Opportunities for Automatic Milking Systems and Grazing in the Upper Midwest

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Outline

- Potential for AMS and grazing in the Upper Midwest: Current & Future Challenges

- The Kellogg Biological Station AMS Project
  - Preliminary results after the 1st year of transition
  - Future directions: Defining "Systems" to address issues of land, labor, profit and climatic change….

Automatic milking systems (AMS)

- > 11,000 units world-wide
- New concept integrating voluntary milking of individual cows with the automation of all steps of the milking process

Cleaning

Attachment

Milking

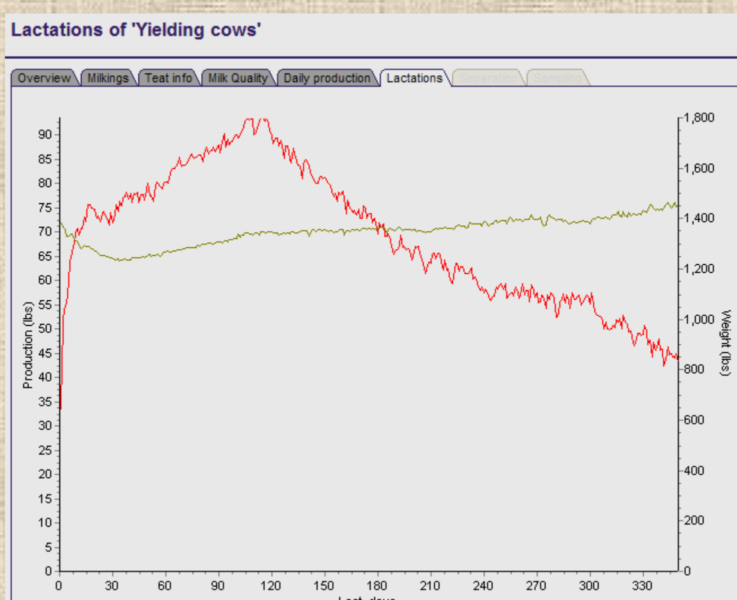
Disinfection

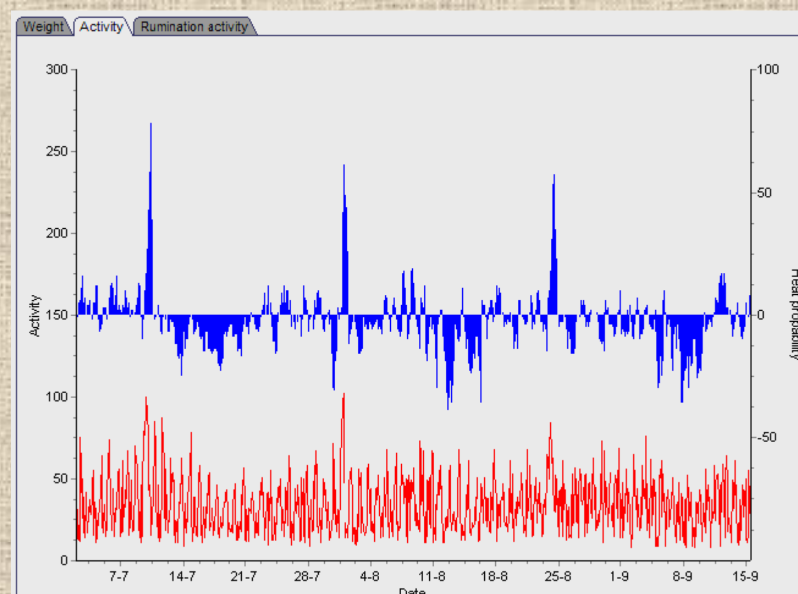
AMS and Technologies

Attentions - Udder health

Udder health | Attention settings

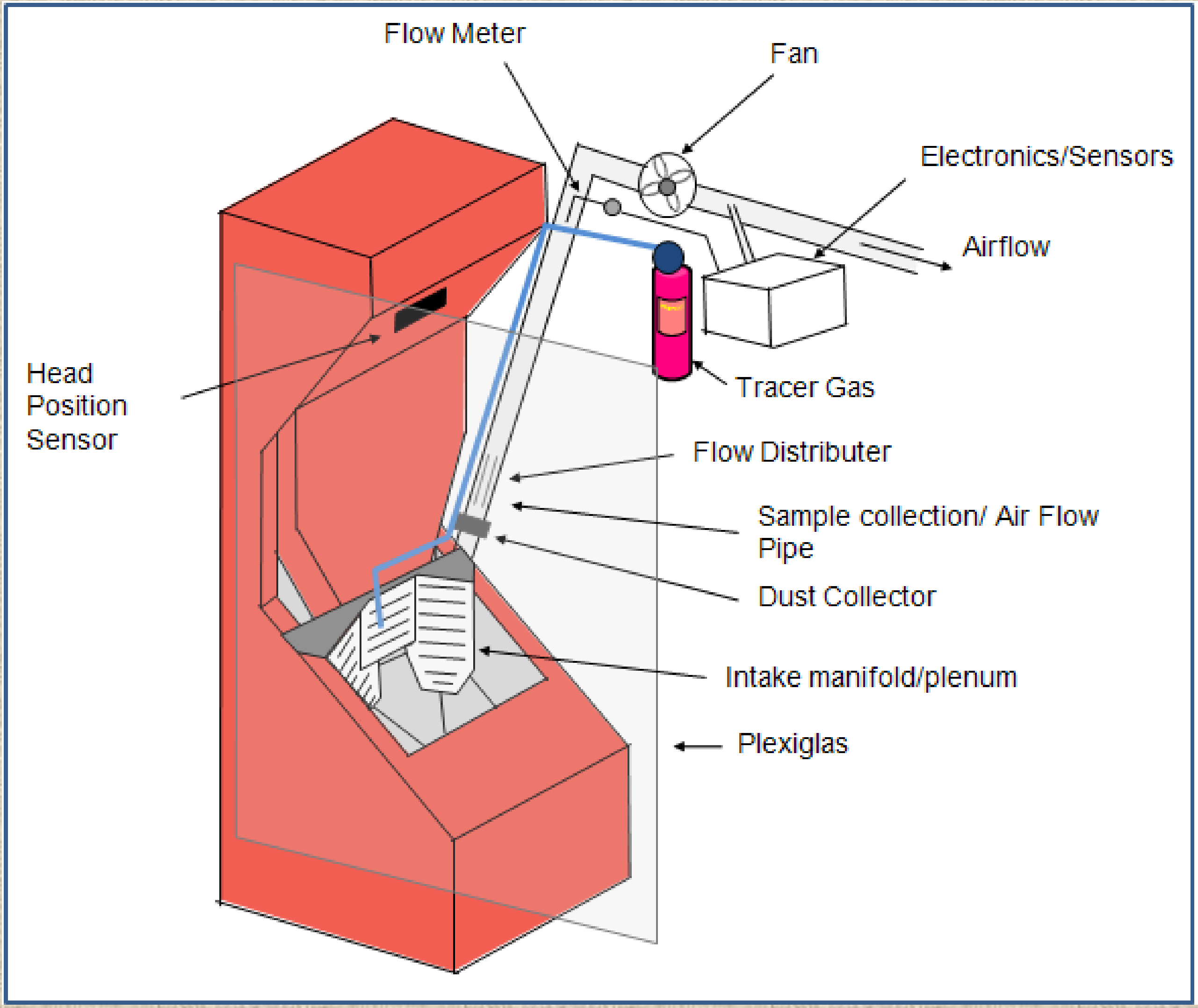
Cow ...	Lact...	Day ...	Dev. ▲	Visit date time		LF CDT	LF SC(	LF COL	RF CDT	RF SC(	RF COL	LR CDT	LR SC(	LR COL	RR CDT	RR SC(	RR COL
2238	252	12.7	-19.1	09-15-2010 05:50	#	82			95		[] Ab...	80			73		
2626	639	15.3	-4.1	09-15-2010 09:02	#	71			65			127 *		[S] H...	0		
2634	532	20.3	-3.0	09-15-2010 04:29		58			62			61			61		[] Ab...
2411	259	74.6	-2.1	09-15-2010 07:06		65			72			70			66		[] Ab...
2621	428	43.2	-0.8	09-15-2010 14:28	#	62			63		[] Ab...	64			63		
2408	7	41.7	1.5	09-15-2010 05:42		76			72			86		[] Ab...	78		
2423	5	47.8	5.8	09-15-2010 05:37		65			62		[S] M...	64			63		[S] M...
2727	2	69.5	12.4	09-15-2010 13:40	#	75		[M] ...	74		[M] ...	78		[M] ...	75		[M]



