**Agreement to participate in the pilot survey**

Your participation is completely voluntary and will be anonymous. To take this pilot survey, you must be:

* At least 18 years old
* You must be a grain farmer who stores grain or grain elevator/operation manager

If you meet these criteria and would like to take the survey, click the button below to start.

To Whom It May Concern

**Questionnaire on Adoption and Challenges of Stored Grain Monitoring Technologies**

Anecdotal evidence suggests that there is low adoption of stored grain monitoring and management technologies on-farms (less than 10%) and off-farms (grain elevators and processing facilities; less than 30%). The reasons for this low adoption have not been investigated and so not clearly understood. With the increasing growth of digital/smart agriculture, and the recent entry of a number of technology start-ups to stored grain monitoring and management space, it is imperative to understand what features these new tools offer, what tools are being adopted or not adopted, and how best to tailor the development of these tools based on challenges/need for managing large stocks of grain on and off-farm.

This research survey aims to gain valuable insights into the current state of stored grain monitoring technologies and management software (apps), and their adoption among farmers and grain elevators in the United States. Your participation and responses will contribute to helping us better understand the state of stored grain monitoring technologies/management apps, and their adoption in order to guide their future developments and strategies within the grain industry. Additionally, one of the outcomes of this research will be to better guide industry and research on what tools and features in stored grain management apps farmers and operation managers desire, and what training need to be developed by industry and our land-grant Extension system.

Thank you for taking the time to share your experiences and perspectives, and do not hesitate to contact me at [ileleji@purdue.edu](mailto:ileleji@purdue.edu).

Sincerely yours,

Klein E. Ileleji, PhD.

Professor & Extension Engineer

Principal Investigator

Agricultural & Biological Engineering

Akhere Olenloa, PhD Candidate

Graduate Research Assistant

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**SECTION 1: This section is about the demographic information of the respondents**

1. What is your gender? [mark only one]

[ ] Male [ ] Female [ ] Prefer not to say [ ] Self describe [*please specify*]: \_\_\_\_\_\_\_\_\_\_\_

1. What is your current age in years?

[ ] 18–24 [ ] 25–34 [ ] 35–44 [ ] 45–54 [ ] 55–64 [ ] Over 65

1. What is your race/ethnicity?

[ ] American Indian or Alaska Native [ ] Asian or Asian American

[ ] Black or African American [ ] Hispanic or Latino

[ ] Native Hawaiian and Other Pacific Islander [ ] White or European

[ ] Other: [*please specify*] My race/ethnicity is best described as: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What is your highest educational level?

[ ] Less than High School [ ] High School [ ] Professional Certification

[ ] 2-Year College/Tech Degree [ ] Bachelor’s Degree [ ] Master’s Degree

[ ] Doctoral Degree [ ] Other: [*please specify*] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. If yes checked one of the degree boxes above, what degree did you obtain?

[ ] Agricultural Systems and Management [ ] Engineering [ ] Agricultural technology

[ ] I do not have a technical degree [ ] Other [*please specify*]: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What is your annual gross cash farm income (GCFI) ($)?

[ ] less than $350,000 [ ] $350,000 – $999,999 [ ] $1 million or more

1. How many years of experience do you have in grain storage and management?

[ ] 0–5 [ ] 6–11 [ ] 12–18 [ ] 19–25 [ ] 26–32 [ ] 33–39 [ ] Over 40

1. Where are you located in the United States?

*(Dropdown box of all 50 US states)*

**SECTION 2: This section is about stored grain facility and their characteristics**

1. Is/Are your stored grain facility(ies) located in the United States?

[ ] Yes [ ] No

* 1. If **yes**: Indicate the state where your stored grain facility(ies) is/ are located in the US

*(Dropdown box of all 50 US states)*

1. What type of grain(s) do you store in your grain storage facility(ies)? (Multiple select checkboxes)

[ ] Corn [ ] Soybeans [ ] Wheat [ ] Rice [ ] Sorghum [ ] Barley

1. On average, what is the total grain storage capacity in your facility?

[ ] Less than 50,000 bushels (1.97 million metric tons)

[ ] 50,001 – 100,000 bushels (1.97 – 3.94 million metric tons)

[ ] 100,001 – 150,000 bushels (3.94 – 5.91 million metric tons)

[ ] 150,001 – 200,000 bushels (5.91 – 7.87 million metric tons)

[ ] 200,001 – 250,000 bushels (7.87 – 9.84 million metric tons)

[ ] 250,001 – 300,000 bushels (9.84 – 11.81 million metric tons)

[ ] Over 300,000 bushels (11.81 million metric tons)

1. What is the average storage period (in months) for grains at your facility?

[ ] Less than 3 months [ ] 4–8 months [ ] 9–13 months [ ] 14–18 months

[ ] 19–23 months [ ] Over 24 months

1. What type of grain storage structure do you have at your facility?

[ ] Cylindrical steel [ ] Cylindrical concrete [ ] Flat storage warehouse

1. What size capacity of grain bins do you have at your storage facility? [*please specify*] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (short answer textbox)
2. Where does your grain storage facility reside?

