Assessing the Impact of Arsenic on Midwest Dairy Operations

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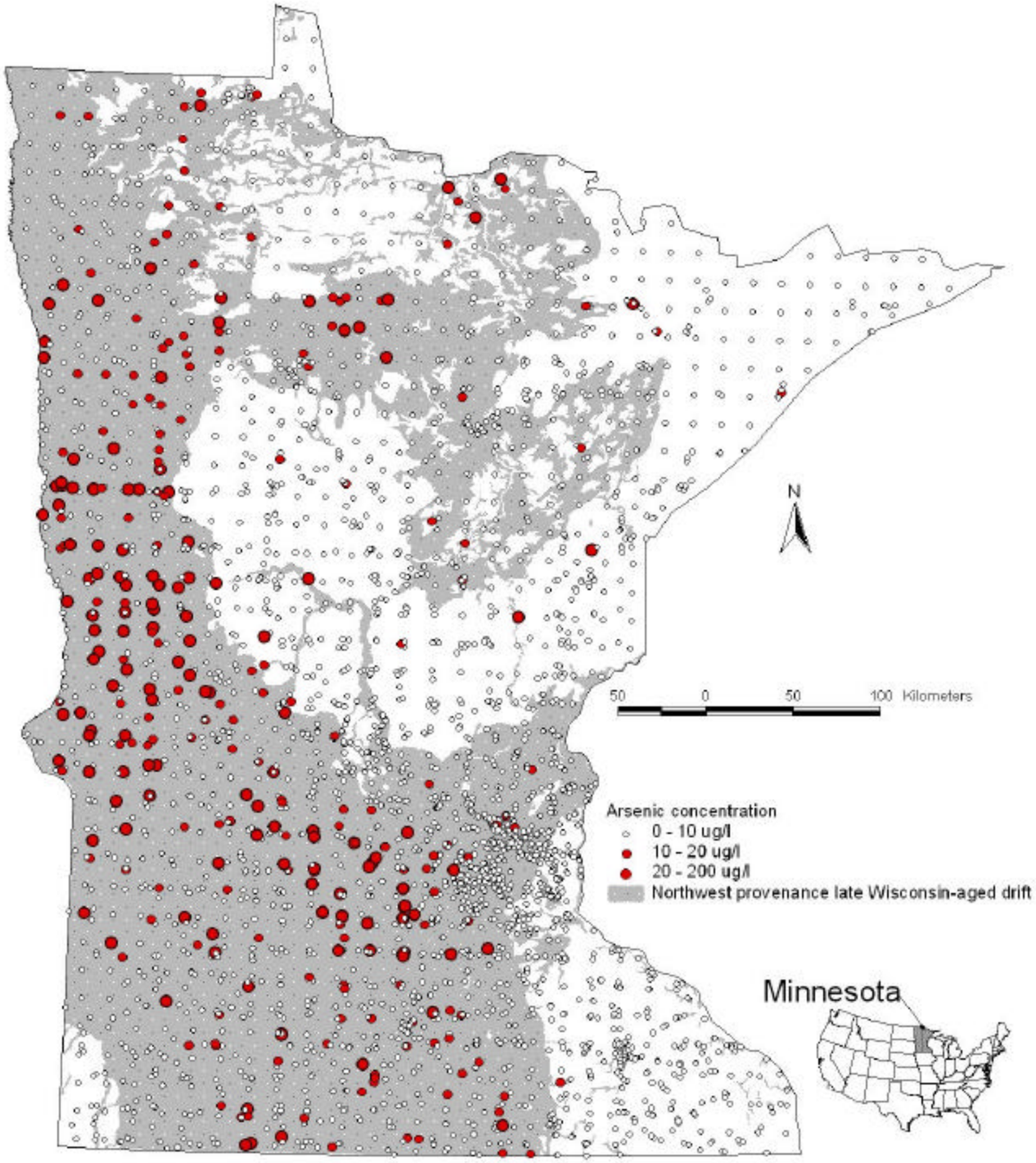
Background

