Comparing Baseline Dairies And Those Using Potential Mitigation Practices

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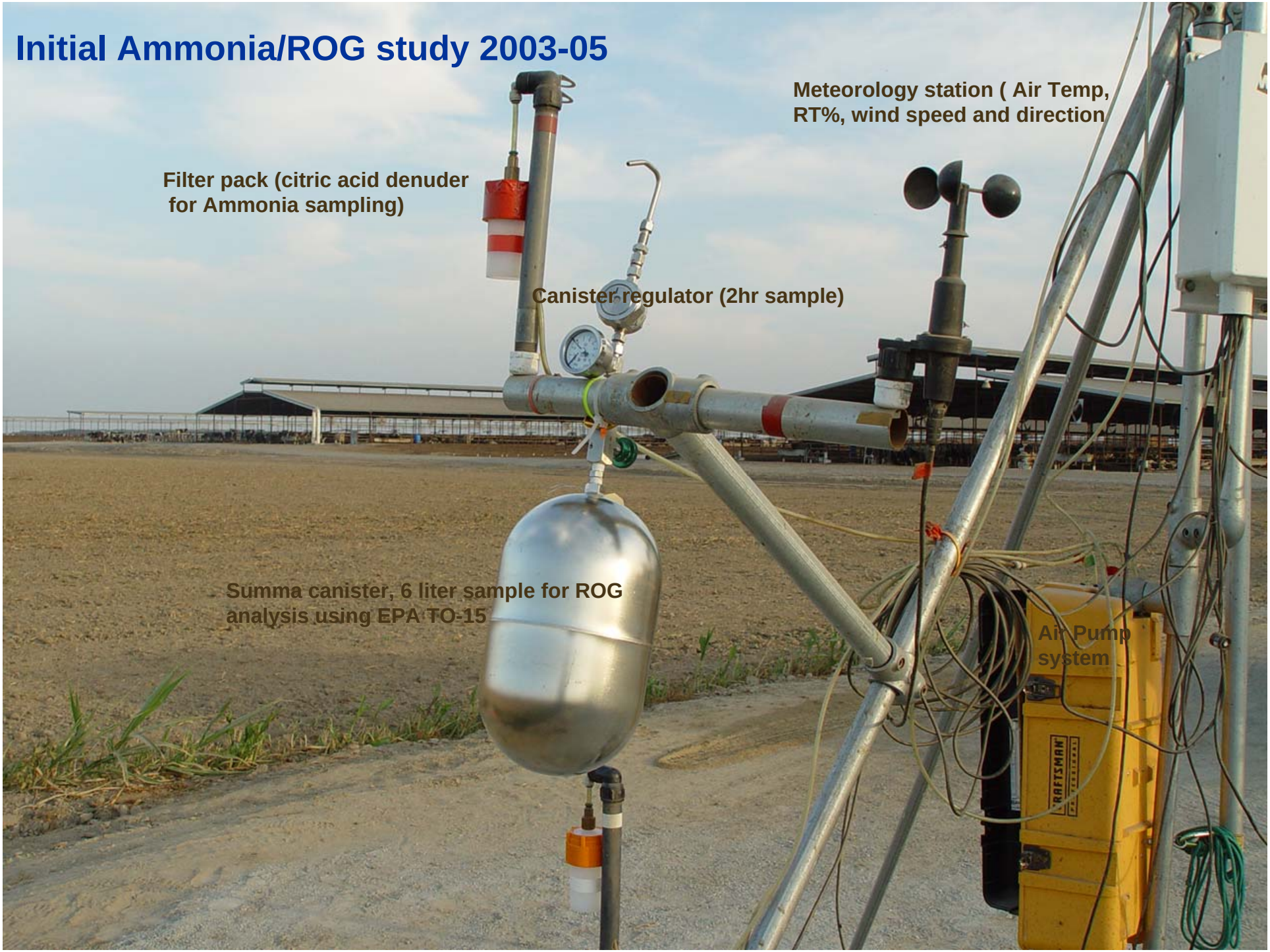
Abstract

A study of ROG emissions related to dairy operations was conducted at two Central California locations in 2003-04. Monitoring and modeling methods developed for that project will be applied to a more comprehensive study to be conducted in 2005-09. The development of that program and examples of some preliminary results will be presented here.

Initial Ammonia/ROG study 2003-05



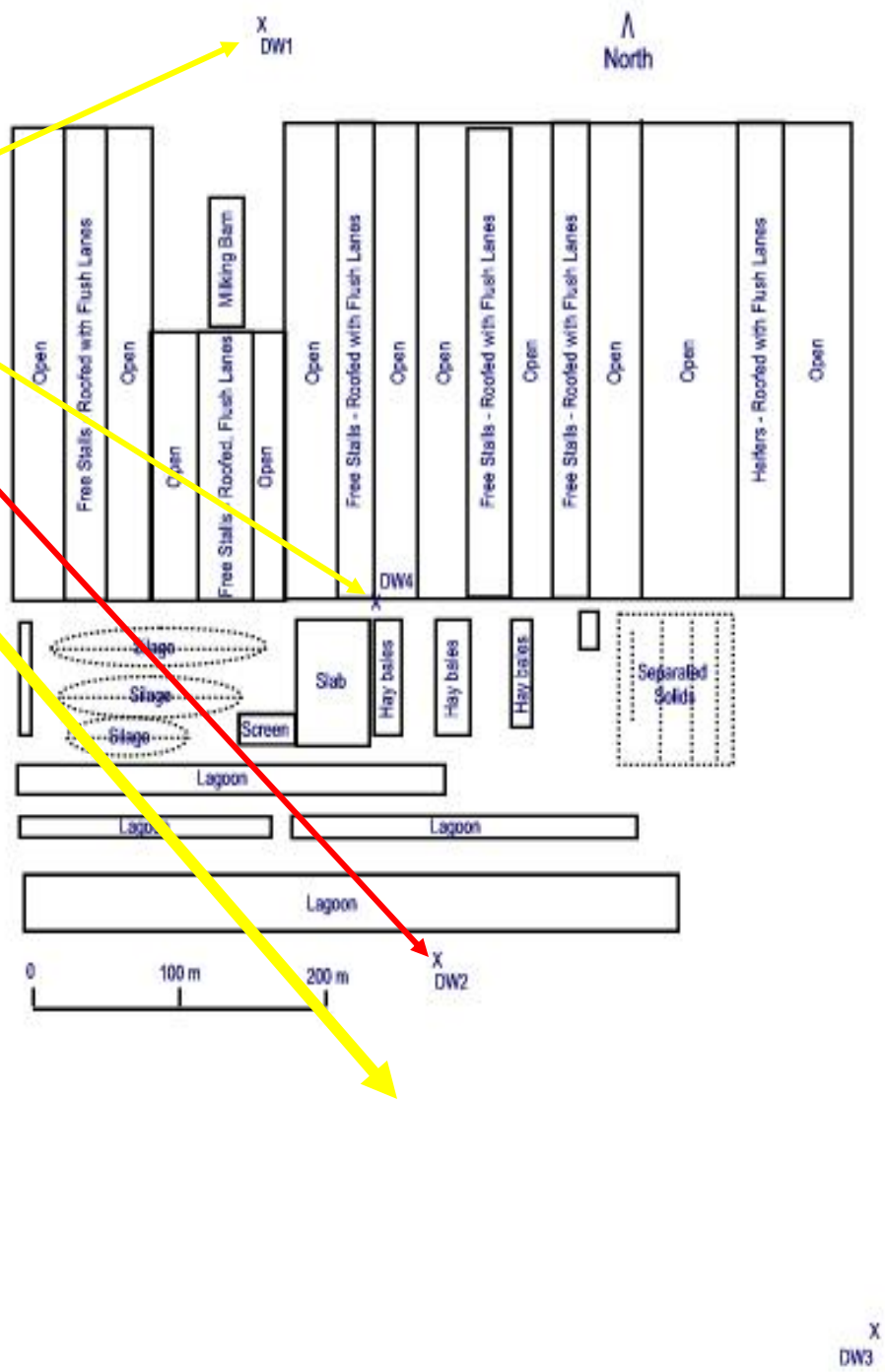
Dairy A
Sampling Locations:

