NDSU NORTH DAKOTA STATE UNIVERSITY

Large-Scale Beef Cattle Precision Management Research Facility

Our Need

A critical need for the beef cattle research program at NDSU is the development and evaluation of emerging precision livestock management tools to manage beef cattle. Featuring the latest innovations, a large-scale research facility would be added at the Beef Cattle Research Complex at Main Station in Fargo, where the largest body of scientists in the state are located. The Beef Cattle Research Complex, completed in 2011, garners national attention. This facility helped the Department of Animal Sciences secure 4 of 5 USDA NIFA grants in 2021. While this is great, it has created a strain on our facilities. To maintain competitiveness with granting agencies, recruit and keep faculty, recruit graduate students, and grow a stronger workforce, our infrastructure needs to be expanded to answer complex questions and maintain and grow our research programs at NDSU. If quality beef cattle research is to continue, it is paramount that our scientists have ready access to research facilities.

The mission of North Dakota State University is to provide transformational education, create knowledge through innovative research, and share knowledge through community engagement that meets the needs of North Dakota and the world. As a department within North Dakota State University, the Department of Animal Sciences serves beef cattle producers and the beef industry by conducting relevant basic, translational, and applied research. To better meet our mission, a dedicated large-scale beef cattle precision management research facility to advance and support emerging precision technology for livestock management, improvement of beef cattle production, natural resource stewardship, and economic viability is needed to foster innovative research and deliver transformative education and Extension programming.

North Dakota is one of the top ten cow-calf states in the U.S. In 2021, the beef industry of North Dakota generated approximately $1.15 billion and ranked fourth in agriculture commodities behind soybeans, wheat, and corn. There is tremendous opportunity for North Dakota to expand our animal agriculture industry because some of the most inexpensive feed resources in the nation are found here. Expanding our animal agricultural industry benefits livestock and beef cattle producers and grain producers, resulting in less dependence on volatile export markets. When the economic importance of beef cattle and crops to North Dakota is considered, the need to strengthen our applied beef cattle research is evident.

DEPARTMENT OF ANIMAL SCIENCES
College of Agriculture, Food Systems, and Natural Resources
Hultz Hall | NDSU Dept 7630 | PO Box 6050 | Fargo ND 58108-6050 | 701.231.7641 | Fax 701.231.7590

NDSU is an EO/AA university.

Proposal

We propose a beef cattle research facility located with the existing Beef Cattle Research Complex. This facility will allow for large-scale, well-replicated, pen-based beef cattle research. The proposed precision management research facility will support cow-calf, stocker, grower, finisher, and nutrient management programs and would allow for greater collaboration between departments and discipline groups and for the development and evaluation of innovative research to advance sustainable beef production.

Investigations of innovative, basic, and applied research would test precision livestock technologies to evaluate cattle performance and welfare, animal health, discover solutions to environmental challenges, and explore manure and nutrient management systems. In addition, demonstration space will provide hands-on experience and training opportunities for the future workforce of North Dakota's beef industry.

The building design would be similar to the existing facility at the BCRC, with a monoslope design and dry lot access for each pen. The proposed facility would consist of **24** pens; each pen would have approximately 25 feet of bunk space for a capacity of 10 cows or 15 to 20 growing cattle. Holding pens will be added to the existing animal handling and feed commodity storage facilities so they would support the additional facility and animals. A suspended walkway will be positioned above the pens for housing current and future precision technology equipment (i.e., animal movement, behavioral patterns, phenotypic signs of health, infrared body temperature, gas sensors, etc.) as well as serving as an observation deck. Included in the infrastructure will be a framework for databases to account for big data collection, storage, and security. The facility will be designed to collect samples and take measurements on individual animals, groups or pens of animals, and entire systems (i.e., feed and animal waste, gasses emitted, environmental variables, etc.). This facility will provide the necessary infrastructure to validate precision technologies and strengthen our collaborative capacity with tech companies (i.e., 701X). This research will foster collaborative relationships across departments, universities, and private industry to help address the needs of North Dakota beef cattle producers.

Some of the research equipment can be used in this research facility and on grazing conditions (RumiWatch system, pedometers, accelerometers, etc.). Others only for enclosed barns (gas sensors) or grazing environment (water systems, virtual fencing, Optiweigh, etc.).

