer 22 (Rating: 2)

As afore-addressed, fermentation of bio-based products, production of cellulose nanofibers, as well as preparation/evaluation of cellulose nanofiber bio-composites have been well-studied and well-known. Additionally, some research has been conducted regarding developing a comprehensive bio-refinery in the mid-west states. Without inclusion and discussion about these activities, this review has to conclude that the background of the investigator(s) as related to the proposed work is limited.

- 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 21 (Rating: 3)

The communication plan and schedule are adequate. Financial plan for the NDSU portion is good, but more detail about personnel that would be supported by the MBI International subcontract would be helpful.

Reviewer 22 (Rating: 3)

It is described in the proposal that the key project participants have been working together in efforts leading to the present undertaking for the past three years; and the team members will regularly communicate by emails and quarterly review meetings. The proposal also has a timetable describing the schedule and milestones of the proposed activities, and a financial plan indicating the allocation of the requested funding. Generally speaking, it is adequate; nonetheless, it would be better if the investigators could include (1) the detailed milestones of the project and (2) more justifications for the requested budget. For instance, the subcontract to MBI international has \$347,530 allocated for personnel, what are the detailed responsibilities of these people?

- 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 21 (Rating: 2)

While it is understandable that equipment may be necessary, no indication was made about what equipment would be purchased.

Reviewer 22 (Rating: 2)

There is a piece of equipment requested to purchase in the subcontract to MBI International with the price being \$45,000. There is no justification on this (and the only) equipment.

- 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 21 (Rating: 3)

Difficult to evaluate, not clearly stated in the proposal. Although, the indication that MBI International has invested over \$8 million in the AFEX technology provides some indication that they have the facilities available to do this work.

Reviewer 22 (Rating: 3)

Although there is no clear statement in the proposal addressing the facilities and equipment available and to be purchased for the proposed research, this reviewer presume it could be adequate since this is a joint research effort among the North Dakota Agricultural Experiment Station, MBI International, the Michigan State University, and others including the North Dakota State University and the Great River Energy.

10. The proposed budget “value” 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 21 (Rating: 3)

Again, difficult to evaluate without more specifics about the work that will be done on the CNF technology. The value of the business plan is commensurate with the budget for that part of the proposal.

It appears that the funding from outside sources exceeds 50% of the total project costs, if past funding is included. However the identified new funding was \$703,000 compared to the \$800,000 request. Of this new funding, \$175,000 was from private sources.

Reviewer 22 (Rating: 3)

This reviewer believes the exploration for development of a business entity in North Dakota to produce cellulose nanofibers as well as ethanol from biomass feedstock is valuable. Nonetheless, the value of the scientific/technical activities/studies in the proposal including fermentation of bio-based products, production of cellulose nanofibers, as well as preparation/evaluation of cellulose nanofiber biocomposites is limited.

Financial 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.

The minimum 50% cash match is demonstrated.

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 21 (Funding May Be Considered)

The proposed project would advance a promising new technology that may improve the economic feasibility of cellulosic energy production, and includes an economic analysis that will clearly quantify the feasibility of the technology from a business perspective. A substantial portion of the project is related to advancement of the actual CNF technology, although it is not

clear how much advancement would be expected from this proposal (in due to the page limitations of the proposal). Overall, it appears to be a good project which could lead to creation of a new bioenergy industry. However, due to the lack of details about how the MBI subcontract would be spent, I cannot recommend definite funding, but instead recommend that funding be considered.

Reviewer 22 (Funding May be Considered)

The goal of this project is to conduct a study for a pilot plant to demonstrate the commercial potential of a technology for producing cellulose nanofibers from biomass feedstock in North Dakota. Additionally, the technology will be integrated with fermentation to produce ethanol (which could further result in the generation of electricity). The produced cellulose nanofibers will be morphologically and structurally characterized/evaluated for making bio-composites that could (potentially and/or partially) substitute the glass fiber reinforced composites. The cellulose nanofibers are, therefore, made from renewable sources, completely biodegradable, less toxic than glass fibers, just as strong as glass fibers with half the weight, and cost less to produce. The cellulose nanofiber bio-composites, on the other hand, may not be completely biodegradable, because the matrix materials of the composites are usually petroleum based so that they may not be biodegradable. The project will also conduct the “Refining the Initial Investment Analysis” for the business, as well as prepare a strategic business plan for integration of public and private sectors. This reviewer believes the exploration for development of a business entity in North Dakota to produce cellulose nanofibers as well as ethanol from biomass feedstock is valuable. Nonetheless, the value of the scientific/technical activities/studies in the proposal including fermentation of bio-based products, production of cellulose nanofibers, as well as preparation/evaluation of cellulose nanofiber bio-composites is limited. Additionally, the proposal lacks the sufficient background/literature information on both the scientific/technical components and the economical modeling/plan components. Therefore, this reviewer’s overall recommendation of this proposal is “Funding May Be Considered”.