Upwind

Downwind of the Free Stalls

Downwind of the Lagoon System

Prevailing wind = 320 degrees

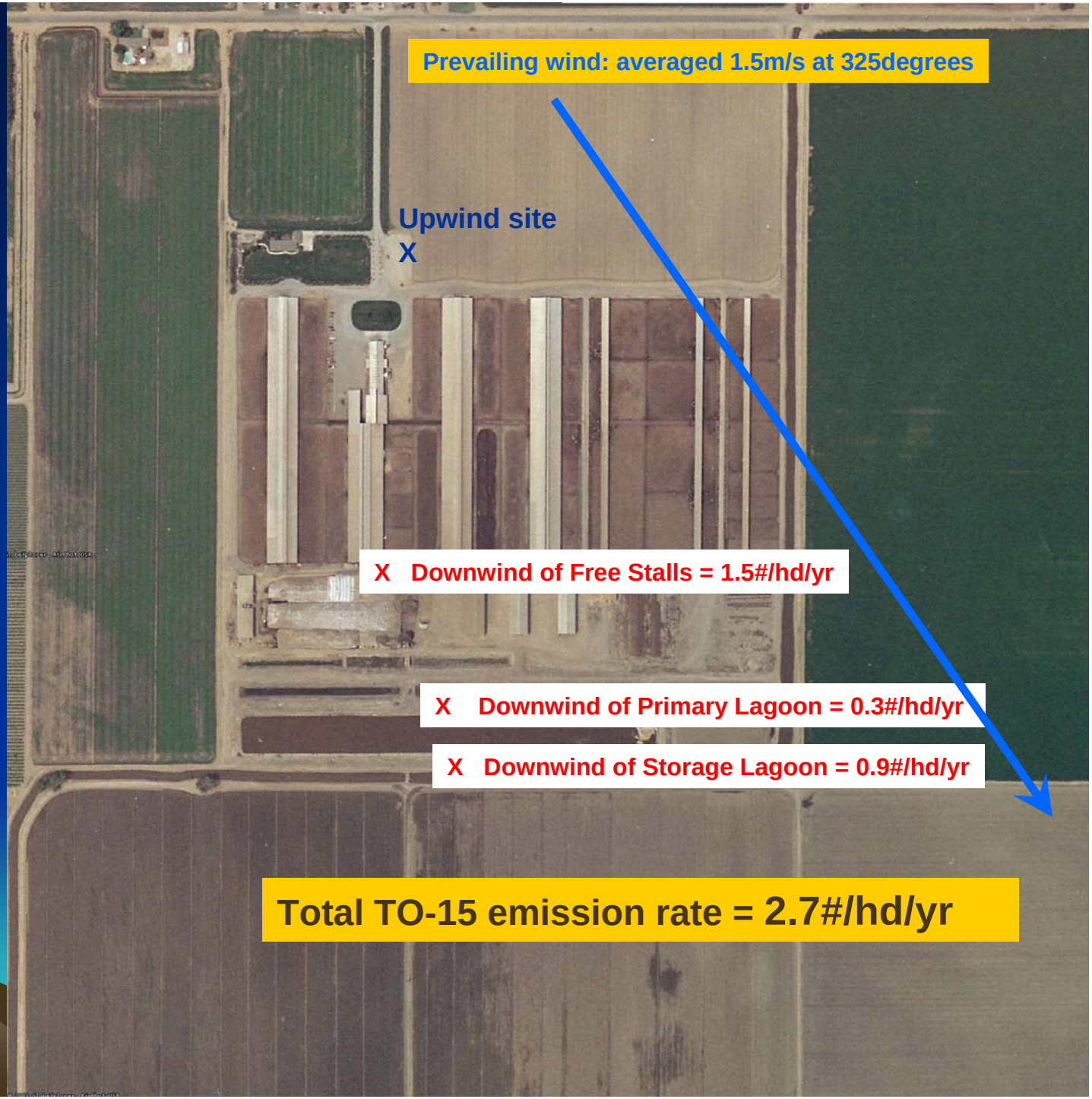


Dairy A

July 22, 2004

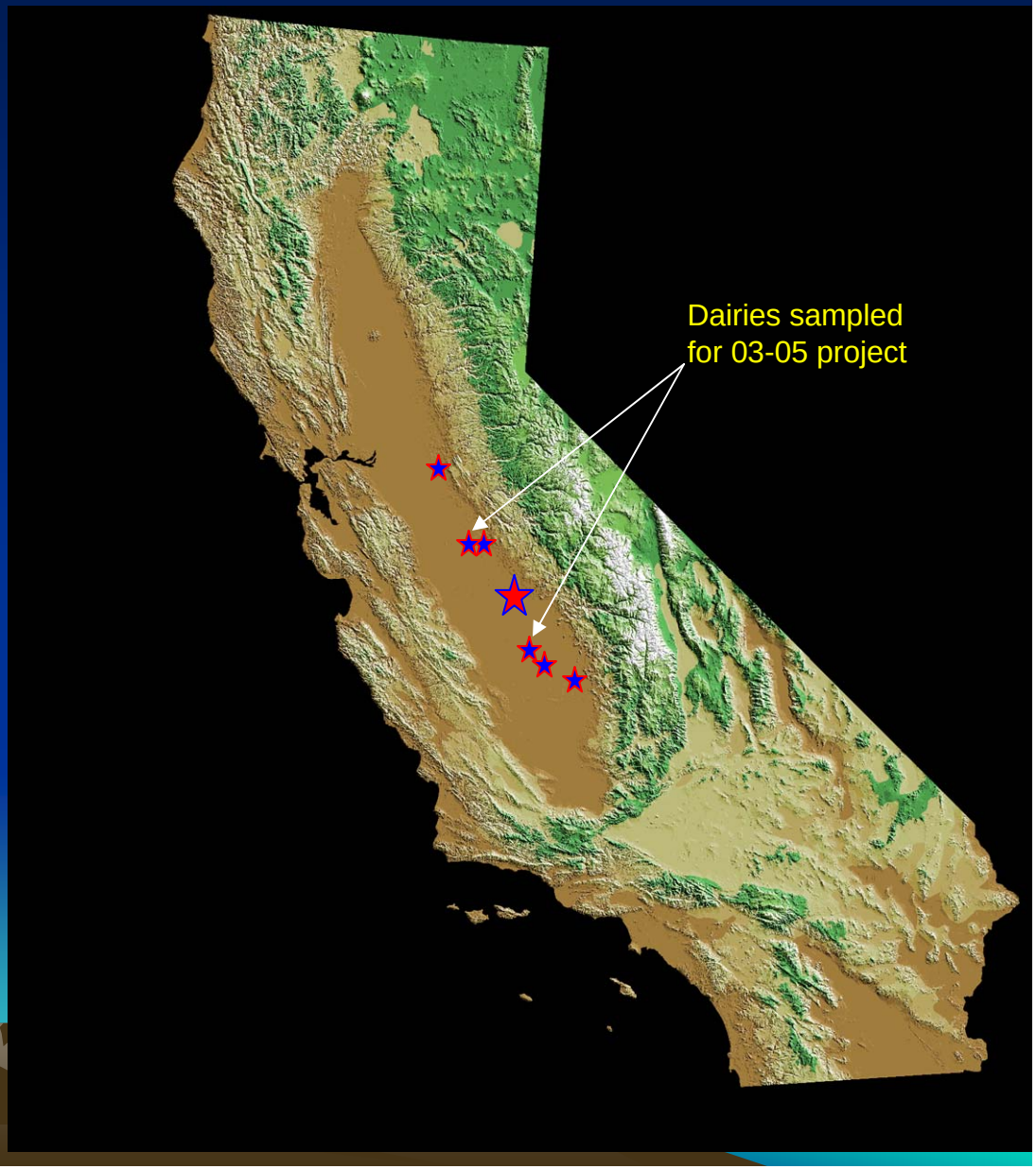
1330 to 1600

Summer wind direction (325) and speed (1.5m/s) were typical for this location. Wind speed in the early afternoon was less than at other locations but the direction was sufficiently consistent for modeling.



CSU-Fresno Dairy Air Quality Projects in the Central Valley

