There has been significant research on the capability of country grain elevators to receive and store grain products while complying with required segregation as well as on the costs of such systems (Hurburgh, 1994; Ingles et al., 2006; Herrman et al., 2002; Wilson and Dahl, 2005).Sausse et al. (2013) note that managing coexistence strategies past the field level (i.e. at the grain merchandising and grain cooperative level) requires both significant coordination and some level of transaction costs. The European study led by Sausse et al. (2013) examined the capability of stakeholders to manage coexistence measures through the use of role-play activities. The study focused on the effectiveness of how these strategies were managed, rather than the effectiveness of the strategies themselves. Additionally, the analysis was based role playing activities rather than actual scenarios. Little evaluation or investigation on the effectiveness of coexistence strategies at specific tolerance levels has been completed.

Kalaitzandonakes et al. (2014) outlined four scenarios where unapproved transgenic traits could enter the grain supply chain as part of their larger economic assessment, but also noted that asynchronous approval of traits leads to difficulty in commodity trade between countries. In situations where a zero or low tolerance level is the law, a greater number of practices will be needed to prevent commingling of approved and non-approved product, which adds cost (Mosher and Hurburgh, 2010; Bullock and Desquilbet, 2002). In cases with low tolerance levels, segregation that meets the legislative requirement may necessitate substantial modifications to production, storage, processing, and distribution processes within the grain supply chain (Kalaitzandonakes et al., 2014).

Testing for purity has been a major method of demonstrating purity, but this system leaves much to be desired for producers and handlers. Testing is one of the most expensive activities of segregation in terms of both money and time needed (Kalaitzandonakes et al., 2014; Bullock and Desquilbet, 2002). Furthermore, testing at a tolerance of 0.9 percent is challenging, particularly when the rate of false positive tests is high. The high rate of rejection can result in the rejection of a significant amount of loads at a feed mill or similar receiving areas (Kalaitzandonakes and Magnier, 2004). Rather than risk rejection of loads and have the non-GM product funneled back into the commodity supply chain, many growers simply exit the market.

Recent Research and Outreach Activities of Proposing Team

Gretchen Mosher has worked with grain traceability and segregation since 2006. She recently used Monte Carlo simulation to model worker safety in corn and biofuel production (Ryan, 2016; Ryan, Schwab, and Mosher, 2016). She has published research on the evaluation of traceability tools, quality management, and the economics of coexistence (Mosher, Laux, and Hurburgh, 2009; Laux, Mosher, and Hurburgh, 2015; Mosher and Hurburgh, 2010). Mosher also developed risk management instructional modules and decision-making documents as part of a 3-year FDA training grant.

Kingsly Ambrose has developed a wheat mill simulation program using EXTEND to study the change in quality of flour within the milling stream (Ambrose et al., 2013). The simulation program helps wheat milling companies to optimize mill flow based on the incoming quality of grain and on the required output quality. He has also used modeling techniques such as discrete element method and finite volume method to simulate and optimize different grain processing operations (Patwa et al., 2016; Siliveru et al., 2015).

Rationale and Significance

Previous researchers have concluded that effective coexistence and segregation of GM and non-GM crops require control measures administered in a flexible manner (Burgeff et al., 2014; Kalaitzandonakes et al., 2014; Devos et al., 2014). A 2004 study by Kalaitzandonakes and Magnier reported that higher tolerance levels lowered processing and production costs, but did not specifically test coexistence strategies and their ability to comply with legal tolerance levels. If the crops fail, as they often do in environments with low or zero threshold levels, the segregated product is funneled back into the commodity supply chain (Wilson and Dahl, 2005).

Accordingly, many questions remain on how to effectively manage the coexistence policies between different countries, stakeholders, and supply chain actors to comply with varied tolerance levels (Burgeff et al., 2014; Devos et al., 2014; Sausse et al., 2009) while still limiting costs to producers and handlers. *This project will increase the limited knowledge base on the effectiveness of existing coexistence strategies to document and maintain purity of non-GM maize to meet legal tolerance levels*.

In this project, we intend to use analytical modeling approaches to test the effectiveness of coexistence practices to meet specified tolerance levels. Although previous research has examined the economic costs of coexistence practices, limited research has examined how effective coexistence practices are, individually or combined together, in meeting tolerance levels. The structural model will be constructed, refined, and utilized to develop a decision-making tool to provide feasible operational techniques for non-GM growers, breeders, and handlers to effectively manage coexistence policies in domestic and international trading situations.