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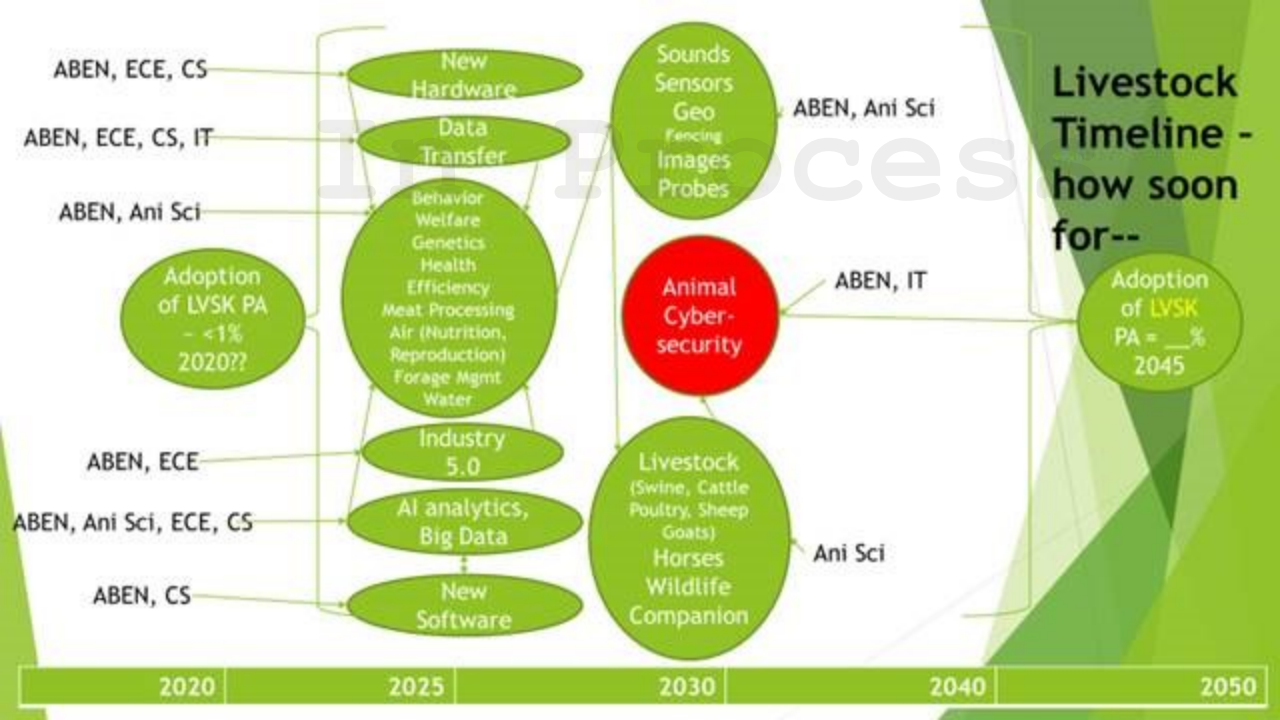
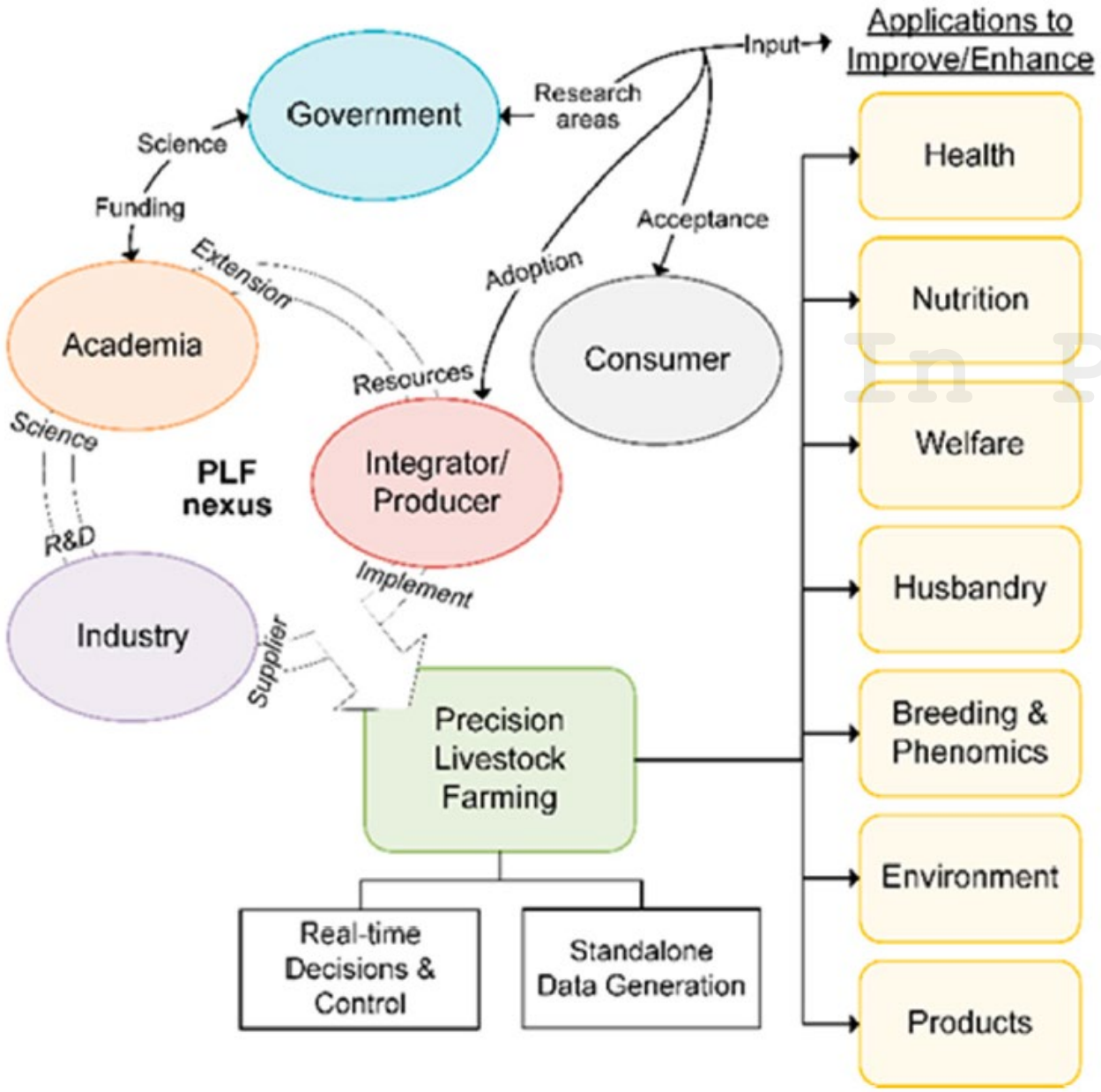
