Welcome to the 2010 Georgia Poultry Conference:

PROCESSING SESSION

*Session Chair: **Jonathan Green, Pilgrim's Pride***

10:45–11:15am **Poultry processing by-products effects on wastewater**, Dr. Brian Kiepper, University of Georgia

11:15–11:45am **Emerging technologies for reclaiming poultry process water**, John Pierson, Georgia Institute of Technology

11:45–12:15pm **Carbon footprinting 101: where do I start?** Jason Perry, University of Georgia

12:15–12:45pm **Microbial interventions in poultry processing worldwide: successes and opportunities**, Scott Russell, UGA

Wednesday, September 29, 2010

Poultry Processing By-Products Effects on Wastewater

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Poultry Science
The University of Georgia
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2010 Georgia Poultry Conference
Athens, Georgia

The University of Georgia
Engineering
Department of Biological and Agricultural Engineering

Water Use by the U.S. Poultry Processing Industry:

~ 9 billion broilers slaughtered annually

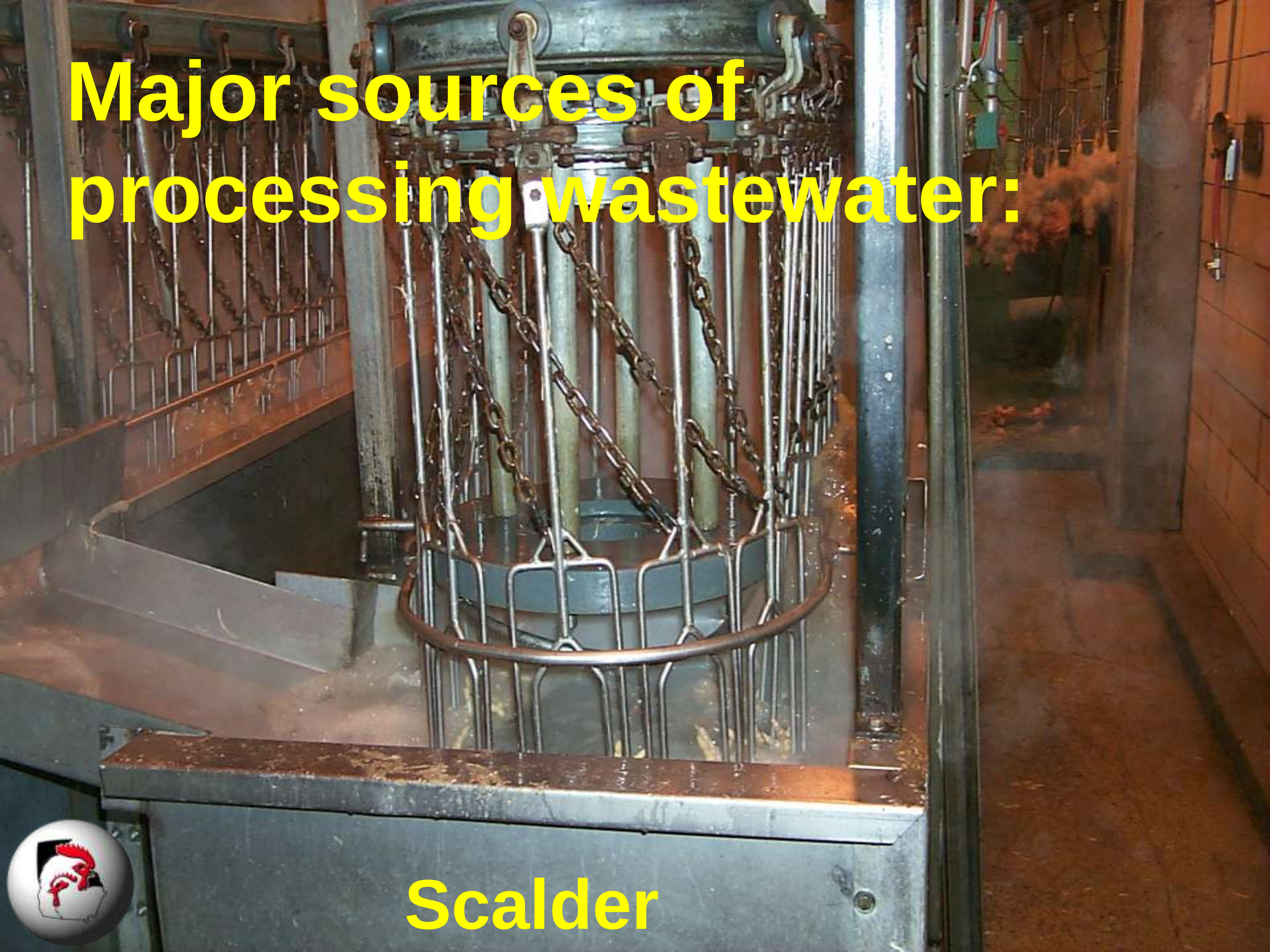
(~ 220,000 birds per plant)