Objectives

The goal of this project is to answer the question "what is a feasible and reasonable tolerance level for segregation of non-GM corn?" The proposed research will address NC-213 objective number 2: "*To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.*" The working hypothesis of this research is that there are coexistence practices that influence the ability of a grain handling facility to segregate non-GM corn so that it meets a specified tolerance level, maintaining the quality and capturing value in non-GM markets. Using analytical modeling approaches to test the most commonly used coexistence strategies at three tolerance levels; we expect to answer two questions:

1) What is a feasible tolerance level for adventitious presence of conventional corn in handling non-GM corn in a grain handling facility?

2) What coexistence and segregation strategies are the most effective at facilitating purity at three specified tolerance levels?

Accordingly, the objectives of this research are to:

1. Construct a structural model with input variables detailing up to five coexistence and segregation practices and three tolerance levels
2. Refine the model to optimize the effectiveness of coexistence and segregation by testing select scenarios at specific tolerance levels
3. Develop a decision-making tool enabling breeders, growers and handlers to successfully segregate non-GM corn at specified tolerance levels

Procedures

Objective 1 – Construction of the model

The subsections below explain the procedure that will be followed in this proposed study. All work contributing to the project objectives will be carried out in a collaborative manner by Iowa State University and Purdue University.

The structural model will focus on the grain supply chain from harvest to the point where grain is transported to the processor or its final user. The Purdue University research team will lead the development and validation. The model will examine coexistence policies on maize because of its wide usage, global economic importance, and open pollination properties (Mosher and Hurburgh, 2010). Previous research has identified three primary sources adventitious presence: impure seeds, equipment residue, volunteer plants from previous crops, and cross-pollination (Demont and Devos, 2008). Strategies for addressing these sources of adventitious presence will be converted to numerical values and used as input variables.

Variables to be modeled include: isolation distance, staggered planting times, machinery cleaning practices, buffer zones, and other environmental factors noted in previous monitoring studies (Jank, Rath and Gaugitsch, 2006). Variability from production systems, crop rotations, cropping patterns, dust, and other natural conditions will be quantitatively modeled when possible. Single point estimates on each variable will be drawn from previous research on pollen transfer and equipment cleaning (Messean et al., 2006; Weber et al., 2007; Council for Agricultural Science and Technology, 2007). Data on natural conditions will be drawn from Cooperative Extension Specialists and cropping data collected by Purdue University and Iowa State University.

Coexistence scenarios will be constructed with the assistance of a non-GM breeding professional and from previous published scenarios, such as those described by Sausse et al. (2013) and Meillet et al. (2015). Using the model as a basis, assumptions of the model will be discussed by the investigators, the non-GM professional, and by other experts in the field of grain handling and coexistence practices.

Tolerance levels will be tested at a minimum of three thresholds. More levels may be tested if warranted. Additionally, Kalaitzandonakes et al. (2014) describe two methods of preventing unapproved transgenic crops from entering the supply chain: prevention and remediation. Prevention activities center on field production, but some, including the use of dedicated facilities and equipment and meticulous cleaning, can also be applied at the grain elevator. The second method described by Kalaitzandonakes et al. (2014) is remediation, which is characterized by repeated testing, isolation, and approval of crops before they are allowed into the segregated pathway. These scenarios will be included in the first set of structural models.

Objective 2 – Refinement and Optimization of the Model

Before refining and optimizing the model, an event tree will be constructed to describe the sequence of events occurring as part of each coexistence scenario. The Iowa State University team will lead this portion of the project, completing the event tree at the end of the first project year. Vose (2008) suggests that event trees offer one of the most useful methods for depicting a probabilistic sequence of events. A probabilistic model is appropriate for this sequence because it gives a distribution of all possible outcomes and then measures how likely each is to occur through the calculation of probabilities. The event tree will be used to prioritize and organize variables to input into the refined and optimized model.

Variables are entered into the model using a stepwise method. Before variables are entered into the model, a distribution will be determined for each variable. Distributions reflect properties of each variable – for example, with isolation time; the distribution would start at zero days and could be as long as 14 days. Using published literature as a guideline for the shape of the distribution, a normal, beta, or triangle distribution could be chosen. Instead of using a single value in the equation, a distribution is entered.