[ ] On-farm [ ] Grain Elevator (Country elevator) [ ] Grain Elevator (Terminal)

[ ] Grain processing facility (Feed mill) [ ] Grain processing facility (food)

1. How long has the business (grain processing, stored grain management) being in operation?

[ ] 0–10 [ ] 11–20 [ ] 21–30 [ ] 31–40 [ ] 41–50 [ ] 51–60 [ ] 61–70 [ ] Over 71

1. Do you lose grains to spoilage?

[ ] Yes [ ] No

1. If ***Yes*** above, approximately by what percentage loss of grain \_\_\_\_\_\_\_\_\_\_\_\_\_?
2. Are any stored grain monitoring technologies (ex. Temperature sensors/cables, CO2 sensors, etc) adopted at your facility? *If* ***Yes,*** *then continue below, if* ***No****, proceed to Section 4 (No. 26).*

**SECTION 3: This section is about stored grain monitoring technologies and their capabilities**

1. Are you the primary decision maker for the use of stored grain monitoring technologies?

[ ] Yes [ ] No

1. Describe the state of stored grain monitoring technologies in your facility by answering these three (3) statements?

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Agree** | **Disagree** | **Do not know** |
| At least one form of stored grain monitoring technology is installed in my facility |  |  |  |
| At least one form of stored grain monitoring technology is functional in my facility |  |  |  |
| Employees are trained to manage stored grain monitoring technologies in my facility |  |  |  |

1. Which of these company’s stored grain monitoring technologies do you use at your facility(ies)? (Multiple select checkboxes)
2. Ag Growth International (AGI)
3. Agrolog
4. AgSense
5. Amber Ag
6. BinMaster
7. Bin-Sense
8. Centaur Ag
9. Cimbria
10. Ergson
11. Extron
12. Farm Shop Mfg. LLC
13. Gescaser
14. Grain Systems (GSI)
15. GrainMonitor
16. GrainX
17. iGrain
18. IntelliFarms
19. OPI
20. Quanturi
21. Skyway Grain Systems Inc.
22. Smart Grain Solutions (SGS)
23. TeleSense
24. Tri-States Grain Conditioning (TSGC)
25. Wiagro
26. Other [*please specify*]: \_\_\_\_\_\_\_\_\_\_\_\_ (short answer textbox)
27. Which of the following features and capability of stored grain monitoring systems do you currently use? (Mark all that apply) (Multiple select checkboxes)
28. Temperature monitoring
29. Moisture monitoring
30. Relative humidity monitoring
31. CO2 monitoring
32. Insect monitoring
33. Volumetric monitoring
34. Automatic data logging
35. Grain conditioning
36. Automatic aeration control
37. Sensors on cables
38. Automatic inventory monitoring
39. Remote data access
40. Actionable decision-making support
41. Early spoilage detection
42. Expert service provider
43. System monitoring alarm
44. Phosphine monitoring
45. Other [*please specify*]: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (short answer textbox)
46. For the following parameters, please briefly describe the use of these monitored parameters if you monitor it.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Parameter monitored** | **How is parameter monitored (for example: using cables, field sensors, hand held devices etc)** | **Frequency of monitoring (for example: hourly, daily, monthly, etc.)** | **How parameter is used in stored grain management (for example: for aeration purpose, tracking spoilage etc)** |
|  | Temperature |  |  |  |
|  | Relative humidity |  |  |  |
|  | Carbon dioxide (CO2) |  |  |  |
|  | Moisture content |  |  |  |
|  | Insect counts |  |  |  |

**SECTION 4: This section is about the perceptions and benefits of stored grain monitoring technologies**

1. For those who use stored grain monitoring technologies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| My experiences with managing stored grain have contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| My challenges with managing stored grain have contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| I am getting a return of investment which contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| I am getting the support and value from using stored grain monitoring technologies |  |  |  |  |  |