5 – 10 gallons of water used /bird processed

(~ 7 gallons / bird) *(Northcutt, 2003)*

45 – 90 billion gallons of high strength wastewater

Major sources of processing wastewater:



Scalder


Feather
Pickers

Evisceration

IOBW

Chillers

Sanitation

Poultry Processing Wastewater Characterization

Total Poultry Processing Wastewater (PPW) Stream:

- Porges (1950), Teletzke (1961), Camp and Willoughby (1968) reported mean BOD PPW concentrations of 1275, 664 and 473 mg/L
- Nemerow (1969) reported PPW at a BOD of 630 mg/L
- Carawan *et al.* (1974) reported PPW at 506 mg/L BOD
- Singh *et al.* (1973) reported an average of 746 mg/L BOD for PPW from 4 processing plants
- USEPA (1975) also revealed wide fluctuation in the PPW organics concentrations (500 to 1300 mg/L)
- Chen (1976) reported a BOD range of 780 to 1250 mg/L at 19 Mississippi broiler processing plants
- Whitehead (1976) reported a final broiler processing plant effluent BOD of 1116 mg/L, with a corresponding COD reading of 1691 mg/L.
- Merka (1989) reported final PPW effluent BOD averages of BOD of 2178 mg/L, COD of 3772 mg/L, and FOG of 776 mg/L

Poultry Processing Wastewater Characterization

Localized PPW Streams:

- In 1972, Hamm sampled wastewater from 7 discrete processing functions at 10 plants and found that the scalder produced wastewater with the highest average COD (2268 mg/L).
- Carawan *et al.* (1974) also measured the organic concentration from 7 process functions and found the highest contaminations in the giblet chiller (3958 mg/L COD).
- Whitehead (1976) reported that supernatant from an offal trailer had the highest BOD (7050 mg/L), while chiller overflow has the least (830 mg/L BOD).
- Lilliard reported in a 1978 study that the highest organic load was produced by a neck chiller (1723 mg/L BOD) and a gizzard splitter (1484 mg/L BOD).

Current PPW Literature

- Most results are **concentration** (mg/L) based since accurate volume of water is needed to calculate **loading** (lbs/day)
  - Woodward *et al.* (1972) reported 26% of PPW BOD load is attributed to the flume transportation of viscera. ~7% of the BOD load was attributed to the scalder, 7% to the chiller overflow
- Little known about the impact of individual by-products introduced into the PPW stream during processing
  - Porges and Struzeski (1962) reported that uncollected blood had a BOD of 92,000 mg/L, and contributed 40% of a broiler slaughter plant's final effluent organic load

Experiment to measure the impact of poultry processing by-products on wastewater

Experiment birds came from existing experimental flock at the University of Georgia

8-week old Cobb 400 broilers

24 male broilers randomly selected and assigned to 1 of 4 treatment groups (n=6)

Transport coops with bottoms used to simulate commercial transportation conditions


- Feed withdrawal at 12:00 am
- Loaded into coops at 6:00 am
- Birds held in coops until 10:00 am
- 6 birds per coop
LC

Experiment Design

- Processing By-Products of Interest
  - Blood
  - External Debris
  - Feathers
  - Viscera
- Bleed Time (2 levels)
  - 60 seconds (Shorter = S)
  - 120 seconds (Longer = L)
- Scalder Water Temperature (2 levels)
  - 50^{o}C (Soft-Scald = S)
  - 60^{o}C (Hard-Scald = H)