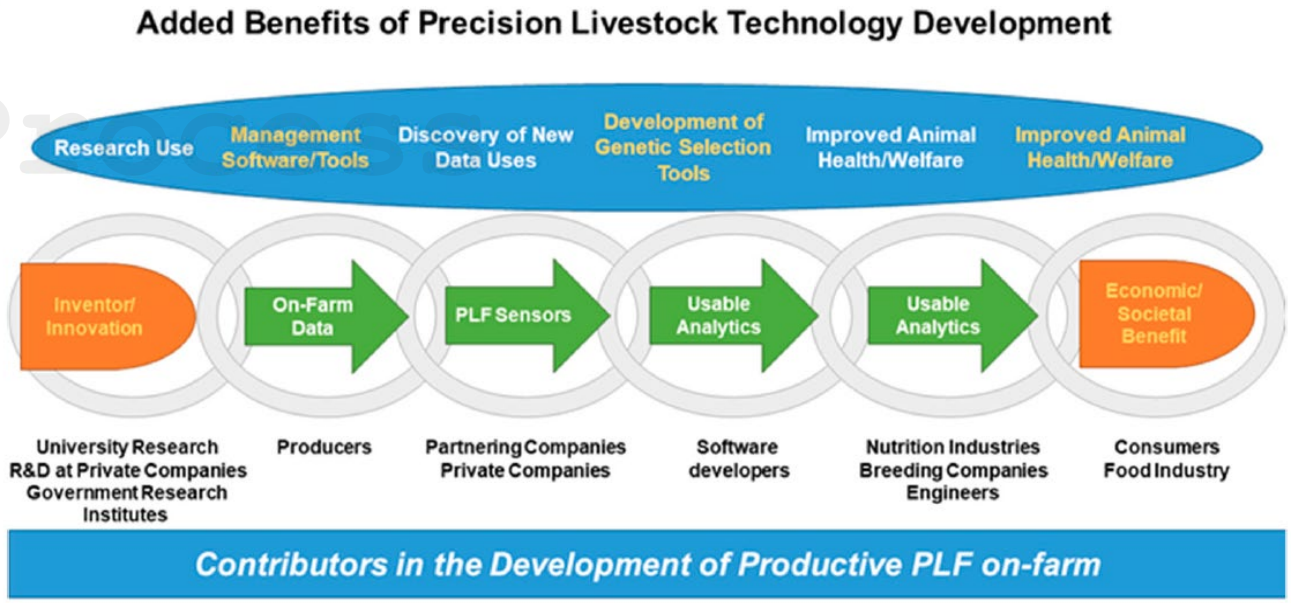
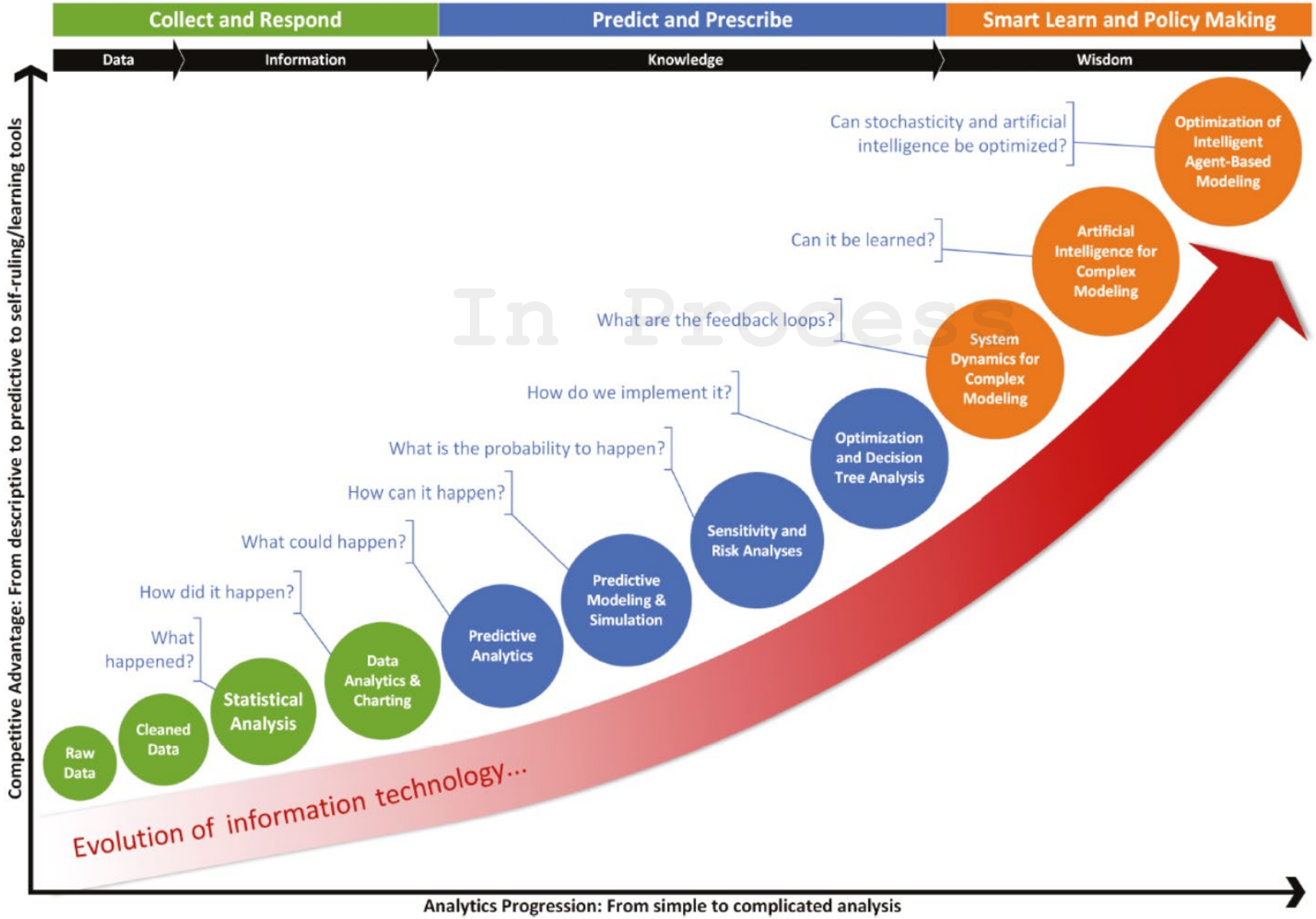