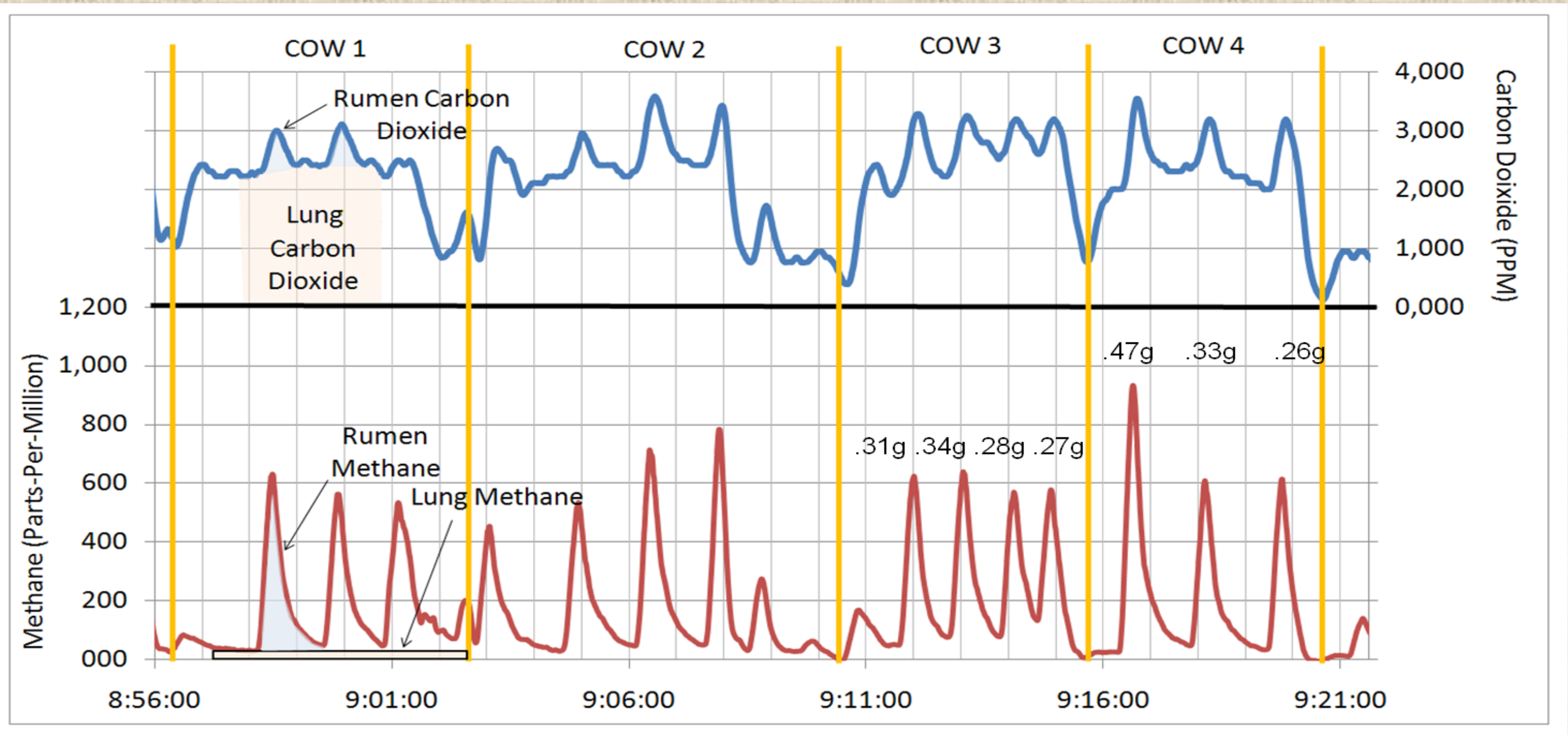


AMS and future technologies

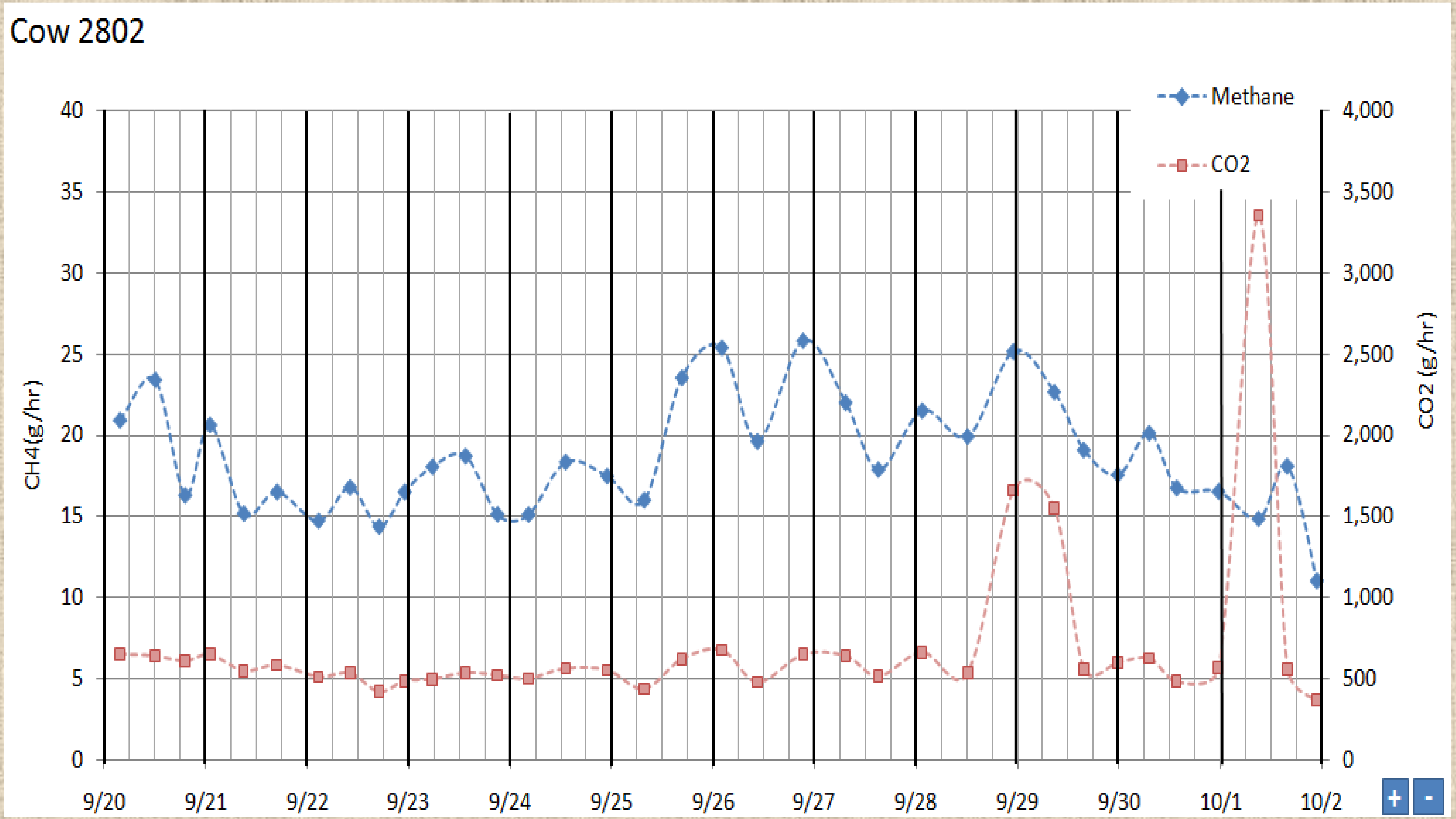
(enteric gas emissions – cow health)



Data from a Lely Robot (at Michigan State University) Four Consecutive Cow Periods Over 20 Minutes

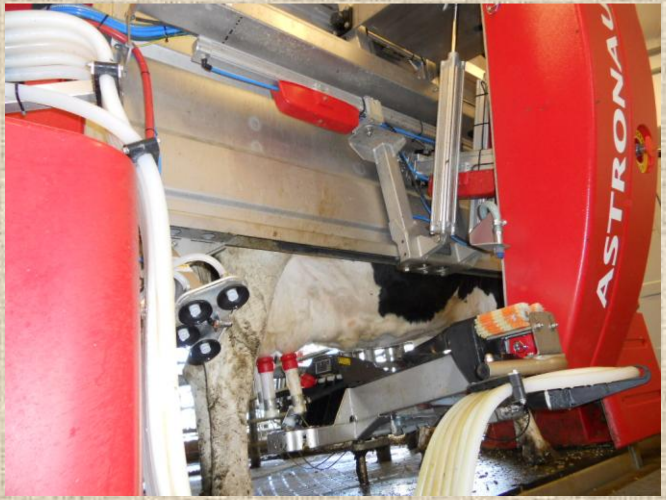


Cow 2802 CH4 and CO2 Emission Trends Over Time



AMS and dairy systems

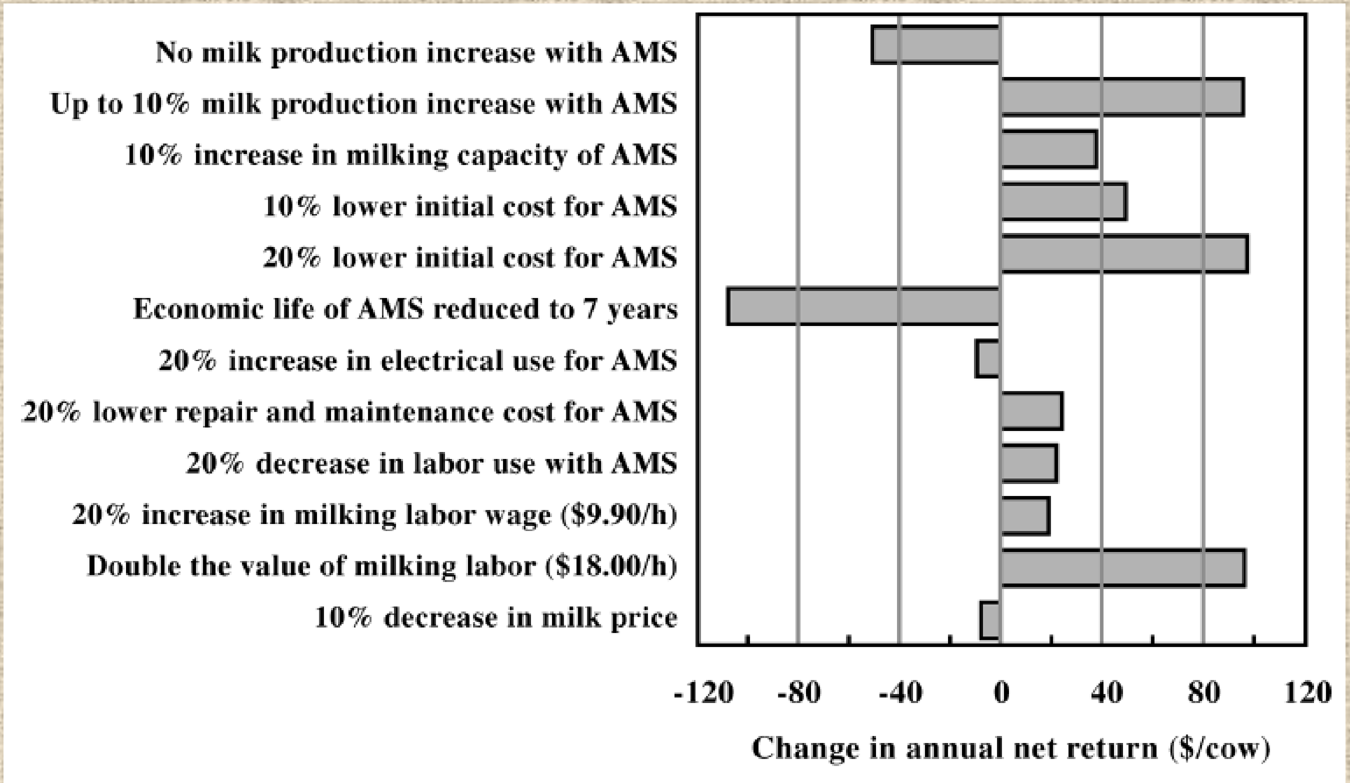
- AMS is a milking system and not a specific type of dairy operation…
- Organize “Robots” around your system …
- Make the “Robots” work for specific production needs and goals…



The US dairy industry, the pressures, and challenges for AMS

- Productivity and profit
- Land, water and other natural resources
- Energy
- Labor
- Animal welfare
- Footprint and Climate change
- Future economic uncertainty?