1. For those who do not use stored grain monitoring technologies **(skips if answering 25)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| My experiences with managing stored grain have contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| My challenges with managing stored grain have contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| I am getting a return of investment which contributed to my decision to adopt stored grain monitoring technologies |  |  |  |  |  |
| I am getting the support and value from using stored grain monitoring technologies |  |  |  |  |  |

1. What are the benefits of using stored grain monitoring technologies by your company/organization/business? (*Skip for those who do not use/adopt stored grain monitoring technologies*)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| Aeration management |  |  |  |  |  |
| Ability for real-time monitoring |  |  |  |  |  |
| Data analytics |  |  |  |  |  |
| Ease of monitoring stored grain |  |  |  |  |  |
| Financial management of stored grain |  |  |  |  |  |
| Indications of early detection of grain spoilage |  |  |  |  |  |
| Interoperable/compatibility with other technologies |  |  |  |  |  |
| Helps in timely intervention |  |  |  |  |  |
| Provides actionable decision-making list/guidelines |  |  |  |  |  |
| Prevent hazard exposure |  |  |  |  |  |
| Reduces stress and labor |  |  |  |  |  |
| Reliability |  |  |  |  |  |
| Saves time |  |  |  |  |  |
| Stored grain monitoring technologies have helped in preventing stored grain spoilage and financial loss |  |  |  |  |  |
| Utilization of stored grain monitoring technologies increase profit |  |  |  |  |  |

1. I believe my company/organization/business benefits of using stored grain monitoring technologies by your organization/business? (*Skip for those who use/adopt stored grain monitoring technologies*)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| Aeration management |  |  |  |  |  |
| Ability for real-time monitoring |  |  |  |  |  |
| Data analytics |  |  |  |  |  |
| Ease of monitoring stored grain |  |  |  |  |  |
| Financial management of stored grain |  |  |  |  |  |
| Indications of early detection of grain spoilage |  |  |  |  |  |
| Interoperable/compatibility with other technologies |  |  |  |  |  |
| Helps in timely intervention |  |  |  |  |  |
| Provides actionable decision-making list/guidelines |  |  |  |  |  |
| Prevent hazard exposure |  |  |  |  |  |
| Reduces stress and labor |  |  |  |  |  |
| Reliability |  |  |  |  |  |
| Saves time |  |  |  |  |  |
| Stored grain monitoring technologies have helped in preventing stored grain spoilage and financial loss |  |  |  |  |  |
| Utilization of stored grain monitoring technologies increase profit |  |  |  |  |  |

1. Factors influencing adoption of stored grain monitoring technologies.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| Demand of the monitoring technologies |  |  |  |  |  |
| Previous experience(s) with stored grain and financial loss |  |  |  |  |  |
| Sensitization by extension workers and services |  |  |  |  |  |
| Grain storage capacity |  |  |  |  |  |
| Availability of financial resources such as Increased profit generation |  |  |  |  |  |
| Research effort |  |  |  |  |  |
| Personal effort |  |  |  |  |  |
| Accessibility to training on new technologies |  |  |  |  |  |
| Incentives by technologies (such as discounted cost, free installation) |  |  |  |  |  |

**SECTION 5: This section is about the challenges and limitations facing the use and/or adoption of stored grain monitoring technologies**

1. Challenges and limitations facing the use and/or adoption of stored grain monitoring technologies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Strongly Disagree** | **Disagree** | **Neither Agree nor Disagree** | **Agree** | **Strongly Agree** |
| Availability of capital |  |  |  |  |  |
| Knowledge on how to use the technology |  |  |  |  |  |
| Trust between the stored grains technological companies |  |  |  |  |  |
| Data privacy concerns |  |  |  |  |  |
| Security concerns (can anyone else access my data) |  |  |  |  |  |
| Cost of technology |  |  |  |  |  |
| Maintenance of technology |  |  |  |  |  |
| Compatibility with other technologies |  |  |  |  |  |
| Continuous evolving technology (upgrade requirements) |  |  |  |  |  |
| Complexity of the technology |  |  |  |  |  |
| User experience of technology |  |  |  |  |  |
| How to derive value from collected data |  |  |  |  |  |
| Lack of understanding how to interpret/use the data |  |  |  |  |  |
| Lack of interest |  |  |  |  |  |
| Lack of service providers/technical support |  |  |  |  |  |
| Installation of stored grain monitoring technologies is stressful |  |  |  |  |  |
| Poor local infrastructure (ex. Inadequate internet connection) |  |  |  |  |  |
| Unreliable sensors |  |  |  |  |  |