Next, the Iowa State University team will lead a Monte Carlo simulation using Crystal Ball® or an equivalent software. The simulation is expected to produce over a thousand scenarios. In each scenario, an individual value from each distribution in the model is sampled until every possible combination of values from all variable distributions is measured (Vose, 2008). The values calculated then reflect a probability of which scenario is most likely to occur and identify a variable or variables that most influence the probability value. The interest of this project is finding the coexistence strategy or set of strategies that have the greatest contribution to successful compliance with specified tolerance levels. Monte Carlo simulation is a widely recognized tool that can model correlation and interdependencies successfully. Another advantage of Monte Carlo simulation is that models can be modified and compared with previous models, which will facilitate the comparison among different levels of tolerance for adventitious presence (Vose, 2008).

Once the Monte Carlo simulation has been completed, a sensitivity analysis will be used to identify the most influential variables in the model. A common method for performing sensitivity analysis is a tornado analysis. This analysis uses values ranging from negative 1 to positive 1 to indicate the influence of a variable. A negative 1 demonstrates that the output is wholly dependent on the input variable but the relationship is negative. Meaning, when the input variable is large, the output from the model is small. A value of zero indicates no influence from the input variable on the output. A positive 1 signifies that the output is wholly dependent on the input variable and the relationship is positive. Meaning, when the input variable is large, the output is also large (Vose, 2008). These analyses will allow measurement of each variable in the model to determine its contribution to successful compliance at specified tolerance levels.

Several variables are expected to be entered into the sensitivity analysis. These include: staggered planting time, buffer distances, equipment clean-out procedures, and dedicated equipment and storage facilities. Other variables may emerge after the model is constructed and the Monte Carlo simulation is performed.

Team members from Iowa State University and Purdue University will work together by phone and electronic communication tools (i.e. Skype) to refine and further test the model against three or more tolerance levels. Project documents will be stored on a shared Dropbox. The Purdue University team will focus on the construction of the initial model and its testing and validation. Iowa State University's team will focus on model refinement and optimization. Drs. Ambrose and Mosher will work with the master's students to create the decision-making tool and disseminate the research findings to national and international audiences.

Objective 3 - Developing Decision-Making Tool

Using information from the event tree analyses, optimized models and sensitivity analyses, a decision-making tool will be constructed. The focus of the decision-making tool will be to guide non-GM maize growers and handlers on coexistence practices that have been shown to positively influence compliance with published tolerance levels. Once a valid model is developed, the team will focus on using the information in the event tree analysis and the model to create a decision-making tool for grain elevator personnel who wish to segregate differentiated grains within their grain handling facility. Iowa State University will lead the initial development of the decision-making tool, with Purdue University providing critical feedback and alternate versions to serve different tolerance level scenarios. It is anticipated that the decision-making tool will include:

- Information on coexistence recommendations to control adventitious presence at several tolerance levels
- Strategies for prioritizing coexistence and segregation practices

- Predictions of adventitious presence in maize under common coexistence scenarios

The decision-making tool will serve as a guidance document for non-GM breeders, growers, and handlings who wish to improve their ability to document and maintain purity levels and non-GM status with maize. The decision-making tool will also be distributed through NC-213, GEAPS, and agricultural and Cooperative Extension media outlets, including through Iowa State University's Ag Decision Maker application. It will also be available at grain quality websites on the Iowa State University and Purdue University homepages.

Anticipated Results, Products, and Impacts

The proposed project will answer a long-standing question in coexistence policy: "What is a feasible tolerance level for adventitious presence of conventional corn in handling non-GM corn in a grain handling facility?" In the short term, the information will be helpful as the USDA prepares to set their standard for adventitious presence tolerance levels. The agency has two years to set such a standard but currently have very little data on which to base their recommendation. In the long term, data and tools generated by this project will facilitate a lower risk level for non-GM growers, breeders, and handlers, perhaps leading fewer of them to exit the non-GM market. With more non-GM producers who can effectively manage and document valid coexistence policies, international markets in Europe and Asia may open, capturing value and generating improvements in the agricultural supply chain.

The optimized model and the decision-making tool for non-GM breeders, growers, and handlers will be shared with the research community through peer-reviewed conference presentations and peer-reviewed journal articles. The anticipated products will also be shared with the grain handling industry through GEAPS, the National Grain and Feed Association, NC-213 members, Extension crops field specialists, Iowa State University's Ag Decision Maker program and other relevant audiences. If demand warrants, the findings could be included as part of a formal Cooperative Extension program within the NC-213 region through the use of Ag Decision Maker applications or through other multi-state committees.

Leveraging Resources

The successful completion of this project will provide the basis for further investigation on structural modeling approaches to evaluating coexistence and segregation strategies for effectiveness in meeting legal tolerance levels. The National Institute for Food and Agriculture (NIFA) offered by the USDA will be explored, specifically programs in Food Safety. A second means of funding will be sought from the USDA Foundational Research Program, which has programs in Biosecurity, Agricultural Technologies, and Food Safety, all of which could be used to fund further work in the structural modeling of coexistence practices. The practical knowledge obtained from this work will be used to design decision-making tools for non-GM breeders, producers, and handlers.