- Currently, a second project funded by CARB and CSU-ARI will monitor emissions from six dairies in the valley to document practices that can reduce ROG emissions.
- Dairies sampled in the initial project ('03 to '05) were the same as those monitored by Dr. Schmidt for his CARB project.



Planned Projects:

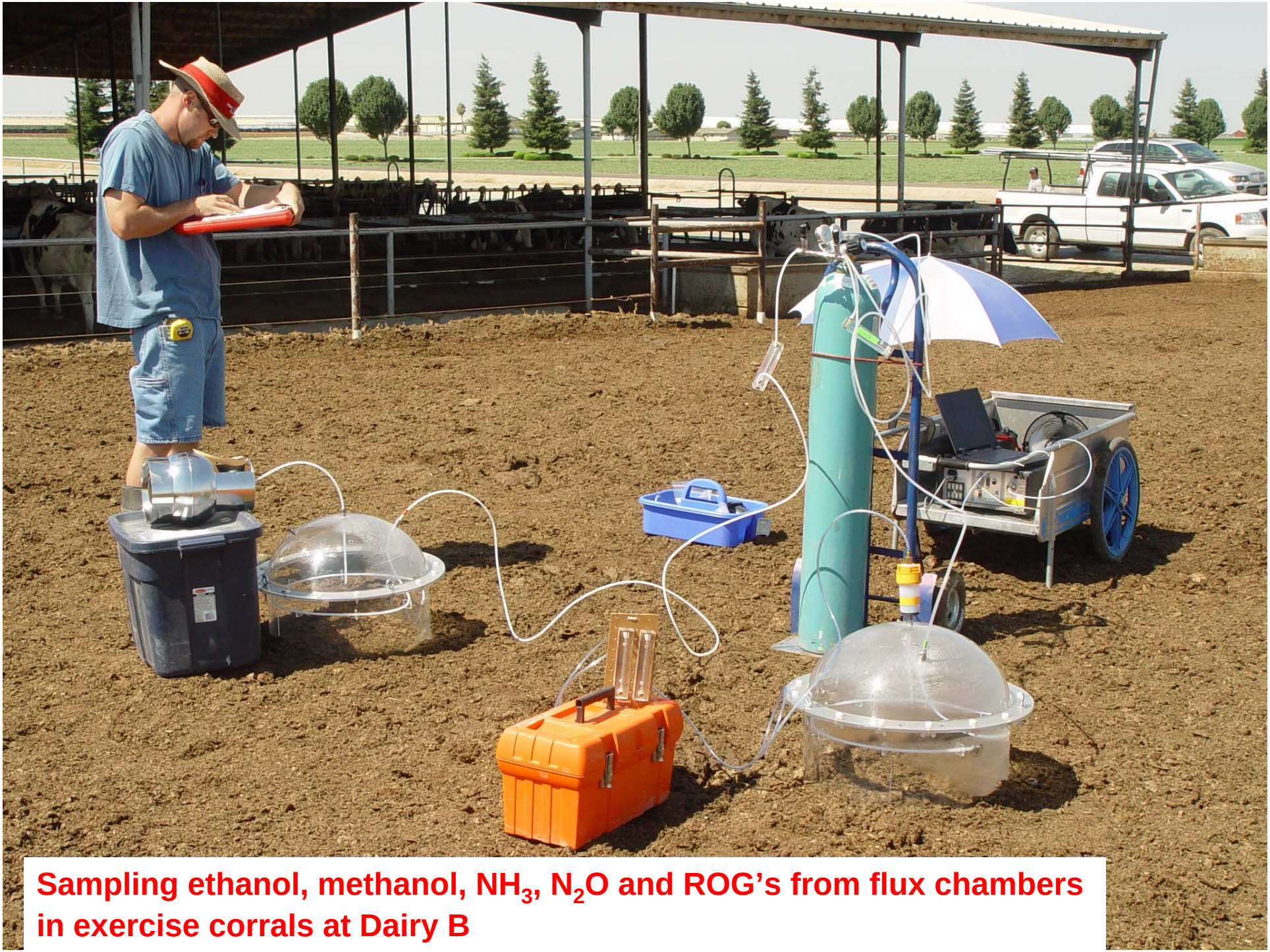
- Phase 2 of CARB funded project will increase the number of monitored dairies to six and analyze for additional compounds. Emphasis will be on comparing emissions from different manure handling systems and evaluation of seasonal and day/night differences in emissions (July'05 to June'07)