Sensitivity analysis of automatic milking systems (AMS) relative to traditional parlor milking systems (Rotz et al., 2003)

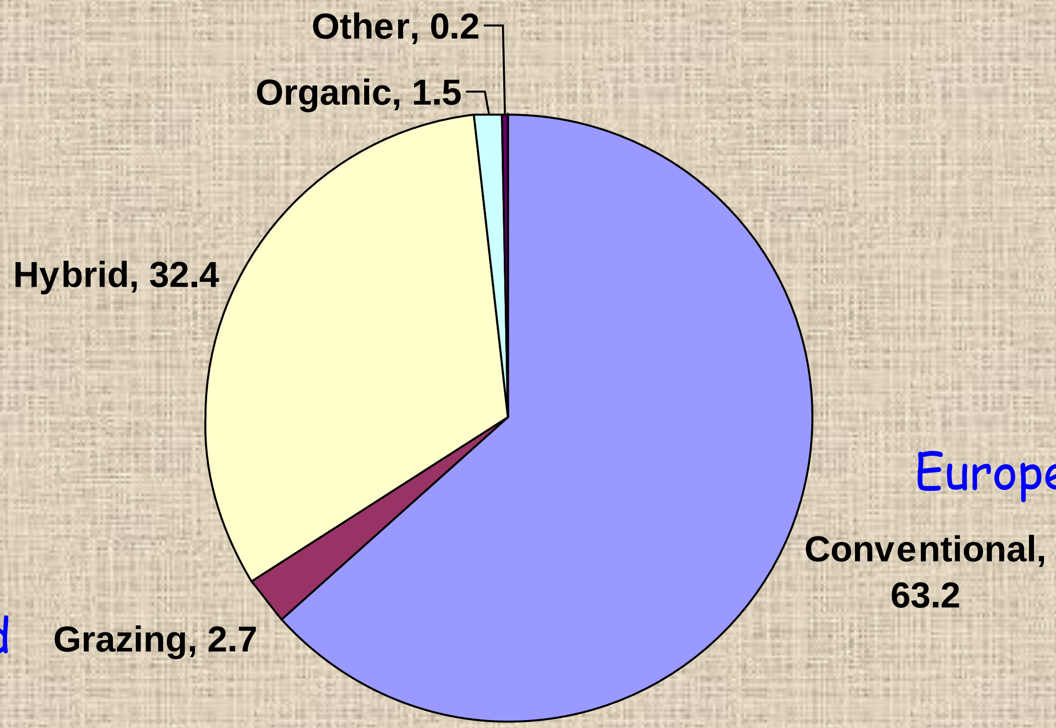


- AMS = High initial investment ($ 200 K per unit)
- Need to maximize milkings and milk output per AMS

Opportunities for AMS in the US

Examples of AMS

Europe, Australia



Europe, Canada

New Zealand

From: Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin

http://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/dairy07/Dairy07_dr_PartI.pdf

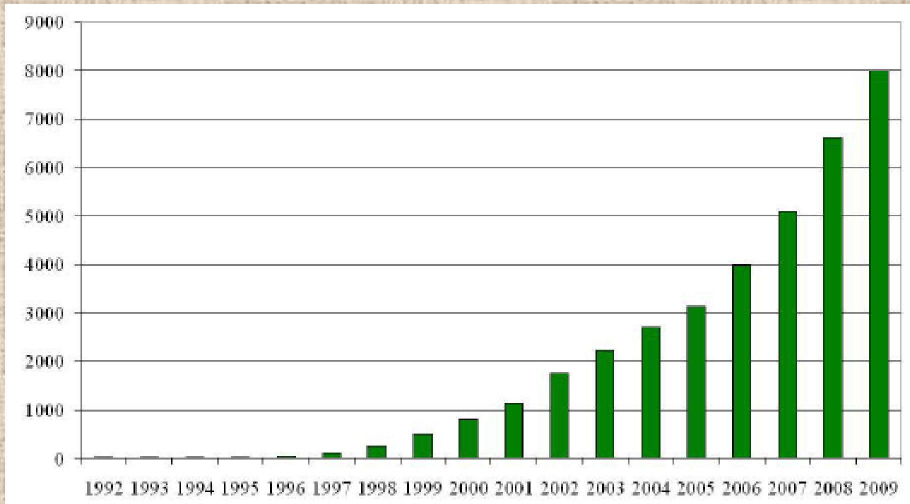
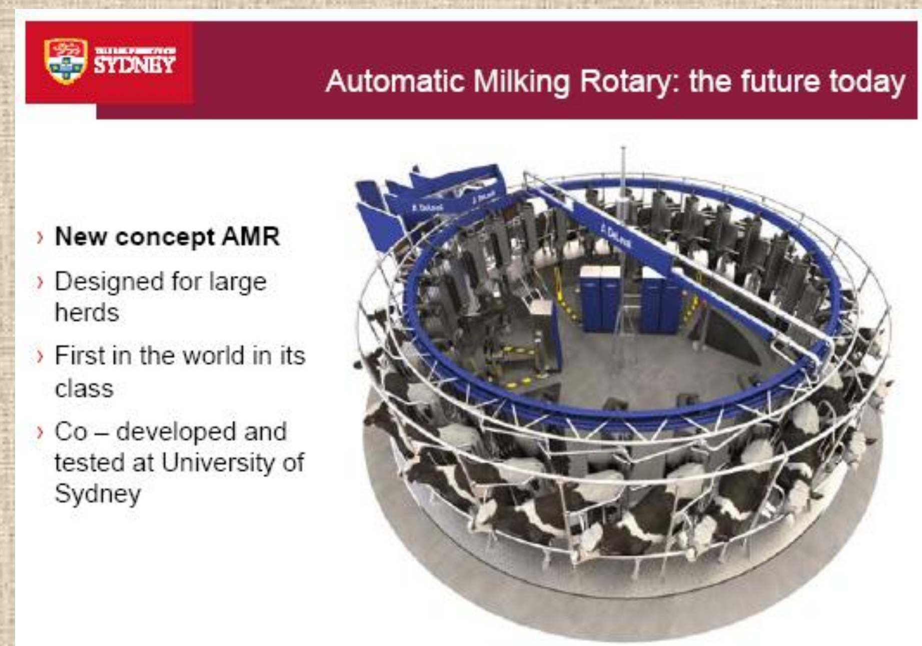


Figure 1. Development of the number of AM-farms world-wide since first introduction in 1992.