Timetable

The following timeline is proposed for this research

Grain elevator site visits, and grain elevator manager/supervisor personnel interviews	January 2015 – April 2014
Construction of initial structural model	May 2017 – September 2017
Validation of initial structural model	September 2017 – December 2017
Creation of event tree analysis	December 2017 – March 2018
Preliminary structural model completion and testing	March 2018 – May 2018
Submit 1 year report	May 2018
Begin refinement and optimization of structural model and evaluation of coexistence variables	May 2018 – September 2018
Perform Monte Carlo simulation on optimized model	September – December 2018
Create decision-making tool and integrate into Ag Decision Maker and other tools	December 2018 – January 2019
Submit journal articles and other dissemination	January 2019 – April 2019
Submit final report (NC-213 report in February 2019)	April 2019

Collaboration

Gretchen Mosher will coordinate the project and will oversee work related to Objective 2: Refining and optimizing the model using Monte Carlo simulation. She will supervise research conducted by the graduate student at Iowa State University. Kingsly Ambrose will oversee work related to Objective 1: Construction and testing of the structural model. He will supervise research performed by the graduate student at Purdue University. Gretchen Mosher and Kingsly Ambrose will work together on Objective 3: Creation and dissemination of the Decision-Making Tool. At least one project meeting (via Skype or other online means) per quarter will be conducted for collaborative discussion between the Iowa State University and Purdue University. Additional meetings will be scheduled as needed.

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AgriGold
WE KNOW CORN

NC-213 Assigned Proposal Nbr: 2016_TC-002

September 8, 2016

Dear Anderson Team Grant Proposal Committee,

Please accept my letter of support for the project "Segregation strategies for non-GM corn: Improving effectiveness through an analytical modeling approach", led by Dr. Gretchen Mosher of Iowa State University and Dr. Kingsly Ambrose of Purdue University.

The need for the proposed project is timely, given that the USDA is presently considering information needed to set a standard for adventitious presence of GM product in non-GM crops. In my experience, the tolerance of 0.9%, set by the European Union and others, is overly restrictive. Current sampling and testing methods at the grain delivery point need to be improved to meet the 0.9% threshold. Growers will leave the program if they feel they are doing everything they can and then get loads rejected. This will cause premiums to increase to get growers to come back or get new growers.

Although several coexistence and segregation strategies have been tested, a comprehensive evaluation of their effectiveness, both individually and together, has not been completed. The information generated by this project will assist breeders, growers, and handlers in prioritizing which coexistence tasks to include to meet tolerance at specific labels. The information is greatly needed to set a reasonable standard for non-GM producers and breeders.

I believe this project effectively meets the objectives of the Anderson Team Grant Program and I support it without reservation.

Sincerely,

Chuck Hill

Chuck Hill
Specialty Products Manager, CCA
AgriGold Hybrids

SPECIALTY
SERIES

NC-213 Assigned Proposal Nbr: 2016_TC-002

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME Gretchen Ann Mosher	POSITION TITLE Assistant Professor
eRA COMMONS USER NAME (credential, e.g., agency login) gamosher	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
Iowa State University, Ames, Iowa	B.S.	8/1996	Food Science
Iowa State University, Ames, Iowa	M.S.	12/2002	FCS Education & Studies
Iowa State University, Ames, Iowa	Ph.D.	5/2011	Agricultural & Industrial Technology

Professional Experience:

Iowa State University, Agricultural & Biosystems Engineering, Assistant Professor, August 2011-present
Iowa State University, Agricultural & Biosystems Engineering, Lecturer, August 2011 – August 2012
Iowa State University, Agricultural & Biosystems Engineering, Post-Doctorate Researcher, May 2011 – August 2011
Iowa State University, Agricultural & Biosystems Engineering, Graduate Research Assistant, August 2006 - May 2011
Iowa State University, Apparel, Educational Studies, & Hospitality Management, Lecturer, August 2003-August 2006
Iowa State University, Animal Science, Research Associate, October 1996 – March 2004

Professional Membership:

American Society for Engineering Education (ASEE), 2006 – present
Association of Technology, Management, and Applied Engineering (ATMAE), 2006 – present
Epsilon Pi Tau, technology honorary, 2008 – present
Gamma Sigma Delta, agricultural honorary, 2007 – present
International Society for Agricultural Safety and Health (ISASH), 2010 – present