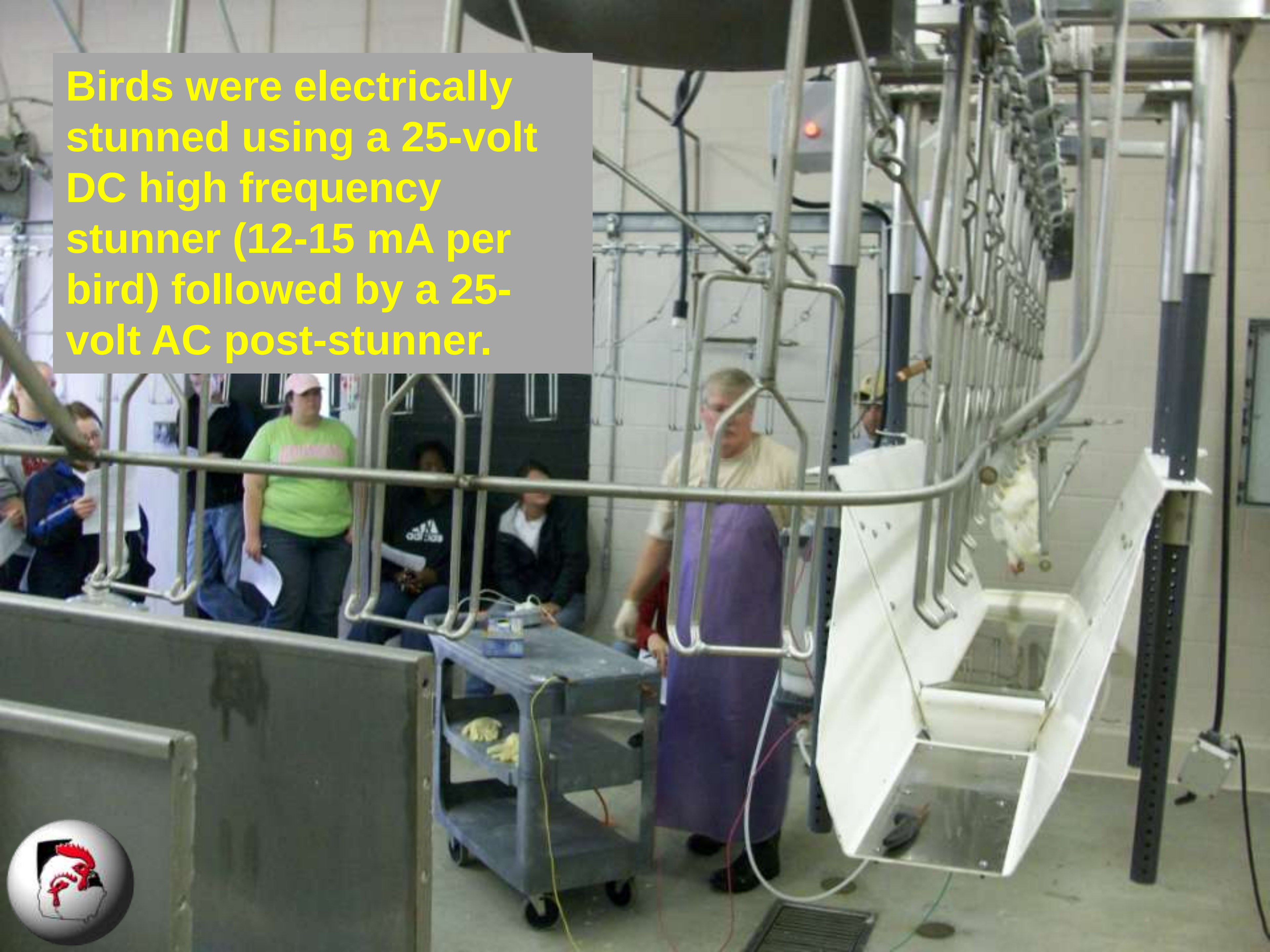
4 Treatments (2x2):
- SS
- SH
- LS
- LH

Live Weight

Live weight (kg) of
24 broilers measured.
Average live weight =
4.09 kg (9 lbs)