(Koning 2010)

Exponential increase of AMS since the first debut in 1992

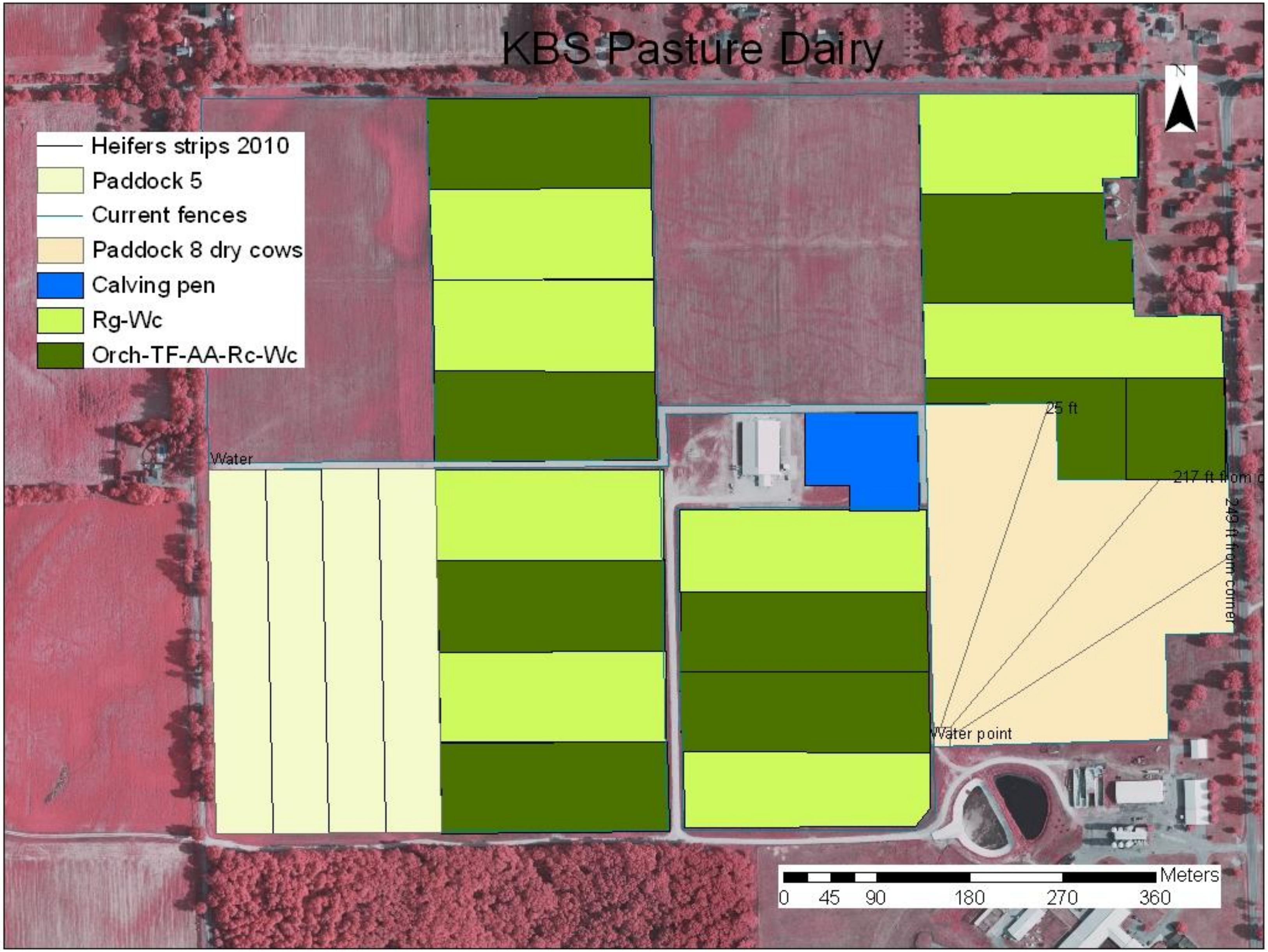


FutureDairy Australia (Garcia et al., 2010)
http://www.delaval.com

With a very promising and competitive future for all segments of the sector (from Small to large dairies and from grazing to confinement dairies)

The Kellogg Biological Station's Pasture & AMS Dairy

A research project on pasture-based dairy systems addressing current and future issues of profit, labor, land and environmental impacts.


KBS Pasture Dairy
N
Heifers strips 2010
Paddock 5
Current fences
Paddock 8 dry cows
Calving pen
Rg-Wc
Orch-TF-AA-Rc-Wc
Water
25 ft
217 ft from c
249 ft from corner
Water point
Meters
0 45 90 180 270 360

The Grazing Component

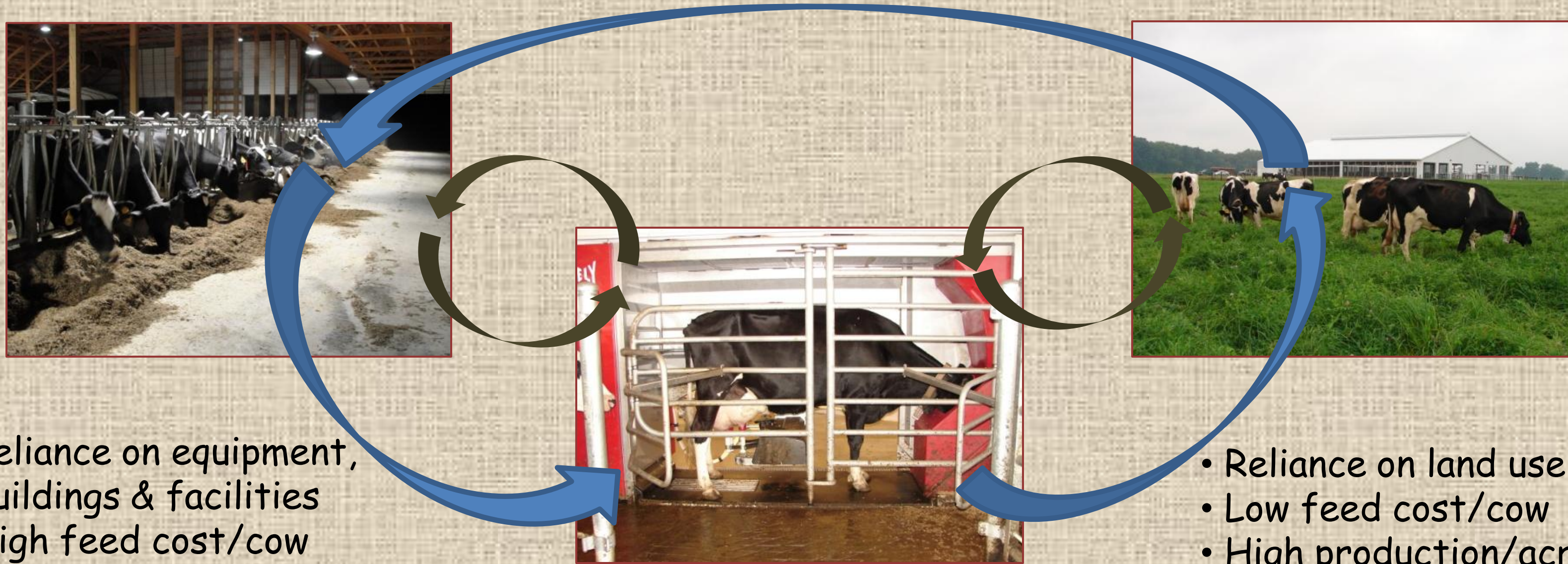
Computer-controlled exit gates

Improved cow laneways (2-way)