Honors and Awards:

- 2016 Andersons Cereals and Oilseeds Early-in-Career Award of Excellence, North Central (NC) 213 Quality Grains Research Consortium (March 2016)
- 2015 ASABE Superior Paper Award for "*Development of a safety decision-making scenario to measure worker safety in agriculture*" by G.A. Mosher, N.Keren, S.A. Freeman, and C.R. Hurburgh, (July 2015)
- Miller Faculty Fellow – Teaching fellowship (2013-2014), (2015-2016), Iowa State University
- 2011 Warner Graduate Student Research Award (Region 4), Epsilon Pi Tau (March 2011)
- 2010 Graduate Research Award. Association of Technology, Management and Applied Engineering (October 2010)
- 2008 Best Conference Paper Award for "*Food traceability using quality management systems to meet the Food and Drug Administration Bioterrorism Act of 2002*" by C.M. Laux, G.A. Mosher and C.R. Hurburgh. National Association of Industrial Technologists – (now ATMAE) (November 2008)

- 2008 Wakonse College Teaching Graduate Fellowship, Center for Excellence in Learning and Teaching, Iowa State University, Ames, IA
- 2005 Outstanding Advisor Award, College of Family & Consumer Sciences, Iowa State University, Ames, IA
- 2002 - Master's thesis awarded Research Excellence Award, Iowa State University Graduate College

Synergistic Activities:

- **September 2013 – present:** Project Director and Institutional Representative for Iowa State University on the Multi-State Committee – Marketing and Delivery of Quality Grains and Bioprocess Coproducts, Multi-state number NC 213
- **September 2010 – present:** Developed and taught GEAPS 530 – Quality Management Systems, non-credit online course offered by the Grain Elevator and Processing Society (GEAPS), as part of the Grain Handling Credential

Selected Publications:

- Grover, A.K., S. Chopra, and **G.A. Mosher**. Food Safety Modernization Act: A quality management approach to identify and prioritize factors affecting adoption of preventative controls among small food facilities. Accepted by *Food Control*.
- Ramaswamy, S.K. and **G.A. Mosher**. 2016. Approaching safety through quality: Factors influencing college student perceptions. *Journal of Agricultural Safety and Health,* 22(2), 149-165.
- Laux, C.M., G.A.Mosher, and C.R. Hurburgh. 2015. Application of quality management systems to grain: An inventory management case study. *Applied Engineering in Agriculture,* 31(1), 313-321.
- Mosher, G.A., N. Keren, S.A. Freeman, & C.R. Hurburgh. Development of a Safety Decision-Making Scenario to Measure Worker Safety in Agriculture.2014. *Journal of Agricultural Safety and Health*, 20(2), 91-107.
- Mosher G.A. and C.R. Hurburgh, Jr. 2010. Transgenic plant risk: Coexistence and economy*. Encyclopedia of Biotechnology of Food and Agriculture,* 1(1), 639-642. Available online July 21 2010.

Selected Proceedings Papers:

- Ryan, S.J., C.V. Schwab, and **G.A. Mosher**. 2016. *Comparing worker injury risk in corn and switchgrass production systems: Results from a probabilistic risk assessment model.* International Society for Agricultural Safety and Health, paper#16-03. Lexington, KY: ISASH.
- Ryan, S.J., G.A.Mosher, and C.V. Schwab. 2015. *Enhancing quality and management decisions with stochastic risk methods*. Presentation given at the Association for Technology, Management, and Applied Engineering (ATMAE) Annual Conference, November 2015, Pittsburgh, PA.
- Mosher, G.A., C.M. Laux and C.R. Hurburgh. 2009. Using mock recall data to measure continuous quality improvement. *Association of Technology, Management, and Applied Engineering (ATMAE) 2009 Conference Proceedings Paper.*
- Laux, C.M., G.A. Mosher and C.R. Hurburgh. 2008. Food traceability using quality management systems to meet the Food and Drug Administration Bioterrorism Act of 2002. *Proceedings of the 2008 National Association of Industrial Technologists.*

Presentations: Dr. Mosher has made 60 research presentations and 18 invited presentations.

Teaching and Graduate Student Advising: Dr. Mosher teaches courses in total quality management and technology senior capstone design; she advises 6 total graduate students, 4 doctoral and 2 master's.

