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Mineral Balances in California Dairy Farms

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Introduction (1)

1. Water Quality Regulations based on Waste Discharge Requirements (**WDR**) are affecting **ALL** dairy producers in CA
2. **WDR** = Waste Management Plan (**WMP**) + Nutrient Management Plan (**NMP**). Today, NMP = nitrogen

Introduction (2)

3. The **NRC (2005)** identified 10 minerals with potential effects on crops yield or the environment (Cd, Cu, Fe, Hg, P, K, Na, Se, S, and Zn), where P is the main concern
4. The bioavailability of minerals of common feeds is not well characterized, and is affected by: intake level, feed type, variations of the same feed, interactions between mineral, soil fertilization, method of analysis, etc. (**NRC, 2001, 2005**)

Objectives:

- Analyze dietary mineral content in commercial dairy farms in Merced Co. California.
- Study the effect of total salt (TS) drinking water contents and milk yield per cow on the milk mineral utilization in lactating dairy animals

Material and Methods (1)

This survey was conducted in Merced County, California:

Forty dairy farms (mean 780±592 cows/dairy) were selected based on:
1. total salt (TS) content in the drinking water for animals (±500 mg/L)
2. milk yield/cow (±32kgmilk/cow/d)

Dry Matter Intake (DMI) was calculated by groups of cows (n=138): Total Mixed Rations (TMR) daily tons/number of cows per group and adjusted by DM content. The average DMI/cow per dairy farm was calculated according to the proportion of animals in each group

Water intake was estimated by Murphy et al., (1983). Flow meters were also installed in 10 dairies to calculate water consumptions

Milk yield per cow was estimated based on Dairy Herd Improvement (DHI) records, and when not available, using bulk tank milk data

Material and Methods (2)

Samples of: TMR, bulk tank milk (am-pm) and drinking water for animals, were taken by duplicate in 2 non-consecutive days in each dairy farm

Chemical analyses (wet chemistry, ANR Lab-UC Davis): Ca, P, Mg, K, Na, Cl, S, Cu, Fe, Mn, Se, and Zn

Experiment design was a complete randomized study with a 2x2 factorial arrangement of treatments: LL, LH, HL, and HH and 10 dairy farms/treatment

Pearson correlation analysis was used to study gross utilization efficiency (milk/intake*100) and the mineral balance (intake-milk) for each mineral

Definitions

- **Dietary mineral content** = concentration of minerals in the diet (TMR + water)
- **GUE (%)** = milk gross utilization efficiency for each mineral (milk/intake*100)
- **Mineral Balance (g or mg/day)** = for each mineral, difference between total intake and milk output

Results: water total salts (TS) and milk yield

	mean	sd	min.	max.
Water total salt (mg/L)				
Low TS	306	114	100	500
High TS	809	310	535	1683
Milk (kg/cow per d)				
Low milk yield	27.0	2.98	20.4	31.0
High milk yield	35.7	2.77	32.1	43.5

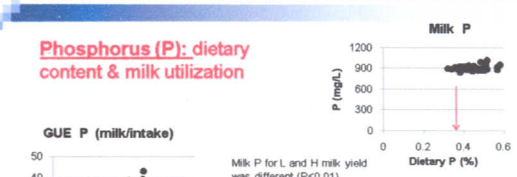
Chloride & sodium from drinking water: percentage of requirements

		WATER (W)			HW range (%)	
		L¥W	H¥W	SE	min	max
Chloride						
Water min/req‡	%	4.4	24.8	3.98	5	104
Sodium						
Water min/req‡	%	8.2	24.9	2.87	8	74

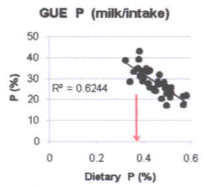
¥ L = low (< 500mg/L) and H = high (> 500mg/L) of Total Salts

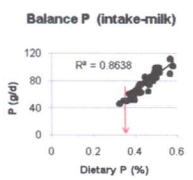
‡ % of mineral requirements covered from minerals in the water

Phosphorus (P): dietary content & milk utilization



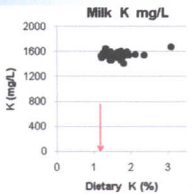
Milk P for L and H milk yield was different (P<0.01)

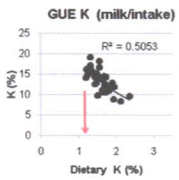


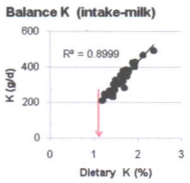


NRC (2001) requirements ↓

Potassium (K): dietary content & milk utilization

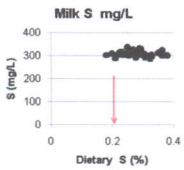




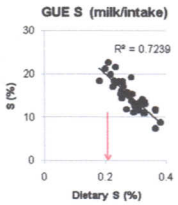


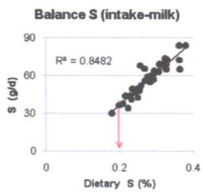
NRC Requirements ↓

Sulfur (S): dietary content & milk utilization



Milk S for L and H milk yield was different (P<0.01)

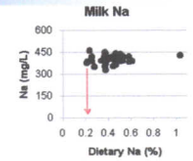


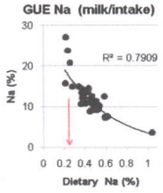


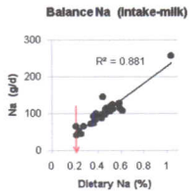
NRC (2001) requirements ↓

Sodium (Na): dietary content & milk utilization

Milk Na for L and H milk yield was different (P<0.02)