Orchardgrass-fescue-alfalfa-clovers

Ryegrass-white clover

Putting The Pieces Together



- Reliance on equipment, buildings & facilities
- High feed cost/cow
- High production/cow

- Fewer cows per robot (60/robot)
- High milking frequency (> 3)
- High yield/milking (> 22 lb)

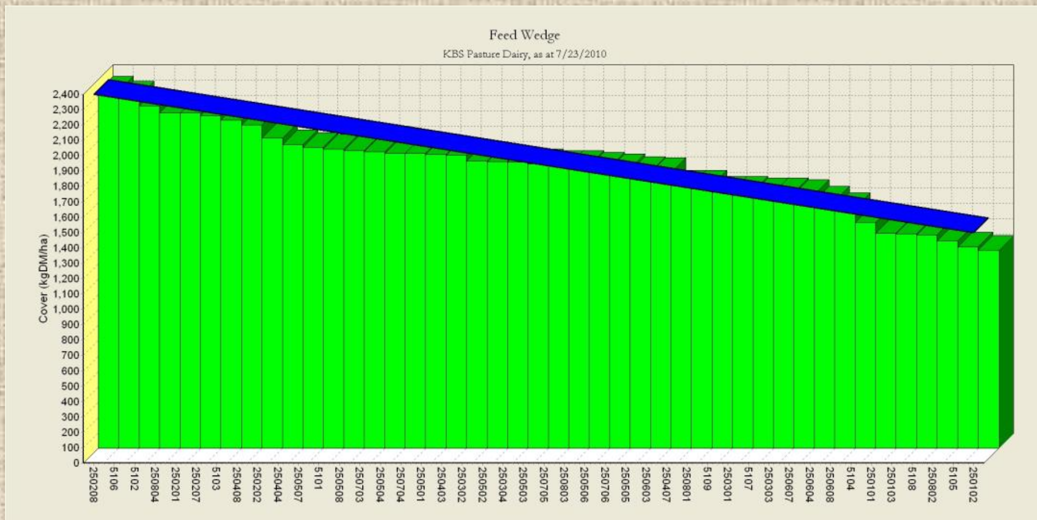
- **Optimize the occupation time per robot**
- **Maximize the milk flow per robot**

- Reliance on land use
- Low feed cost/cow
- High production/acre
- Lower production/cow

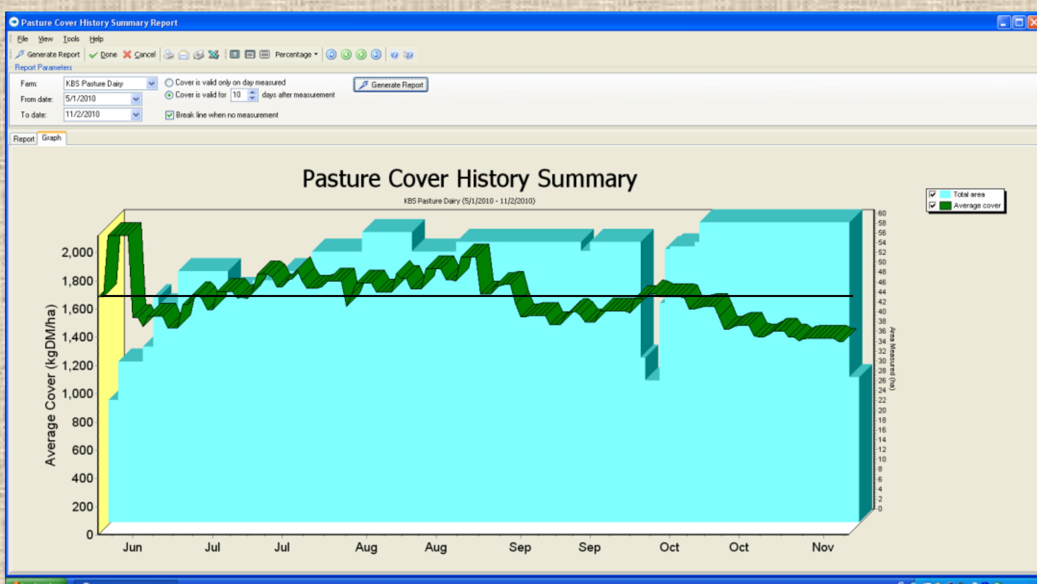
- More cows per robot (> 60/robot)
- Low milking frequency (< 3/d)
- Low yield/milking (< 22 lb)

Efficient year-around Automatic Milking requires strategic management plans to optimize voluntary milkings and milk flow per robot along the year

Precision grazing management



Laser-based Rapid Pasture Meter



Transitioning to pastures

Table 2. Milking behavior and performance of dairy cows

	Week												
	1	2	3	4	5	6	7	8	9	10	11		
	Time on pastures (h)												
Variable	0	2	4	6	8	12	12	12	12	12	12	SEM	*P* <
Cows, number/group	48	49	47	47	47	48	45	44	45	42	41	3	0.87
Body weight, kg	608	606	605	602	596	600	600	603	605	604	600	14	0.76
Milkings, milkings/cow/d	3	2.7	2.9	2.7	2.6	2.4	2.5	2.4	2.5	2.8	2.7	0.1	<0.01
Milk, kg/d	30.7	28.6	28	26.2	25.6	25.1	26.6	26.6	26.7	28.6	27.9	1	0.07
Milk, kg/milking	10.3	10.5	9.6	9.8	10	10.6	10.5	11.3	10.6	10.1	10.5	0.1	<0.01
Average milking time, min	3.5	3.6	3.4	3.4	3.4	3.6	3.6	3.9	3.6	3.5	3.6	0.1	<0.01
Milk speed, kg/min	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0.1	0.96
Cows milked voluntarily, % cow/d	93	90.4	93	91.6	89.9	86.6	90.3	88.5	88.4	91.8	91.4	2	0.08
Cows fetched, % cow/d	7	10	7	8	10	13	10	12	12	8	9	2	0.08

Cow with GPS collar

- Preliminary analysis of grazing patterns recorded with GPS collars (Left picture) reveled that some cows traveled more than 2,500 m per day
- Large animal to animal variation in grazing patterns, including distance traveled and frequency of pasture visits within and across days