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EDUCATION

Ph.D., Agricultural and Biological Engineering 2010
Purdue University, West Lafayette, IN, USA.
M. S., Agricultural Processing 1998
Tamil Nadu Agricultural University, Coimbatore, India.
B. S., Agricultural Engineering 1996
Tamil Nadu Agricultural University, Coimbatore, India.

PROFESSIONAL POSITIONS

Assistant Professor 2015 August – Present
Department of Ag. & Biological Engineering, Purdue University, W. Lafayette, IN, USA.
Assistant Professor 2012 January – 2015 August
Department of Grain Sci. and Industry, Kansas State University, Manhattan, KS, USA.
Postdoctoral Research Assistant 2011 January – 2011 December
Department of Ag. and Biological Eng., Purdue University, West Lafayette, IN, USA.
Graduate Research Assistant 2007 - 2010
Department of Ag. and Biological Eng., Purdue University, West Lafayette, IN, USA.
Scientist 2001 - 2007
Central Institute of Post Harvest Engineering and Technology (CIPHET), Indian Council of Agricultural Research (ICAR), Abohar, Punjab, India.
Senior Research Fellow 1998 – 2001
Department of Bioenergy, Tamil Nadu Agricultural University, Coimbatore, India.

RESEARCH SUMMARY

Dr. Ambrose leads a research group focusing on the application of particle technology in grain handling, milling and grain processing. His research group focuses on research areas namely: (1) milling of whole grains and specialty crops; (2) particulate flow and materials handling, (3) grain drying, and (4) dust explosion prevention. Major professor for 4 M.S. (3 graduated) and 3 Ph.D. student. Supervised 2 post-doctoral research associates and hosted 2 overseas visiting scientists.

TEACHING AND OUTREACH

Grain Drying and Storage – ASM 550; Grain Processing – FS 455 (co-taught with Dr. Hamaker). At Kansas State University (2012-2015) - Materials Handling (GRSC 310), Particle Technology for Solids Handling and Processing (GRSC 780) and Advanced Grain Processing (GRSC 840).

Dr. Ambrose's outreach activities include training industry workers and supervisors on preventing grain dust explosions. He has trained more than 800 grain handling processing industry workers through programs conducted in Colorado, Indiana, Kansas, Kentucky, Minnesota, Missouri, Nebraska, South Dakota, and Texas.

Honors and Awards

- NC-213 Andersons Cereals and Oilseeds – 2014 **Early-in-Career Award of Excellence**
- **Bilsland Dissertation Fellowship,** 2010. Purdue University, West Lafayette, IN, USA.
- **Purdue Agriculture TEAM Award,** 2009. The Integrated Corn Ethanol Co-Products Team. Purdue University, West Lafayette, IN, USA.
- **Norman E. Borlaug Fellowship,** 2006. USDA. To undergo training on "High Pressure Processing" at The Ohio State University, Columbus, OH, USA.
- **Best Scientist,** 2005. CIPHET, Ludhiana, India.
- **Certificate of Appreciation**, 2005. CIPHET, Ludhiana, India. For contribution towards the development of technology "Algorithm for maturity index calculation and development of color chart for mango".

Synergistic Activities

- Member of American Society of Agricultural and Biological Engineers (ASABE)
- Member of American Association of Cereal Chemists (AACC International)
- Co-Chair, Rheology Division, AACC International (2014-2016)
- Chair, Food Process Engineering Division of ASABE (2015-2016)

Patents

- Jha, S.N., Chopra, S. and **Kingsly, A.R.P.** 2004. Method of determining maturity of intact mango on tree. India. 250880. Date of filling: 12/02/2004. Date of Issue: 02/10/2012.