- Matching CSU Ag Research Initiative funding will add analytical capability for alcohols, N_2O and other non-canister procedures as well as an additional year (September'05 to June'08)

- USDA and UNH funding to study Nitrogen/Carbon ratios at the same 6 dairies. (July'05 to June'08)

“Typical” CA Dairy

- Free stalls and exercise corrals.
- Flush lane manure collection system.
- Separation of solids and liquid.
- Solids used variously.
- Storage of liquid in lagoon system for flush water and recycling of nutrients to cropland
- Dairies A, B, C, and D



Sampling ethanol, methanol, NH_3, N_2O and ROG's from flux chambers in exercise corrals at Dairy B

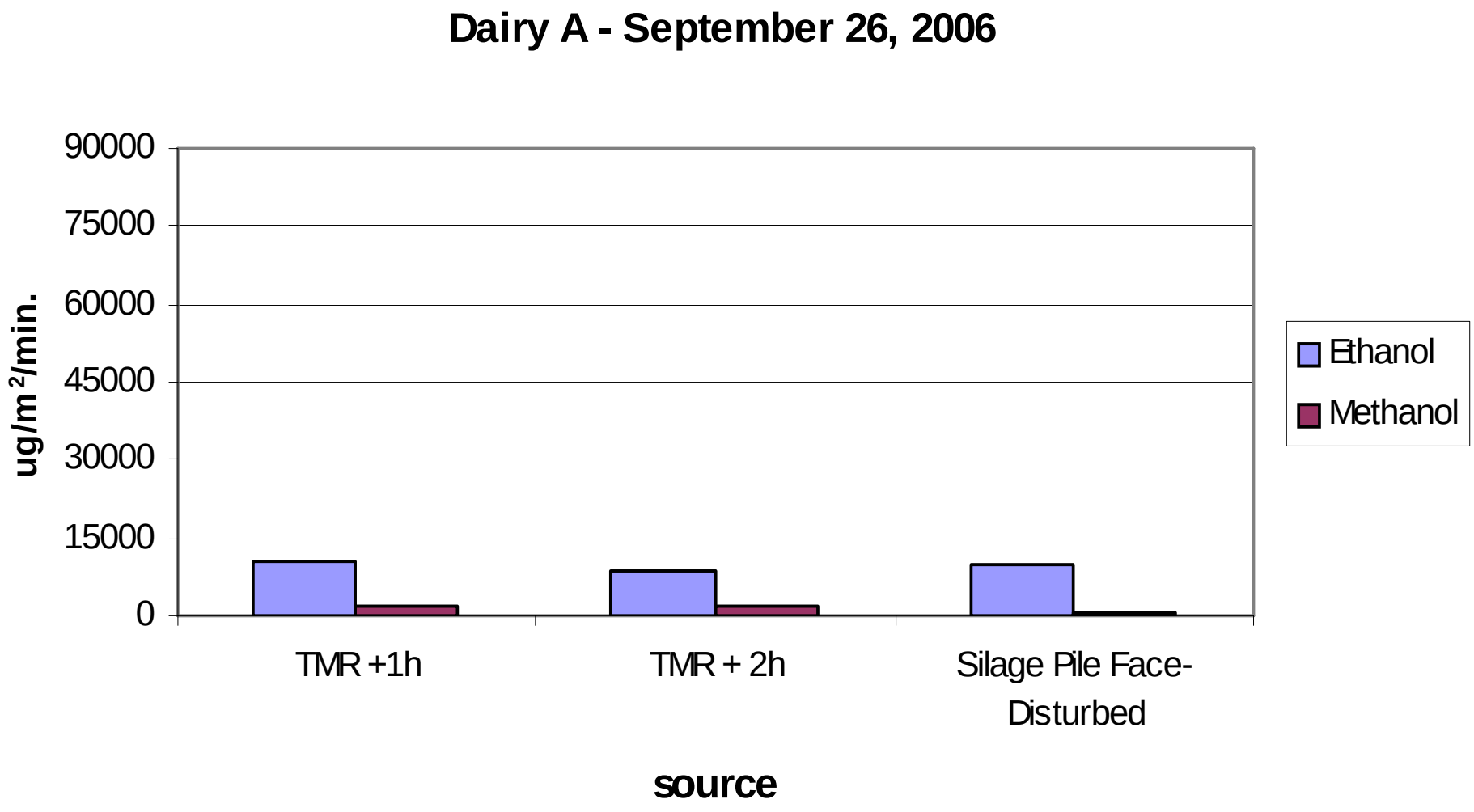
Sampling ethanol, methanol, NH_3, N_2O and ROG's from flux chambers on flush lanes at Dairy B

Sampling ethanol, methanol, ammonia and ROG's from Total Mixed Ration (TMR) using flux chambers at Dairy A