ABEN, ECE, CS
New Hardware
ABEN, ECE, CS, IT
Data Transfer
ABEN, Ani Sci
Behavior
Welfare
Genetics
Health
Efficiency
Meat Processing
Air (Nutrition, Reproduction)
Forage Mgmt
Water
Adoption of LVSK PA - <1% 2020??
ABEN, ECE
Industry 5.0
ABEN, Ani Sci, ECE, CS
AI analytics, Big Data
ABEN, CS
New Software
Sounds
Sensors
Geo Fencing
Images
Probes
ABEN, Ani Sci
Animal Cyber-security
ABEN, IT
Livestock
(Swine, Cattle Poultry, Sheep Goats)
Horses
Wildlife
Companion
Ani Sci
Livestock Timeline - how soon for--
Adoption of LVSK PA = __% 2045
2020
2025
2030
2040
2050

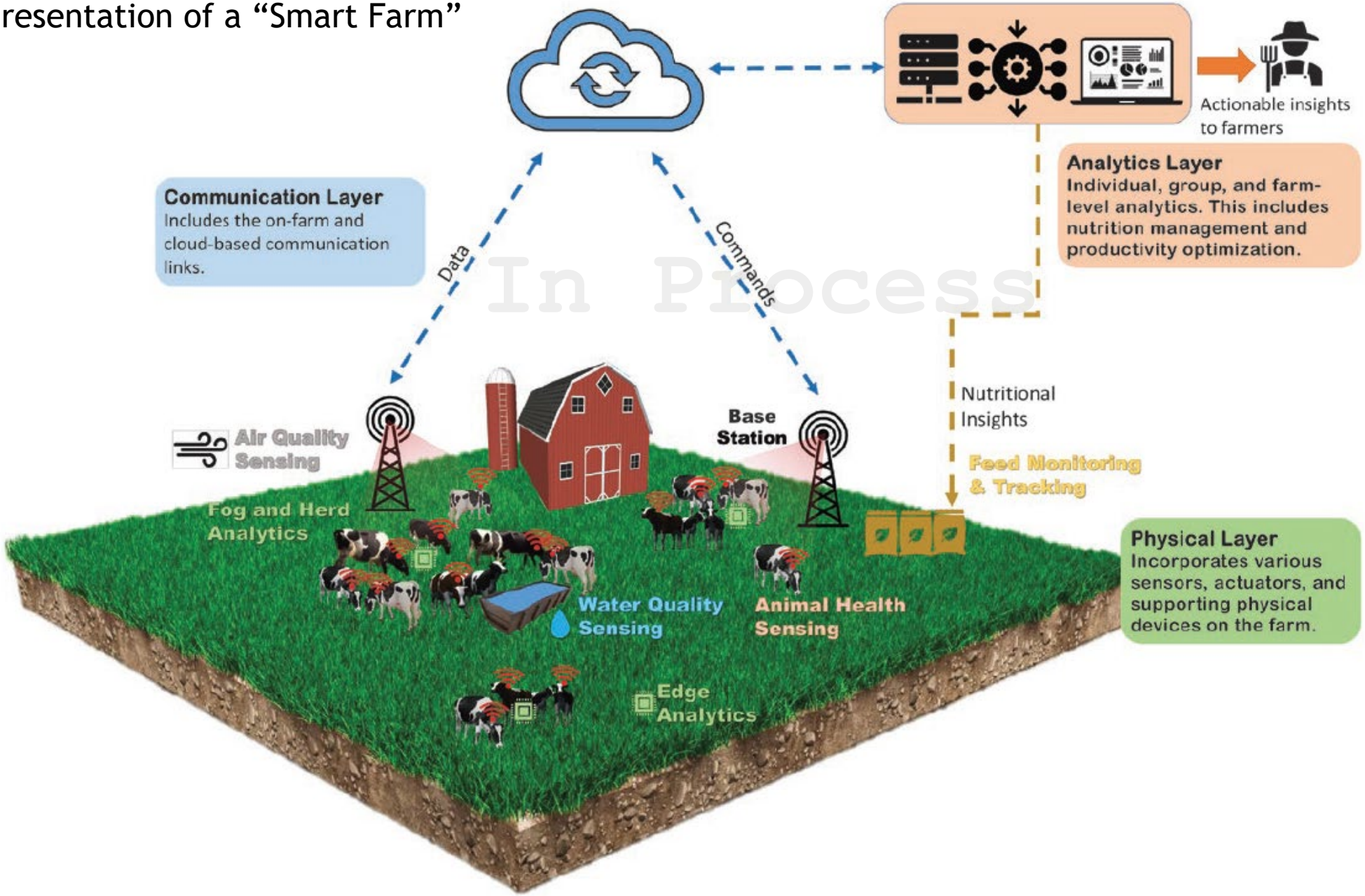
Stakeholders participation in PLF

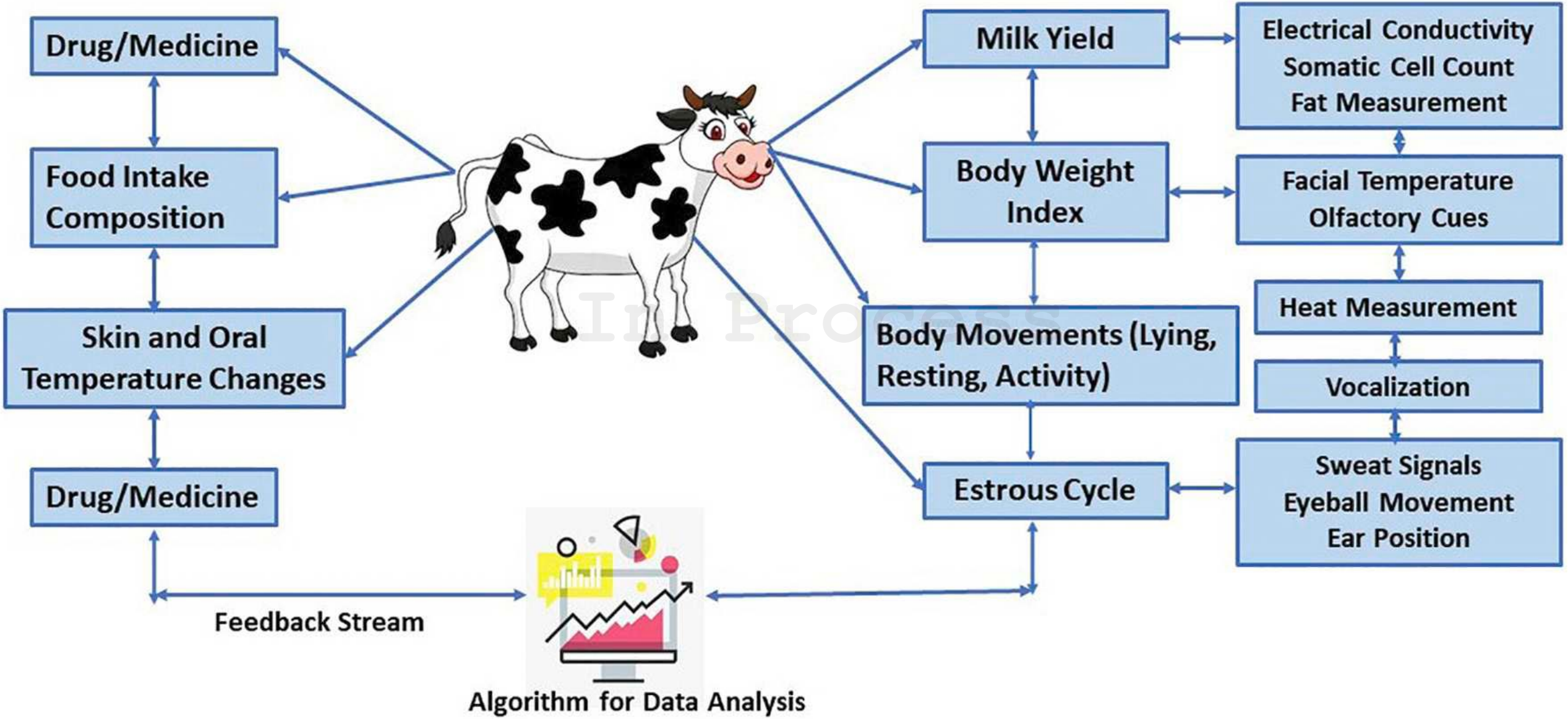





Collect and Respond
Predict and Prescribe
Smart Learn and Policy Making
Data
Information
Knowledge
Wisdom
Competitive Advantage: From descriptive to predictive to self-ruling/learning tools
Analytics Progression: From simple to complicated analysis
Raw Data
Cleaned Data
What happened?
Statistical Analysis
How did it happen?
Data Analytics & Charting
What could happen?
Predictive Analytics
How can it happen?
Predictive Modeling & Simulation
What is the probability to happen?
Sensitivity and Risk Analyses
How do we implement it?
Optimization and Decision Tree Analysis
What are the feedback loops?
System Dynamics for Complex Modeling
Can it be learned?
Artificial Intelligence for Complex Modeling
Can stochasticity and artificial intelligence be optimized?
Optimization of Intelligent Agent-Based Modeling
Evolution of information technology…
In Process

Representation of a “Smart Farm”





A representation of how machine learning algorithms might interpret data to create optimal growth conditions in dairy farming

DRAFT

NOT FOR CONSTRUCTION

SCALE, FEET

0 25 50 75 100

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REV.	BY	DATE	DESCRIPTION OF CHANGES