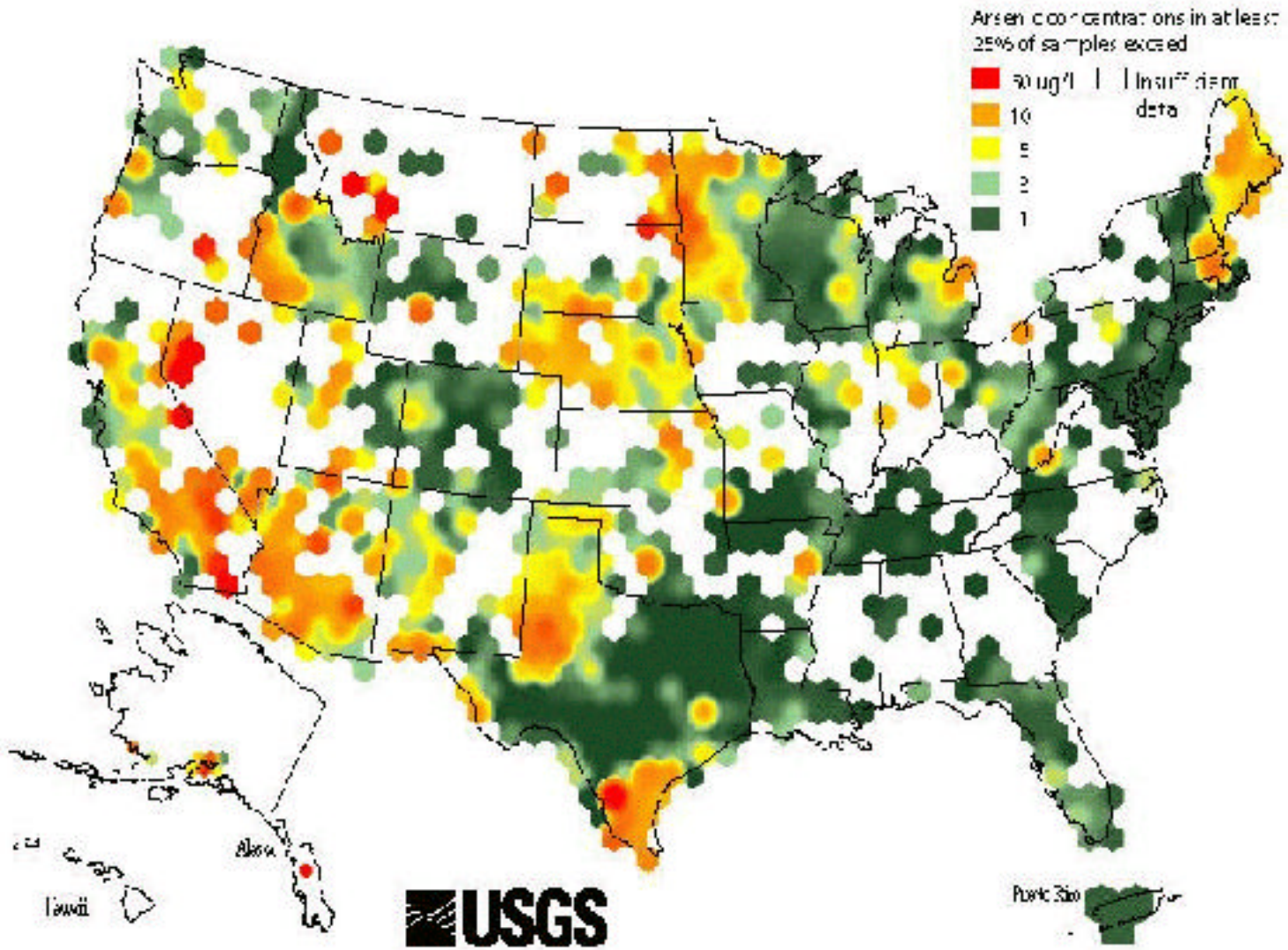
- Elevated arsenic levels – in Minnesota and U.S.
- Known human health risks
- Study of exposure through well water, 1998-99
- Dairy farmers concerned about herd health (and dairy products)
- Called a county educator, who called campus, and
    - Ta-Da – the Land Grant Mission works