No significant difference in mean live weights among treatments *(P=0.5208)*

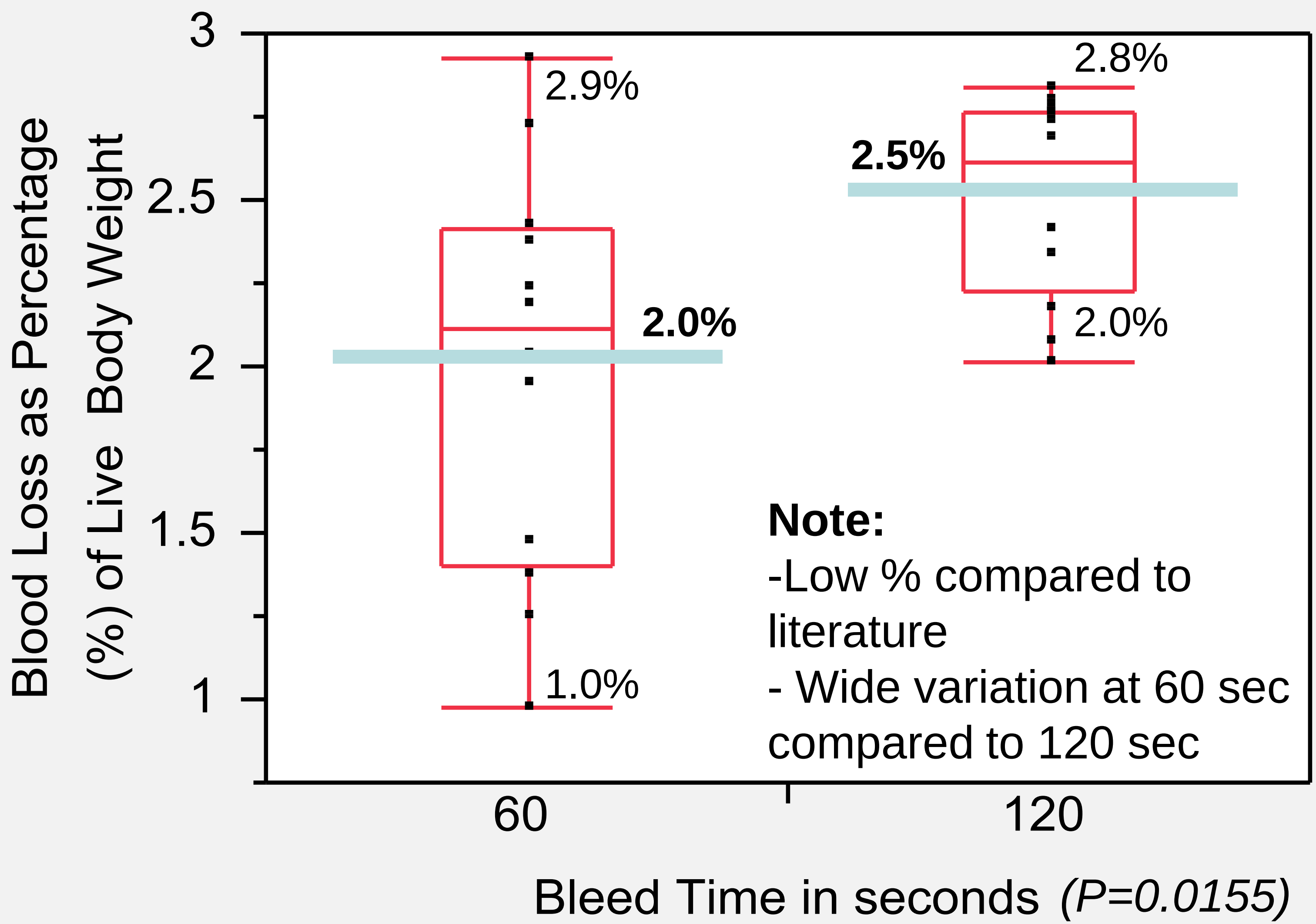
Birds hung from shackle line prior to electric stunning


Birds were electrically stunned using a 25-volt DC high frequency stunner (12-15 mA per bird) followed by a 25-volt AC post-stunner.