DGA CONSULTING ENGINEERS
4200 21ST ST. SE UNIT 101 MANDAN ND 58554

NDSU DAIRY
DAIRY
NE 1/4 SECTION 35, T 140 N, R 49 W
CASS COUNTY, ND

PROPOSED HEIFER/DRY COW BARN

DATE:	APR 8, 2020
SCALE:	1" = 50'
DRAWN BY:	NAP
CHECKED BY:	NAP

SHEET: C1.1

In Process

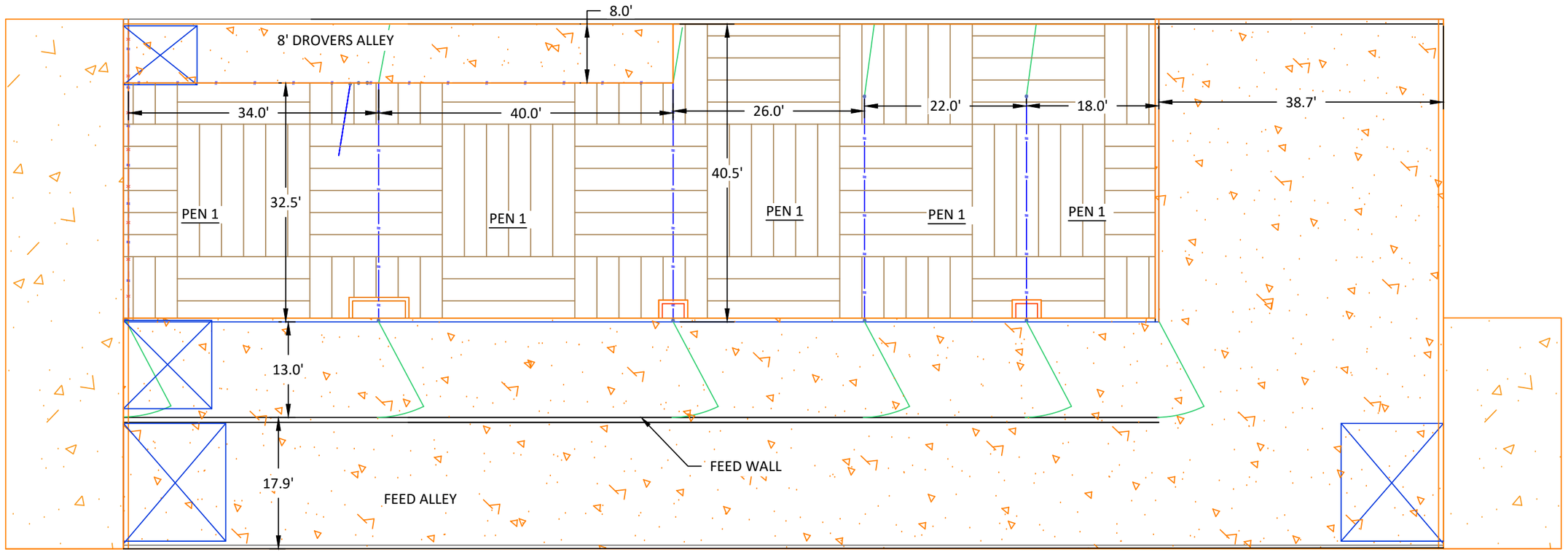
PEN 1
11 HEAD CLOSEUP PEN
36" BUNK SPACE
100 FT²/HEAD
ADD COWS WEEKLY

PEN 2
14 HEAD FAR-OFF PEN
34" BUNK SPACE
92 FT²/HEAD

PEN 3
18 HEAD LATE
PREGNANT HEIFER PEN
17" BUNK SPACE
59 FT²/HEAD

PEN 4
18 HEAD LATE EARLY
PREGNANT HEIFER PEN
15" BUNK SPACE
50 FT²/HEAD

PEN 5
18 HEAD BREEDING
HEIFER PEN
12" BUNK SPACE
41 FT²/HEAD



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SHEET: A1.1

Dairy Barn Improvements

New Heifer Barn

This building would have capacity for 65 head. Barn space would be primarily for developing heifers that are currently housed outside from 6 months old until freshening (first calf) at 22-24 months of age. Housing these animals indoors will have major implications towards improving the health, feed efficiency, and growth performance of these developing milk cows. This gable roofed 50'x 80' facility will be positioned in near proximity to main barn, with the close-up pen allowing for a short walk to the milk parlor- facilitating animal movement while improving animal handler safety. This facility would also have pen space for the dry cows, thereby liberating space in the free stall barn. In the second page you will find the schematics that were developed in 2020. We are doing the same request.

Robotic Milking System

Two robotic milking stations would be well suited to the current barns production of 100 cows in milk. Some adjustments to the barn are required to fit the robots and to allow the necessary space for access and exit to it: pens have to be eliminated and expansions of the NW and SE corners of the barn should be added. Robotic milking would greatly reduce the current labor constraints required for 2x/day milking, while also creating new research opportunities for the dairy. Significant improvement (15%) in milk production would likely be observed with the addition of this equipment.

Auto Feeder for baby calves

Individual calf hutches (the current system) are highly labor intensive resulting in multiple feedings daily of pre-weaned calves. An automated feeding system would reduce labor and allow labor to be reallocated to monitor and manage calf health and performance on a more flexible schedule. Automatic calf feeder software can monitor individual milk intake, number of visits rewarded and unrewarded, as well as rate of milk intake. This plethora of information would open up research opportunities at the dairy while also benefitting calf health.

Milking Parlor

Our parlor is also in need for renovation. Having it available will help our research and outreach programs to demonstrate the differences in management (pros and cons) of conventional vs. robotic milking system. This would be a tremendous impact and a comparative advantage to fulfil our land grant mission.

Robotic milking system

Auto feeder calves