Arsenic concentrations in Minnesota wells

Larger red circles indicate higher levels

Gray shading is Des Moines lobe till, from Canada


Arsenic concentrations in at least 25% of samples exceed
50 ug/l
10
5
2
1
Insufficient data
Alaska
Hawaii
Puerto Rico
USGS

Investigators:

- Vince Crary – Extension Educator, Otter Tail County
- Mindy Erickson – Civil Engineering
- Jim Linn – College of Ag, Food, Environmental Science
- Barb Liukkonen – Water Resource Center
- Zen Miller - Extension Educator, Outagamie County
- Mike Murphy – College of Veterinary Medicine

- *Funded by the Great Lakes Regional Water Leadership Team*

Applying knowledge to improve water quality
Great Lakes
Regional Water Program
A Partnership of USDA CSREES
& Land Grant Colleges and Universities

Project Goals

- To investigate whether arsenic in drinking water is affecting dairy cattle health or passing into dairy products.
- To identify an appropriate biomarker (hair, hoof, blood, urine) to indicate arsenic exposure in dairy cattle.
- To assess state of knowledge about the effects of arsenic in drinking water on dairy.

Project Objectives

- Conduct pilot study
  - Enlist dairy farms in MN & WI; plus control herd
  - Test well water, animal tissue, feed, milk
- Convene “expert” panel
  - Assess state of knowledge
  - Minneapolis, March 10, 2005

Pilot study, 2004-05

- Sampled well water, 11/2004
- Recruited study farms with highest arsenic concentrations
- Control herd – campus
- 5 cows from each herd
- January 2005, sampled:
  - Urine, blood, hair, hooves
  - Feed, forage, bulk milk

Arsenic analysis …

- U of MN Geology & MN Dept. Ag.
  - Graphite furnace – Atomic absorption spectrometry
  - ICP-MS - Inductively coupled plasma mass spectrometry
- Limits of detection in analysis
  - Blood - 25 ppb wet weight
  - Urine - 10 ppb wet weight
  - Hair - 50 ppb dry weight
  - Hoof - 50 ppb dry weight
  - Feeds - 100 ppb dry weight
  - Milk - 5 ppb wet weight
  - Cheese - 50 ppb dry weight

Results: Well water

- Wells from 25 dairy farms in areas known to be high in arsenic
- Only one declined
- Results from 0.5 to 119 ppb
- 4 > 50 ppb
- Sampled quarterly