Publications *(Recent Refereed Publications)*

1. Patwa, A., **Ambrose R. P. K**. and Casada, M. E. 2016. Discrete element method as an approach to model the wheat milling process. *Powder Technology*. 302: 350-356.
2. **Ambrose, R. P. K.**, Ileleji, K. E., Doane, P. and Cecava, M. 2016. Liquid holding capacity of corn wet mill liquid coproducts to corn stover. *Applied Engineering in Agriculture*. (Accepted).
3. Ileleji, K. E., Li, Y., **Ambrose, R. P. K.** and Doane, P. H. 2016. Experimental investigations towards understanding important parameters in wet drum granulation of corn storver biomass. *Powder Technology*. 300: 126-135.
4. Manikantan, M. R., **Ambrose, R. P. K.** and Alavi, S. 2016. Dynamic flow properties of coconut flours. *International Journal of Food Engineering*. 12(6): 577-586.
5. Sanghi, A. and **Ambrose, R. P. K.** 2016. Analysis of the effect of prevailing weather conditions on the occurrence of grain dust explosions. *Journal of Agricultural Safety and Health*. 22(3): 187-197.
6. Siliveru, K., Kwek, J. W., Lau, G. M. L. and **Ambrose, R. P. K.** 2016. An image analysis approach to understand the differences in flour particle surface and shape characteristics. *Cereal Chemistry*. 93: 234-241.
7. **Ambrose, R. P. K.**, Jan, S. and Siliveru, K. 2016. A review on flow characterization methods for cereal grain-based powders. *Journal of the Science of Food and Agriculture*. 96:359-364. **[Invited review]**.
8. Manikantan, M.R., **Ambrose, R. P. K.** and Alavi, S. 2015. Flow-specific physical properties of coconut flours. *International Agrophysics*. 29: 459-465.
9. Bian, Q., **Ambrose, R. P. K.** and Subramanyam, B. 2015. Effects of chaff on bulk flow properties of wheat. *Journal of Stored Products Research*. 64:21-26.
10. Bian, Q., **Ambrose, R. P. K.** and Subramanyam, B. 2015. Effects of insect-infested kernels on bulk flow properties of wheat. *Journal of Stored Products Research.* 63:51-56.

CURRENT & PENDING SUPPORT

Name: Gretchen A. Mosher

Instructions:
Who completes this template: Each project director/principal investigator (PD/PI) and other senior personnel that the Request for Applications (RFA) specifies
How this template is completed:

- Record information for active and pending projects, including this proposal.
- All current efforts to which PD/PI(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
- Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors, including other USDA programs.
- For concurrent projects, the percent of time committed must not exceed 100%.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
	Active:				
Mosher, G.A.; R.P.K. Ambrose (Purdue); D. Maier (ISU); K. Ileleji (Purdue)	Department of Labor, OSHA, Susan Harwood Targeted Topic Grant	$140,000	October 1, 2015 – September 30, 2016	10%	Training on prevention of grain dust explosions
Mosher, G.A.; J.R. Vanstrom (ISU)	John Deere North America	$2,500	July 1, 2016 – March 31, 2017	4%	Use of industry case studies to improve student competencies in teamwork and critical thinking
Mosher, G.A.; D.R. Raman (ISU); A.L Kaleita (ISU)	American Society of Engineering Education, Engineering Technology Division	$4,284	May 1, 2016 – April 30, 2017	3%	Engineering technology transfers: Factors predicting success
Mosher, G.A; C. Bern; S. Chopra; C. Hart, C. Hurburgh, K. Rosentrater; A.Shaw (all ISU)	NC 213 Multi-state Hatch (NIFA)	No monetary allocation	10-1-2013 – 9-30-2018	5%	Marketing and Delivery of Quality Grains and BioProcess Coproducts
	Pending:				
Chopra, S.; G. Mosher; C. Hurburgh (all ISU)	National Institute of Standards and Technology, Engineering Laboratory	$40,000	7-1-2016 – 12-31-2016	3%	Facilitating information transfer in bulk grain to food or feed supply chains

Mosher, G.A.; R.P.K Ambrose (Purdue); D. Maier (ISU)	Department of Labor, Susan Harwood Follow-on Grant	$126,000	10-1-2016 – 9-30-2017	10%	Continuation of training to prevent grain dust explosions
Mosher, G.A.; Ambrose, R.P.	Anderson Research Grant Program	$150,000	5-1-2017 – 4-30-2019	10%	Segregation strategies for non-GM corn: Improving effectiveness through an analytical modeling approach

This file MUST be converted to PDF prior to attachment in the electronic application package.

CURRENT & PENDING SUPPORT

Name: Rose Prabin Ambrose

Instructions:
Who completes this template: Each project director/principal investigator (PD/PI) and other senior personnel that the Request for Applications (RFA) specifies
How this template is completed:

- Record information for active and pending projects, including this proposal.
- All current efforts to which PD/PI(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
- Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors, including other USDA programs.
- For concurrent projects, the percent of time committed must not exceed 100%.