Cow Traffic: animal to animal variations

High ranking cows: 3.1 milkings/day; Milk production 65 lb/day

Low ranking cows: 2.2 milkings/day; Milk production 51 lb/day

Milk composition

Table 3. Milk composition

Variable	Week 1	2	3	4	5	6	7	8	9	10	11	SEM	*P* <
Time on pastures (h)	0	2	4	6	8	12	12	12	12	12	12		
SCC, 1000's	152	175	113	146	164	170	169	147	136	125	116	20	0.20
Fat, %	3.80	3.77	3.72	3.76	3.78	3.87	3.84	3.8	3.77	3.83	3.81	0.03	0.02
Protein, %	2.95	2.94	2.94	2.87	2.95	3.01	3.03	3.06	3.04	3.05	3.00	0.03	<0.01
Other solids, %	5.82	5.69	5.72	5.7	5.76	5.73	5.75	5.75	5.75	5.77	5.75	0.01	<0.01
MUN, mg/dl	15.3	15.5	15.0	11.5	7.7	7.8	6.8	8.4	8.1	8.4	8.4	0.9	<0.01

Robot performance

Table 4. Robot Performance

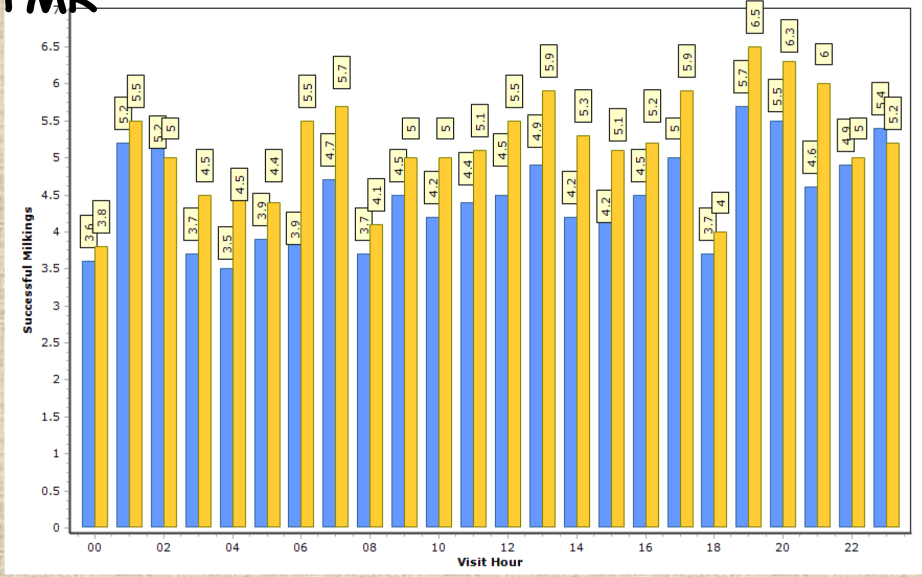
	Week												
	1	2	3	4	5	6	7	8	9	10	11		
	Time on pastures (h)												
Variable	0	2	4	6	8	12	12	12	12	12	12	SEM	*P* <
Milk,kg/d	1479	1394	1320	1239	1203	1201	1193	1168	1195	1215	1142	133	0.42
Visits, visits/d	237	194	226	202	189	160	165	139	164	193	155	29	0.05
Refusal, refusals/d	89	57	86	74	63	42	47	34	50	70	43	17	0.06
Failures, fails/d	4.9	4.5	2.4	2.7	4.8	5.5	5	2	2.7	4	2.4	1.9	0.58
Time milking, h/d	16	15	15	14	14	13	13	13	13	14	13	2	0.60
Time free, h/d	5	7	7	8	8	8	9	9	9	8	9	2	0.52
Time cleaning, h/d	2	2	2	2	2	2	2	2	2	2	2	0.2	0.89

- Number of visits per robot declined as the time of access to pastures increased. This reflects the declining pattern in the number of milkings per cow.
- Although not significant, the time free of robots (not milking) increased with grazing.

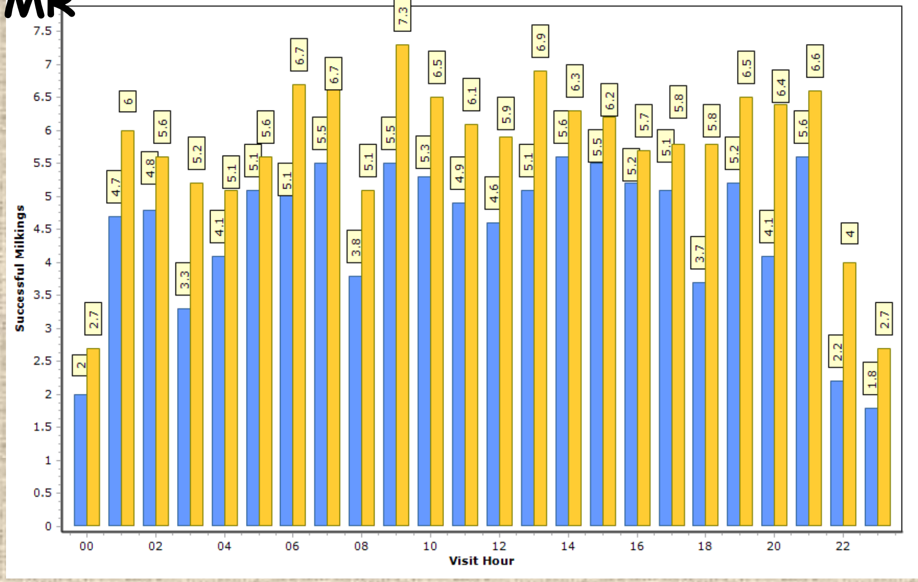
Efficient combination of Automatic Milking & Grazing requires strategic management plans to sustain milk flow per robot. This could be achieved by enticing cows to visit milking robots more frequently and/or by increasing the number of cows per milking robot.

Distribution of milkings per day (2010)

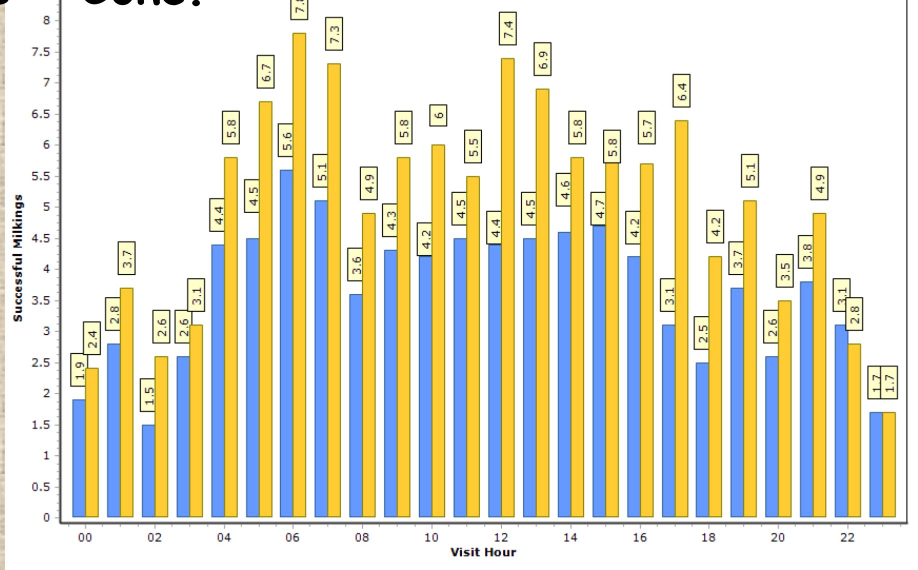
TMR



PMR



Pasture + Conc.