Results: Feed

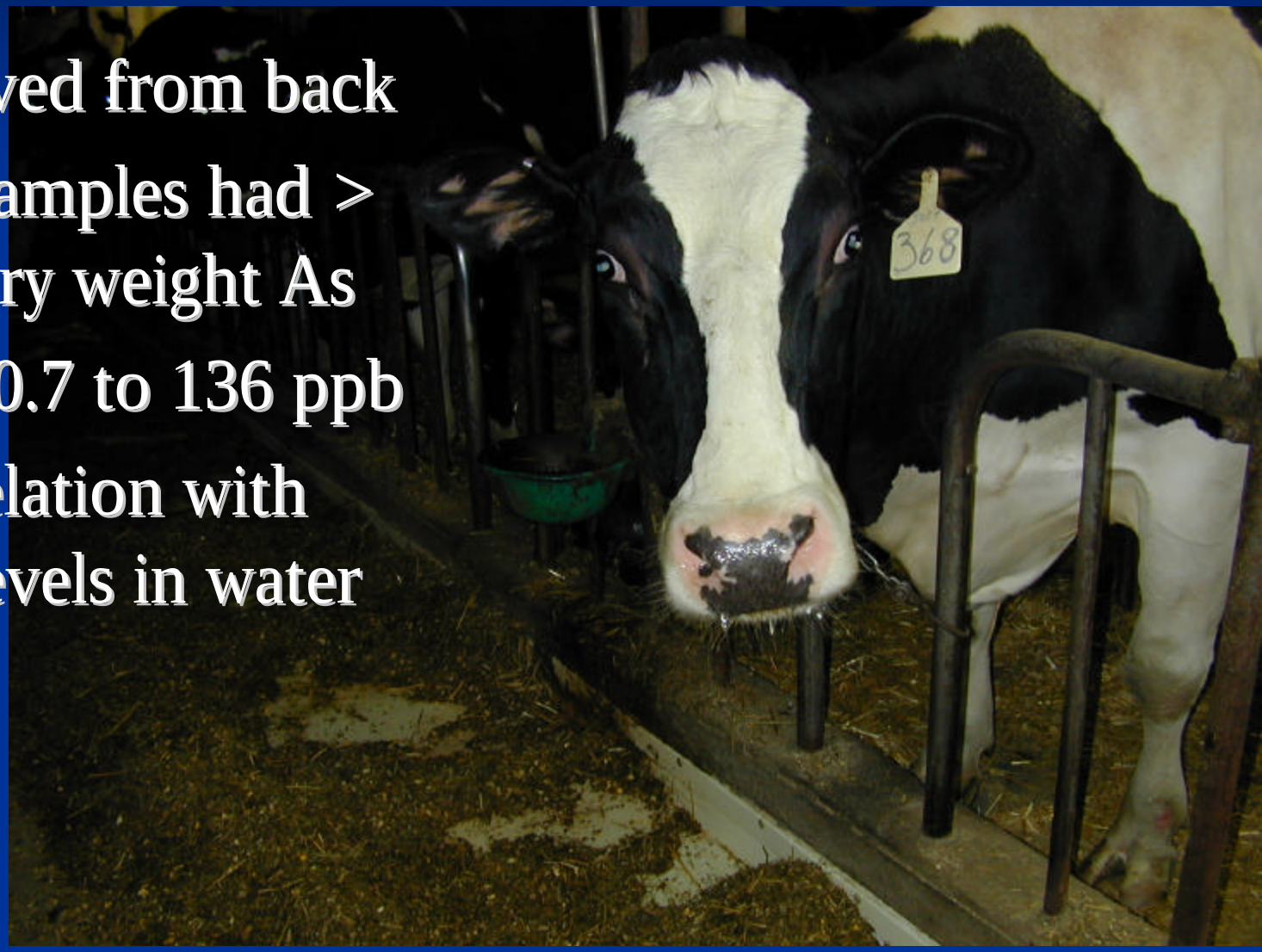
- Feed samples – grain, supplements, hay, silage
- All but one sample were < 100 ppb dry weight
- One supplement contained 7380 ppb arsenic

Results: Blood

- Sample collected from tail vein
- All samples were < 25 ppb wet weight arsenic

Results: Hair

- Hair shaved from back
- 5 of 25 samples had > 50 ppb dry weight As
- Range: 60.7 to 136 ppb
- No correlation with arsenic levels in water