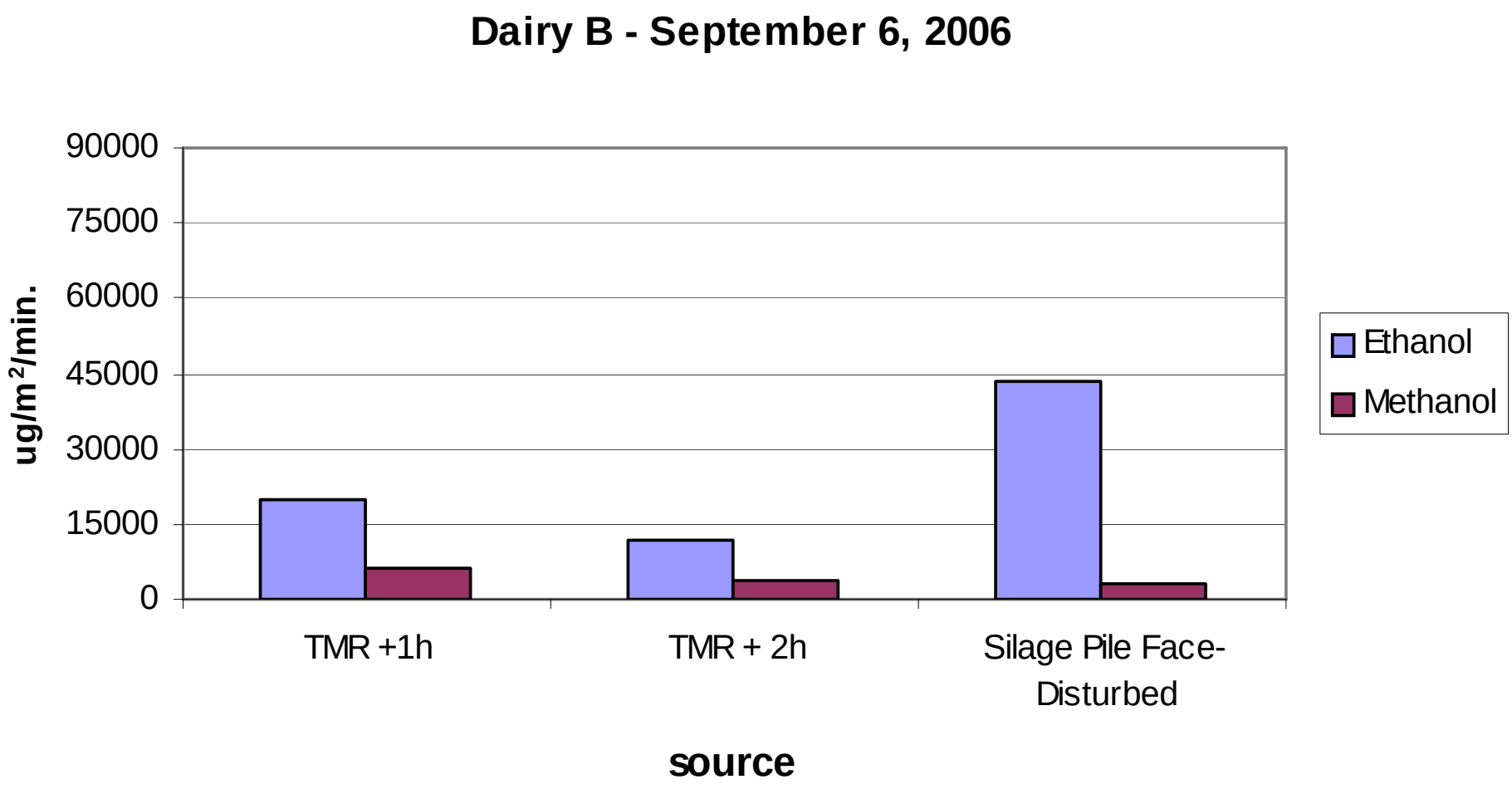
Initial monitoring of emissions from feeding operations and silage storage.

					Ethanol		Methanol		Ammonia	
Dairy	Location	Date	Source	Hours Post	ug/m2/min	average	ug/m2/min	average	ug/m2/min	average
B	1	7/10/2006	TMR	0.9	27959.3	25327.6	6306.4	5670.8	2334.8	2057.2
B	2	7/10/2006	TMR	1.0	22695.8		5035.1		1779.7	
B	3	7/10/2006	TMR	1.8	22864.9	21669.7	5142.7	4961.9	1730.5	
B	4	7/10/2006	TMR	1.9	20474.5		4781.1		1592.0	
F	1	7/24/2006	TMR	1.3	23782.3	24361.8	3824.2	3617.4	1530.3	
F	2	7/24/2006	TMR	1.4	24941.3		3410.5		1630.4	
F	3	7/24/2006	TMR	2.3	4927.9	9622.8	0.0	1261.3	328.9	
F	4	7/24/2006	TMR	2.4	14317.7		2522.6		951.1	
F	5	7/24/2006	Silage Pile Face-Disturbed		102131.3	78554.2	12478.3	10426.7	9394.6	
F	6	7/24/2006	Silage Pile Face-Disturbed		54977.1		8375.0		5702.9	
C	1	8/8/2006	TMR	1.1	81608.5	79918.3	938.4	1070.4	406.7	
C	2	8/8/2006	TMR	0.9	78228.2		1202.4		359.3	
C	3	8/8/2006	TMR	2.2	51717.5	46079.8	629.0	638.2	220.0	
C	4	8/8/2006	TMR	2.0	40442.1		647.5		144.2	
C	5	8/8/2006	Silage Pile Face-Disturbed		55701.4	81813.7	1284.8	1817.9	701.7	
C	6	8/8/2006	Silage Pile Face-Disturbed		107926.0		2351.0		886.7	
B	1	9/6/2006	TMR	0.7	20571.1	19750.2	6760.5	6466.2	699.0	
B	2	9/6/2006	TMR	0.8	18929.3		6171.9		638.2	
B	3	9/6/2006	TMR	1.8	12989.7	11818.7	3691.4	3720.0	492.5	
B	4	9/6/2006	TMR	1.9	10647.7		3748.5		514.0	
B	5	9/6/2006	Silage Pile Face-Disturbed		43556.7	43556.7	3116.2	3116.2	3521.9	
A	1	9/26/2006	TMR	0.9	9826.8	10514.9	1463.1	1590.1	469.3	
A	2	9/26/2006	TMR	1.0	11203.1		1717.0		545.3	
A	3	9/26/2006	TMR	2.0	9126.6	8728.2	1722.1	1813.7	484.5	
A	4	9/26/2006	TMR	2.0	8329.9		1905.4		539.9	
A	6	9/26/2006	Silage Pile Face-Disturbed		10020.0	10020.0	908.1	908.1	692.8	
A	7	9/26/2006	Tomato Processing Waste		3298.1		490.4	245.2	66.2	
A	8	9/26/2006	Tomato Processing Waste		4898.9		0.0		131.9	