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
	Active:				
Ambrose, R.P.; Illeji, K., Maier, D.E., Mosher, G.A.	Department of Labor, OSHA, Susan Harwood Targeted Topic Grant	$140,000	9/30/2015 – 9/30/2016	10%	Training on prevention of grain dust explosions
Ambrose, R.P.	Anderson Research Fund, The Ohio State University	$20,032	1/01/2015-12/31/2016	2%	Intrinsic characteristics of modified DDGS and development of effective handling strategies
Ambrose, R.P.	National Grain and Feed Association	$26,875	1/01/ - 12/31/2017	2%	Compiling and reporting information on agricultural dust explosions
Ambrose, R.P.	Abbott Nutrition	$30,000	12/15/2015-3/31/2017	9%	Optimizing power blending for content homogeneity
	Pending:				
Tormoehlen, R.; Field, W.E., Ambrose, R.P.	National Institutes of Health	$9,146,947	9/01/2016 – 8/31/2021	10%	Heartland Center for Agricultural Safety and Health
Ambrose, R.P.	NIFA, USDA	$500,000	1/01/2017-12/31/2019	2%	Mechanisms and mitigation of dust generation during grain handling and processing
Yazawa, K., Ambrose, R.P.	NIFA, USDA	$410,706	1/01/2017-12/31/2018	10%	High efficiency corn ethanol co-generation systems

Ambrose, R.P.	Abbott Nutrition	$3,875	9/15/2016 – 12/14/2016	2%	Optimizing powder blending for content homogeneity
Mosher, G.A., Maier, D.E., Ambrose, R.P.	Department of Labor, OSHA	$126,000	10/1/2016 – 19/30/2017	10%	Continuation of training to prevent grain dust explosions
Mosher, G.A., Ambrose, R.P.	Anderson Research Fund, The Ohio State University	$150,000	5/01/2017- 4/30/2019	2%	Segregation strategies for non-GM corn: Improving effectiveness through analytical modeling approach

NC-213 Assigned Proposal Nbr: 2016_TC-002

ANDERSONS RESEARCH FUND – RESEARCH PROPOSAL BUDGET

Category	Year 1 Amt. requested from Andersons	Year 2 Amt. requested from Andersons	Total
Salaries and Wages*			
Post-Ph.D. research associate(s)			
Graduate assistant			
Stipend	**24,600**	**25,338**	
Tuition and fees	**5,629**	**5,865**	
Hourly wage			
Other (specify in Budget Narrative)			
Total	**30,229**	**31,203**	**61,432**
Fringe Benefits			
Post-Ph.D. research associate(s)			
Graduate assistant	**2,411**	**2,483**	
Hourly wage			
Other			
Total	**2,411**	**2,483**	**4,894**
Materials and Supplies	**500**	**100**	**600**
Equipment (List individual pieces of equipment that are essential to the project in the Budget Narrative.)	**0**	**0**	**0**
Travel – domestic & foreign	**5,560**	**4,750**	**10,310**
Publication charges	**800**	**964**	**1,764**
Subcontract – Purdue University	**35,500**	**35,500**	**71,000**
Indirect costs**			
Total (Max. $75,000/yr. from Andersons Research Grant Program)	**75,000**	**75,000**	**150,000**

*Andersons funds cannot be used for faculty salaries, departmental space, or facilities.

**The Andersons Research Grant Program policy specifies that no indirect costs can be charged to this project.

NC-213 Assigned Proposal Nbr: 2016_TC-002

BUDGET NARRATIVE

IOWA STATE UNIVERSITY

SALARY, WAGES, AND FEES ($61,432)
Senior Personnel:
Principal Investigator – Dr. Gretchen Mosher: no salary is requested.

Other Personnel:
1 - Graduate Research Assistant (GRA)

- MS, non-engineering, half-time
- Salary is requested for 12 months each year
- A 3% salary increase is included for each subsequent year.

Tuition: Year 1 - $5,629 Year 2 - $5,865
Per ISU policy, funding is requested each year to provide 50% tuition support for the one (1) MS Non-Engineering Graduate Research Assistant. Tuition is listed at the rates approved by the Iowa State University.

FRINGE BENEFITS ($4,894)
Fringe benefits are calculated at 9.8% for the Graduate Research Assistant.

TRAVEL ($10,310)
Domestic – Travel funds are requested to attend the NC 213 meetings in 2017 and 2018, as well as professional conferences related to this project each year. The purpose of attending the meetings and conference is to present new project results to the scientific community as they become available.

Foreign – Funds are requested for travel to one international conference to present new project results to the scientific community.

PUBLICATION CHARGES ($1,764)
Funds are requested to defray publication costs of scientific articles in various peer-reviewed journals as a result of this research. Funding support for two shorter manuscripts (i.e. 12-14 pages each) or one longer manuscript for ASABE journals is requested.

SUBCONTRACT – Purdue University ($71,000)
A detailed budget and budget narrative are included in the proposal for the subcontractor.

INDIRECT COSTS ($0)

Not allowable, per sponsor guidelines (page 10).