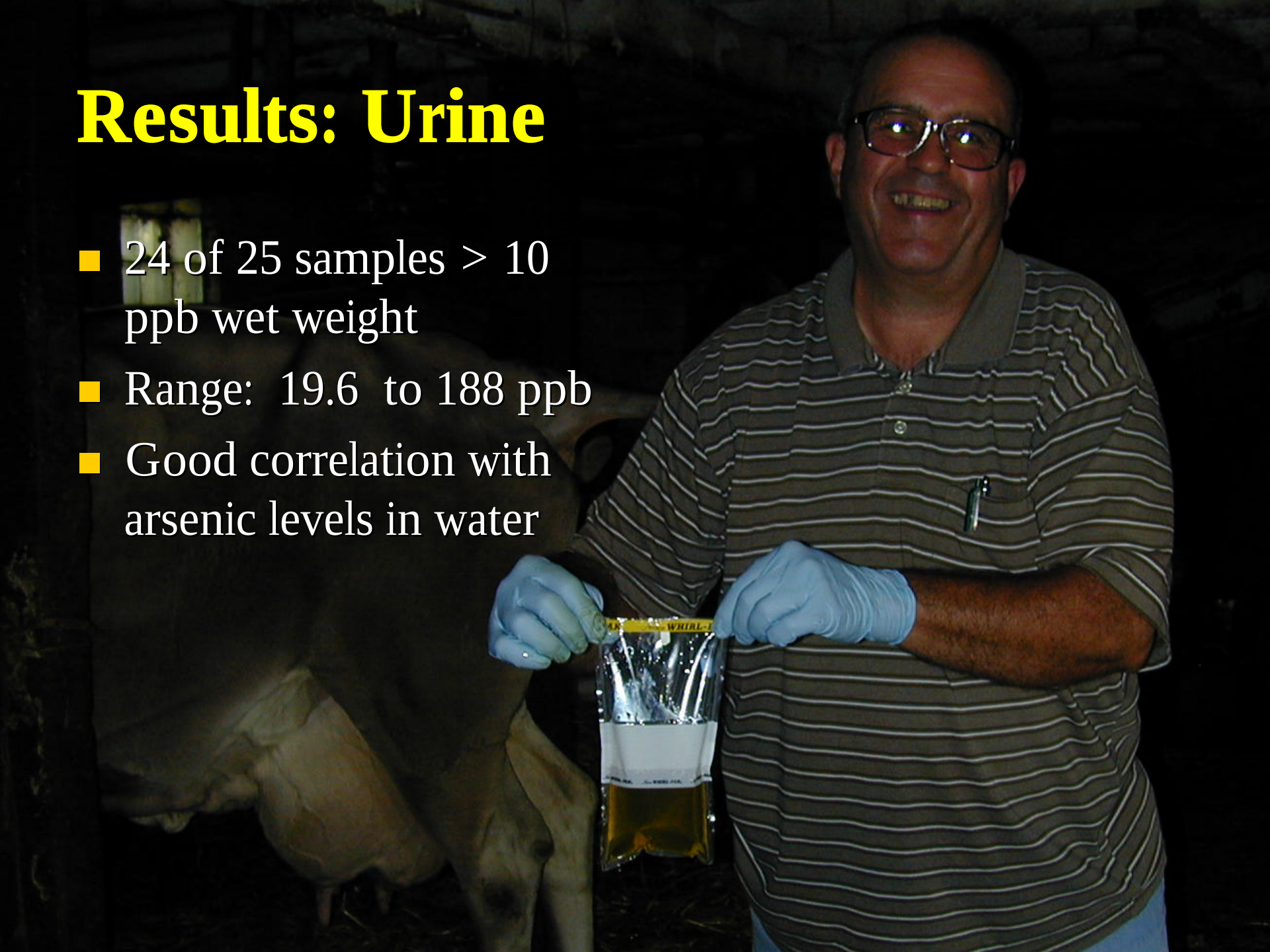


Results: Hooves

- Clipped and cleaned
- 2 of 25 samples were > 50 ppb dry weight
  - 112 ppb
  - 334 ppb
- No correlation with arsenic levels in water

Results: Urine

- 24 of 25 samples > 10 ppb wet weight
- Range: 19.6 to 188 ppb
- Good correlation with arsenic levels in water



Arsenic in urine as Biomarker

Water As (ppb)	Urine As (ppb)	Stnd Dev
< 10	16	4
42	40	8
55	35	15
66	81	23
113	137	38

Results: Arsenic in Milk

- All 5 samples were < 5 ppb wet weight

Results: Arsenic in Cheese

- Single sample so far – 10 pending
- From farm with 113 ppb
- < 50 ppb arsenic

Conclusions:

- Urine arsenic concentration appears to show that arsenic in well water was absorbed by the dairy cattle
- Arsenic did not show up in the bulk milk we sampled or first processed cheese

Phase Two

- U of MN Rapid Response funds
- Well water (100 farms)
- Hi, Med, Lo groups
- 5-7 cows in each group
- Milk, cheese, meat
- Organs from cull cows
- Bull calf study