Ethanol, methanol and ammonia from Total Mixed Ration (TMR) at Dairy A

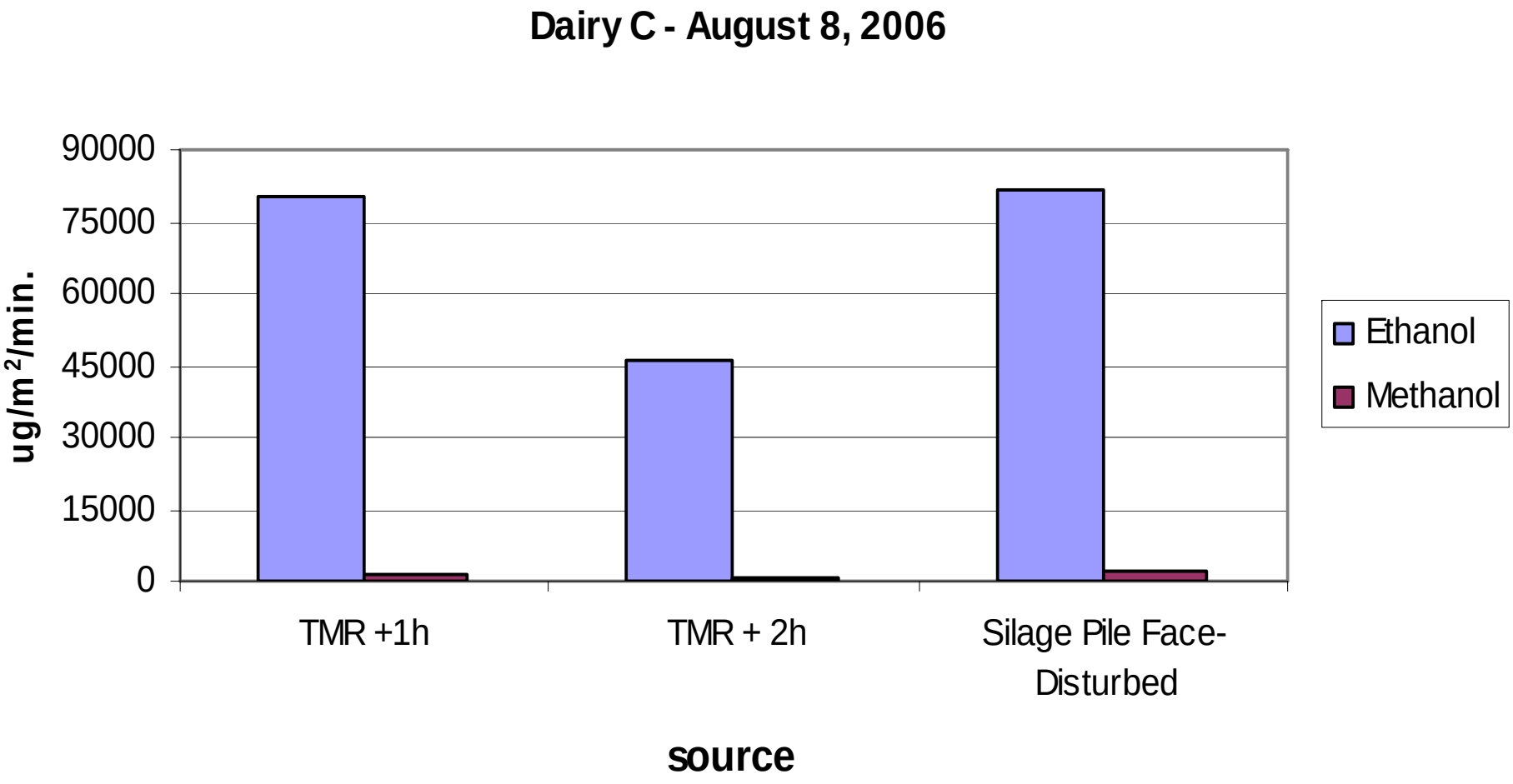

Dairy A - September 26, 2006
90000
75000
60000
45000
30000
15000
0
ug/m2/min.
TMR +1h
TMR + 2h
Silage Pile Face-Disturbed
source
Ethanol
Methanol

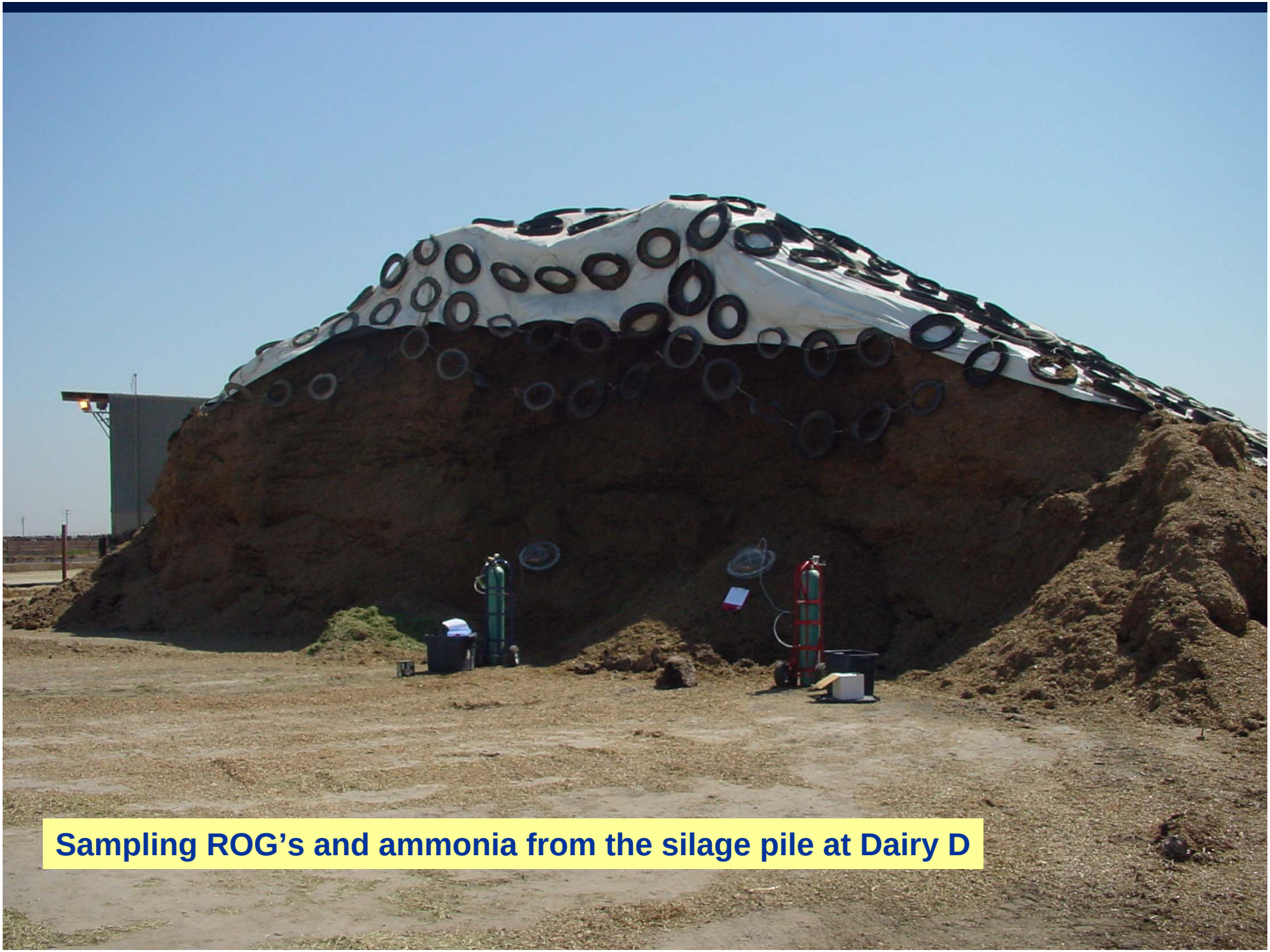
Monitoring fluxes from the Total Mixed Ration at Dairy B.
Demonstration at CARB field day, September 6, 2006