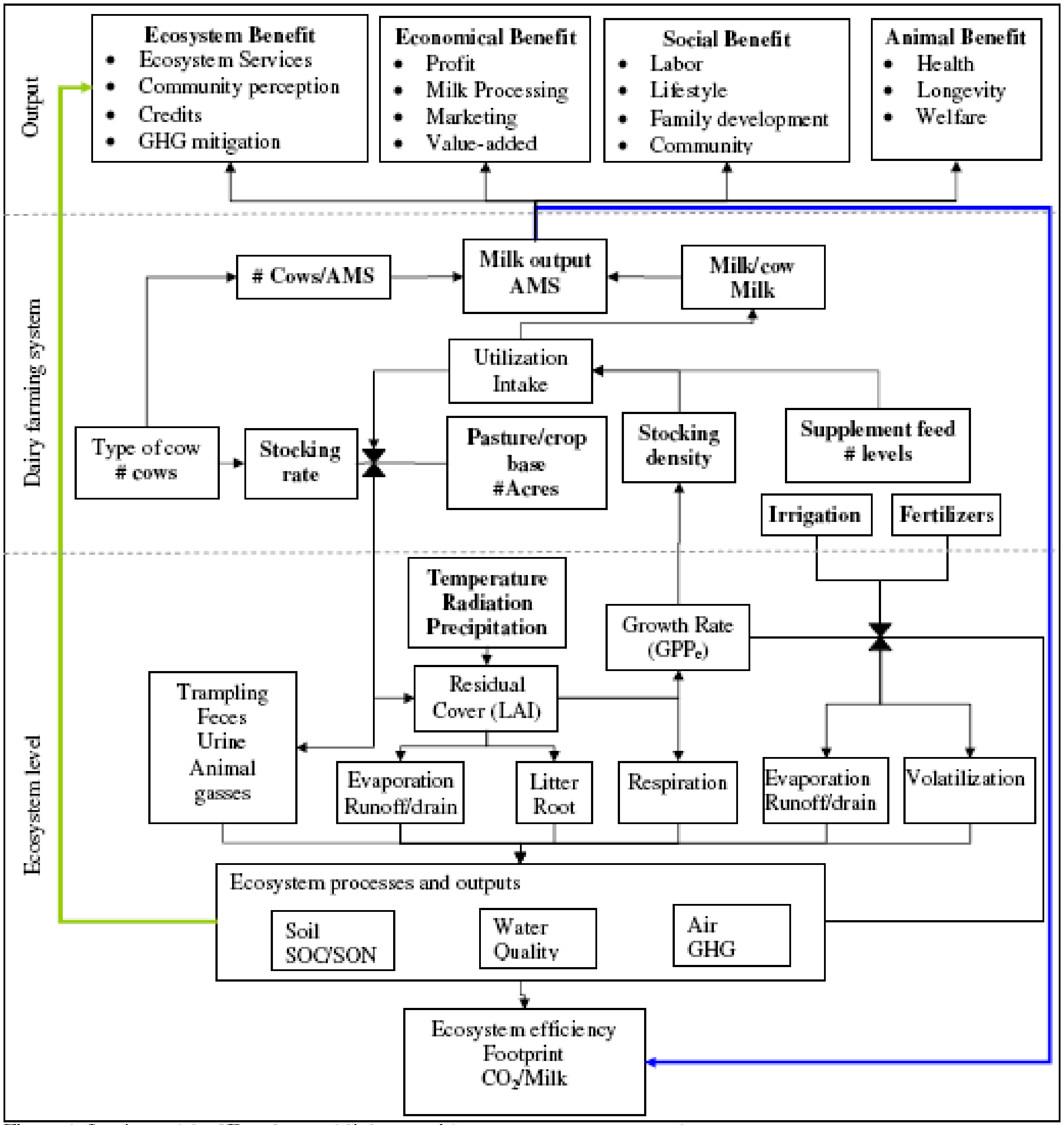


Figure 1. Logic model of Farmlets and linkages with ecosystem processes and outputs

Table 1. Proposed Experimental Farmlets to be established at the Kellogg Farm Pasture Dairy, Kellogg Biological Station, Hickory Corners, MI. SR=stocking rate

Level	High SR – High feed input	Low SR – High animal input
Animal	60 lactating cows: • 30 % of cows NZ Friesian • 70% of cows NA Holstein • 100% of year around calved cows	75 lactating cows: • 30 % of cows NZ Friesian • 70% of cows NA Holstein • 20% of seasonally calved cows and 80% of year around calved cows
Forage base	16 ha with 2 ha strips of: • Ryegrass-White clover • Alfalfa, Red clover, White clover, Fescue, Orchardgrass • Strategic irrigation	24 ha with 16 ha of 2 ha strips of: • Ryegrass-White clover • Alfalfa, Red clover, White clover, Fescue, Orchardgrass • Strategic irrigation
Grazing management	• Temporal and spatial pasture allocation • 2 breaks per day • Pregrazing biomass ~2500 ± 200 kg/ha • Postgrazing residual ~1700 ± 200 kg/ha	
Feeding system	Grazing season: • Pasture (60%) • pTMR (15%) • Concentrate (25%) Winter season: • TMR (76%) • Concentrate (24%)	Grazing season: • Pasture (75%) • Concentrate (25%) Winter season: • TMR (76%) • Concentrate (24%)
Expected milk output	Grazing season: • 65 lb/day • 2.8 milkings • 3980 lb/AMS/d Winter season: • 75 lb/day • 3.1 milkings • 4500 lb/AMS/d	Grazing season: • 55 lb/day • 2 milkings • 3980 lb/AMS/d Winter season: • 75 lb/day • 3.1 milkings • 4500 lb/AMS/d
Dairy System generalities	• High stocking rate • High supplemental feed input • Constant ratio of animals to AMS • High milk output per cow and area	• Low stocking rate • Low supplemental feed input • Variable ratio of animals to AMS • Low milk output per cow and area
Dairy production goals	• Maximizing pasture utilization (~ 7000 lb/acre) • Optimize AMS utilization by maximizing milk output per AMS • Lowering footprint/kg milk • Nutrient (nitrogen and phosphorus) retention • GHG mitigation	

Summary

- AMS is a particular system of milking, not a particular type of dairy operation….
- AMS can work successfully under different types of dairy operations (confinement vs. grazing)….
- Transition to AMS could be a relatively fast process, but needs to be planed ahead. Cows quickly adapt within 7 days.
- Guidelines for AMS planning (i.e. Farm layout and barn design) and management (i.e. milking, feeding, routing) are needed. But, these guidelines need to be specific to the expectations and goals of each type of dairy operation (i.e. Confinement, Grazing, Hybrid)
- Long-term AMS research is still needed.

Thanks!!