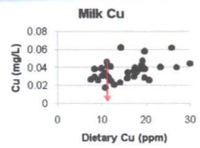


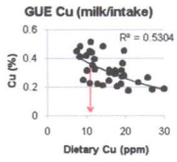


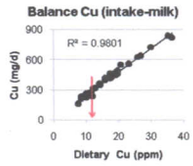
NRC (2001) requirements ↓

Copper (Cu): dietary content & milk utilization

Milk Cu for L and H milk yield was different (P<0.08)

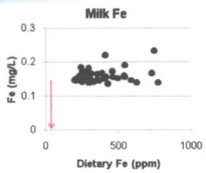


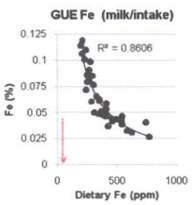


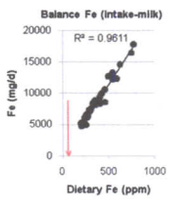


NRC (2001) requirements ↓

Iron (Fe): dietary content & milk utilization

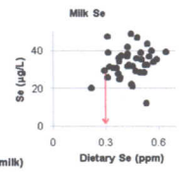


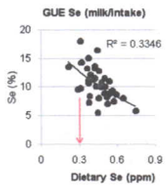


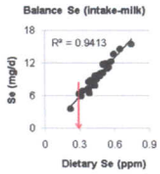


NRC (2001) requirements ↓

Selenium (Se): dietary content & milk utilization

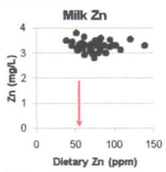


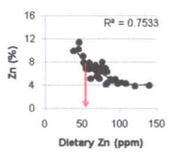


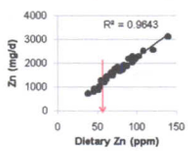


NRC (2001) requirements ↓

Zinc (Zn): dietary content & milk utilization







NRC (2001) requirements ↓

Conclusions (1)

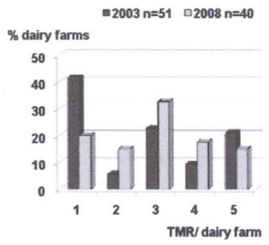
- Same macrominerals in drinking water (≥ 500mgTS/L), should be included in the diet (Ca, Mg, Cl, Na, S) to control dietary mineral content and balance
- Concentrations of Ca, P, Na, S, and Cu in milk was different for high and low yielding cows

Conclusions (2)

- Feeding according to NRC requirements maximized Mineral's Milk Gross Utilization Efficiency (GUE = milk/intake)
- Dietary (TMR+water) minerals' content were highly correlated with % minerals harvested in milk (GUE) and mineral balances

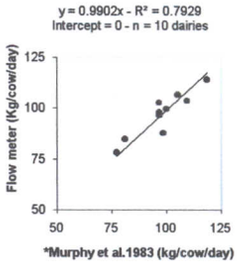
THANKS!

Number of Total Mixed Rations (TMR) in Merced Co. dairy farms



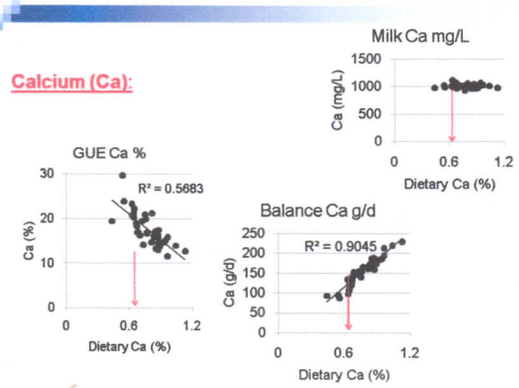
(e.g. 3 TMR = fresh, high, and low groups)

Water intake estimations

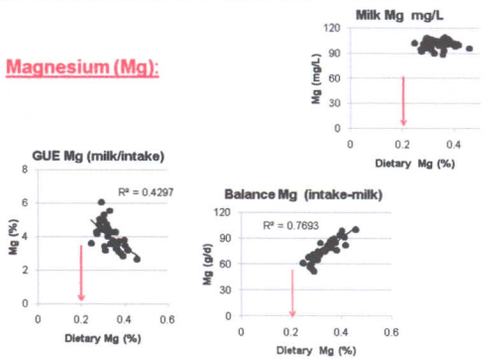


* Free Water Intake (FWI)= 15.99+1.58DMI+0.9Milk+0.05Na intake+1.2MinT°C

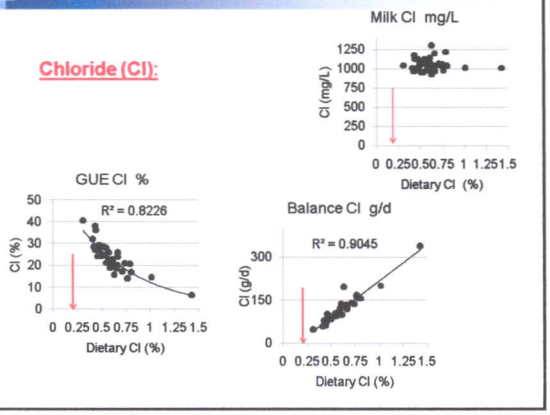
Calcium (Ca):



Magnesium (Mg):



Chloride (Cl):



Manganese (Mn):