Dairy B - September 6, 2006
90000
75000
60000
45000
30000
15000
0
ug/m2/min.
TMR +1h
TMR + 2h
Silage Pile Face-Disturbed
source
Ethanol
Methanol

Dairy C: Low organic loading can support sulfur reducing,
Photosynthetic, purple bacteria that may reduce odors.

Dairy C: secondary lagoon with circulator


Dairy C - August 8, 2006
90000
75000
60000
45000
30000
15000
0
ug/m 2/min.
TMR +1h
TMR + 2h
Silage Pile Face-Disturbed
source
Ethanol
Methanol



Sampling ROG's and ammonia from the silage pile at Dairy D

Dairy D: Application of lagoon effluent to recycle nutrients by forage production.

Land Application of Lagoon Effluent at Dairy D (June, 2006)

Alternative Dairy E

- Free stalls and exercise corrals.
- Manure/urine slurry is vacuumed into a truck to avoid the use of flush water.
- Manure slurry is fed into a digester to generate methane and possibly to reduce ROG emissions.
- Treated slurry is separated with solids used for bedding and liquid stored in a lagoon for subsequent cropland application.

Dairy E: Vacuum truck to collect manure slurry

Dairy E: Methane digester. Residence time = 21 days, Supplies 100kW generator

Dairy E: lagoon for liquid from the digester

Dairy E: Solids separation by screw press

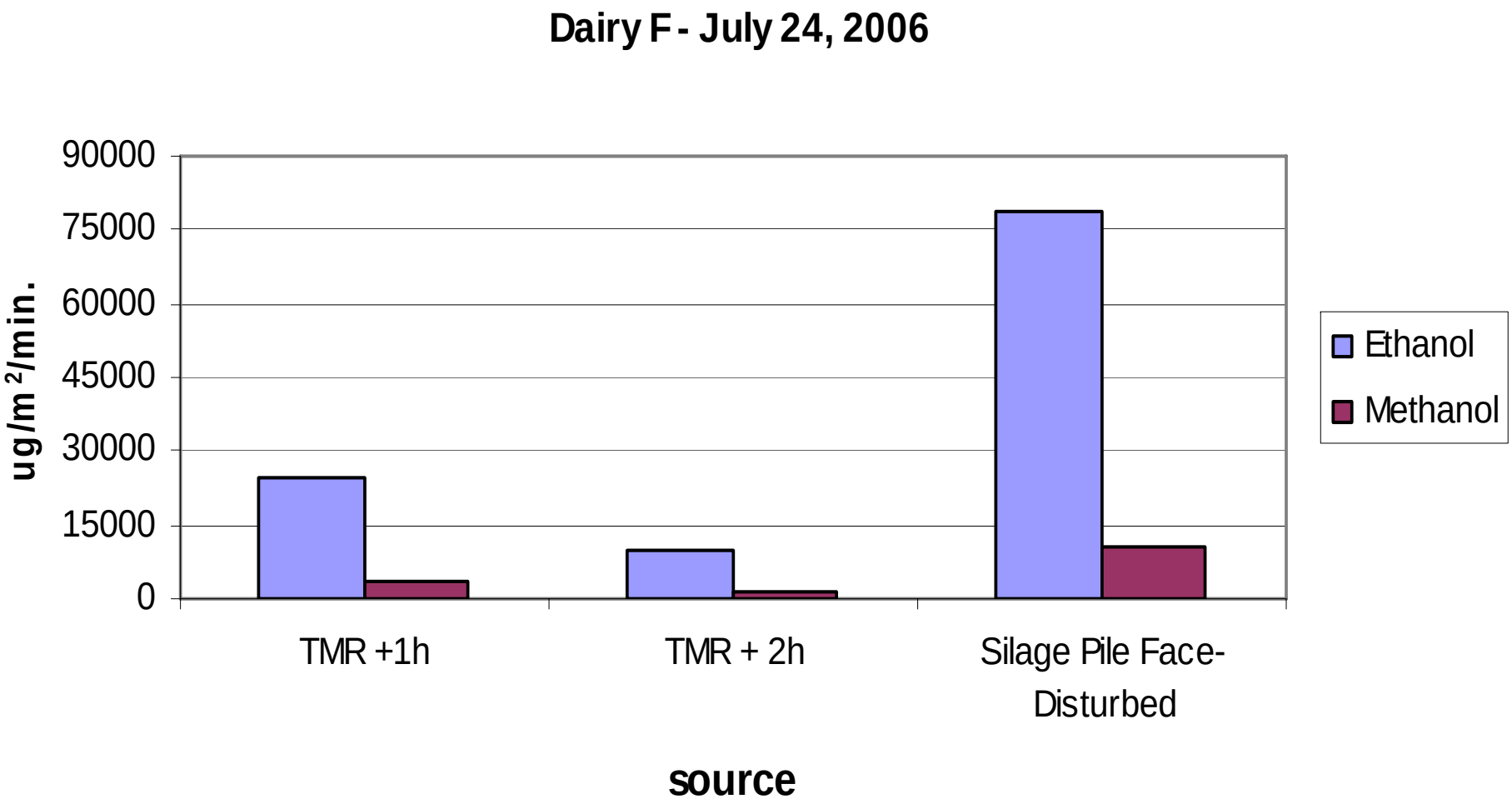
Alternative Dairy F

- Free stalls and exercise corrals
- Manure/urine slurry scraped into a collection pit.
- Manure slurry pumped into a large tank-trailer for injection below the soil surface of cropland.

Manure Slurry Pit (Dairy F)

Dairy F: Manure slurry collected by scraper and applied to cropland

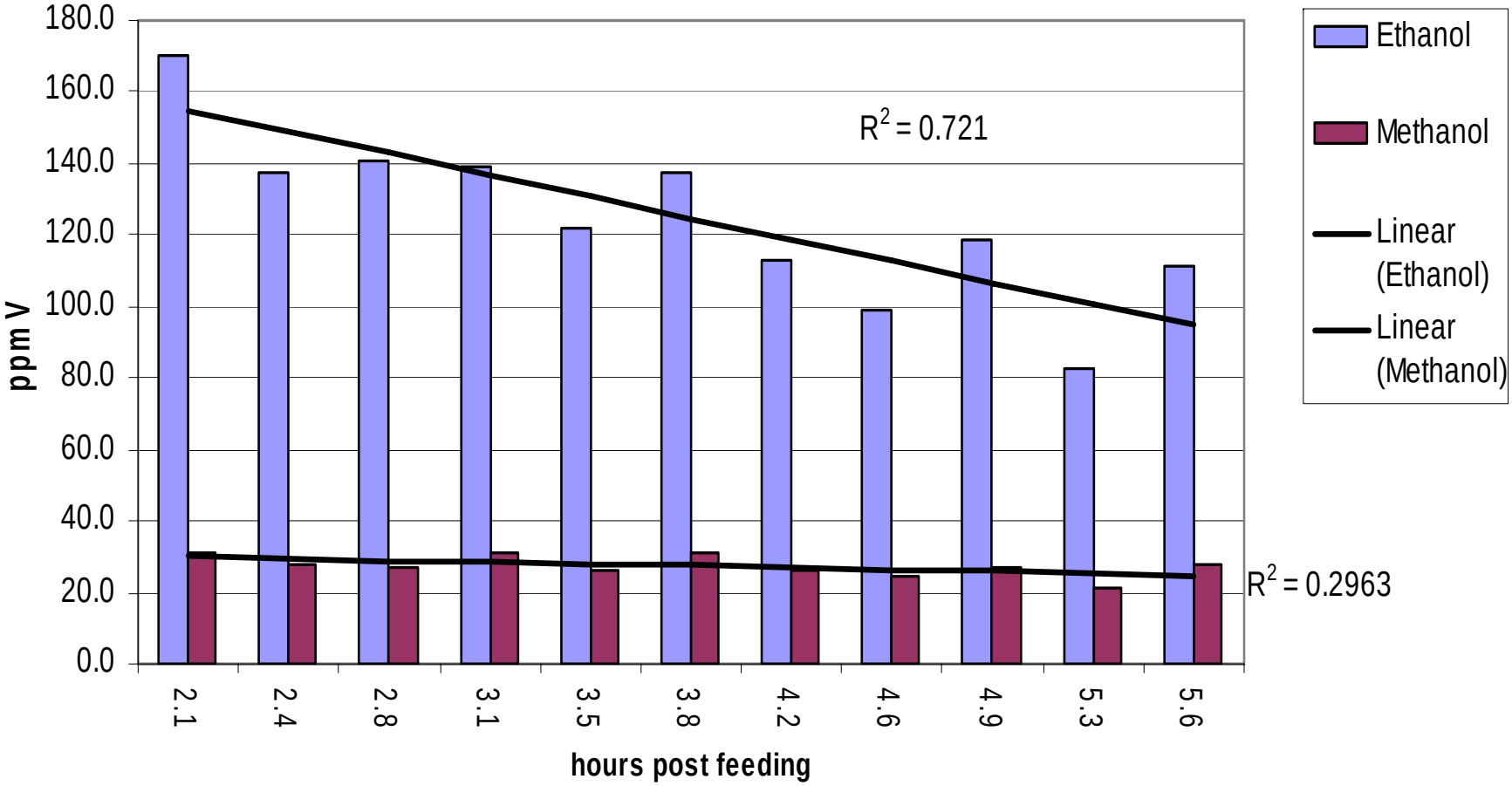
Ethanol, methanol and ammonia from Total Mixed Ration for dry cows at Dairy F


Dairy F - July 24, 2006
90000
75000
60000
45000
30000
15000
0
ug/m 2/min.
TMR +1h
TMR + 2h
Silage Pile Face-Disturbed
source
Ethanol
Methanol

Feed Sampling Procedures

- Flux chamber sampling within the first hour after TMR is delivered.
- Second sampling an hour after the first.
- INNOVA monitoring for ethanol, methanol, NH_3, N_2O, CO_2 and water vapor.
- Second NH_3 sample with denuder
- ROG sample for GCMS at UCI and CSUF
- Temperature of air and surface
- Flux chambers were used at Dairy A from initial TMR delivery for six hours to monitor changes in emissions during for the time the TMR was available.

Dairy A - October 3, 2006
Pair averaged



Complete Monitoring Program

- Each of the six dairies will be monitored three times/year beginning fall-'05 through spring/summer-'08.
- Ambient, upwind/downwind canister sampling for GCMS analysis at UCI and CSUF.
- Flux chamber sampling of TMR, silage, flush-lanes, open lots and land applications. Real time monitoring with INNOVA (ethanol, methanol, NH_3, N_2O, CO_2 and water vapor) plus canister samples taken for GCMS.
- Solids and liquid samples collected at various points through the manure handling process and analyzed for N and C compounds for the DNDC project.
- Feed and silage samples taken for analysis by a commercial dairy lab.