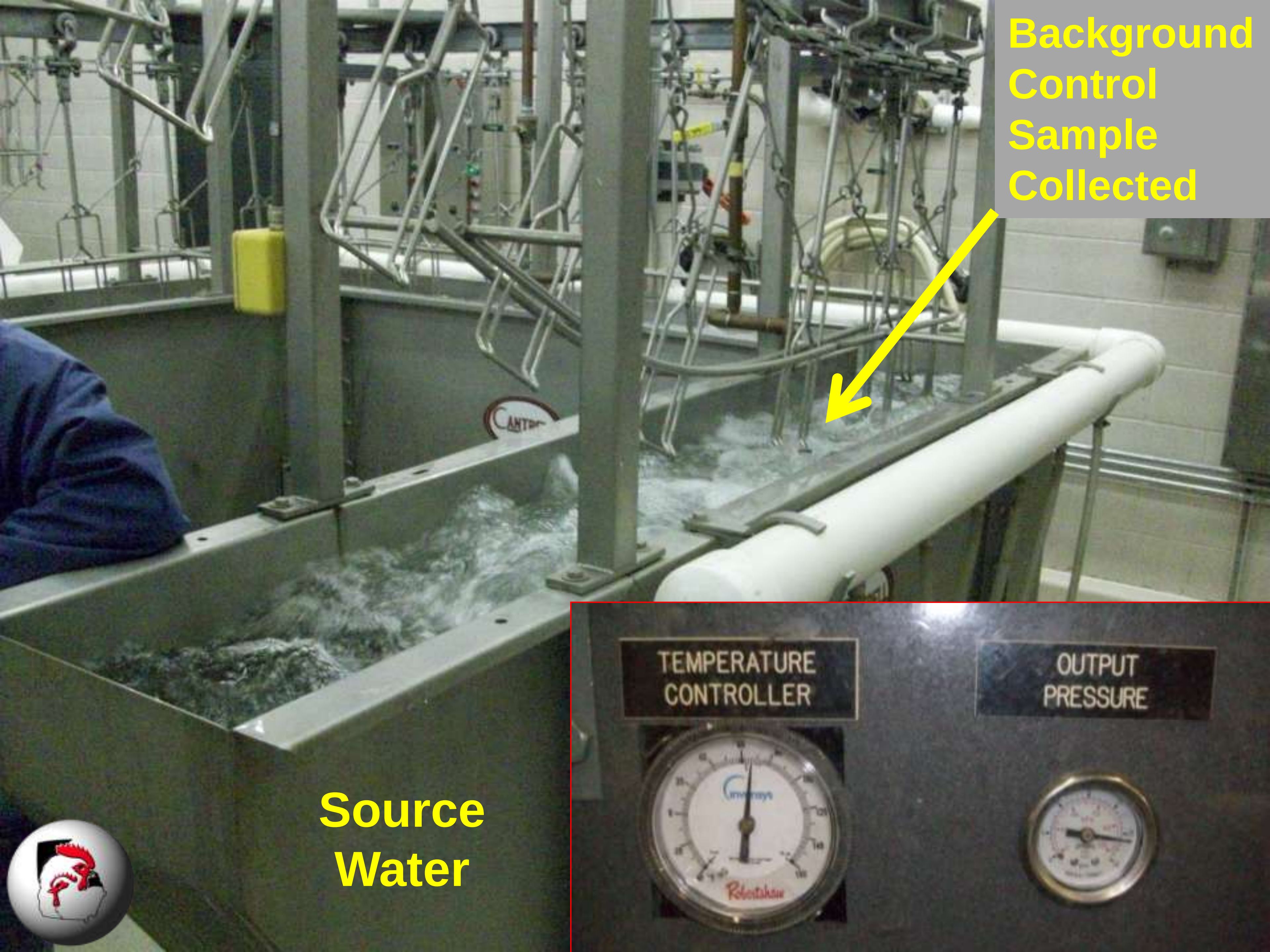
Working in 2-man teams birds were simultaneously decapitated (to minimize variation in neck cuts) within 30 seconds of exiting the stunning tunnel. Previous research has shown that there is no significant difference in blood loss volume between broilers exsanguinated via neck cut versus decapitation (McNeal et al., 2003)

The birds were bled for either 60 seconds (S) or 120 seconds (L)
Draining blood was collected in zip log bags and weighed

Blood Loss as % of Live Weight




Individual scalder
pots holding 16
liters of heated
water


Background
Control
Sample
Collected
Source
Water
TEMPERATURE
CONTROLLER
OUTPUT
PRESSURE
Robertshaw


After blood collection for
the specified time period,
additional blood was
allowed to drip into an
individual metal container of
scalder water set below
each bird.

The carcasses were then simultaneously dipped into the scalding container and agitated for 2 minutes. After agitation, carcasses were removed and re-hung on the shackle line.

Following scalding, 2L samples of well-mixed scalder water were collected from each of the three scald containers and placed on ice

Wastewater Analytics

The scalder background and 24 scalder wastewater samples were analyzed for:

- **COD** (chemical oxygen demand method 5220D),
- **TS** (total solids method 2540B),
- **TSS** (total suspended solids method 2540D),
- **TVS** (total volatile solids 2540E), and
- **TKN** (total Kjeldahl nitrogen method 4500-NorgD)

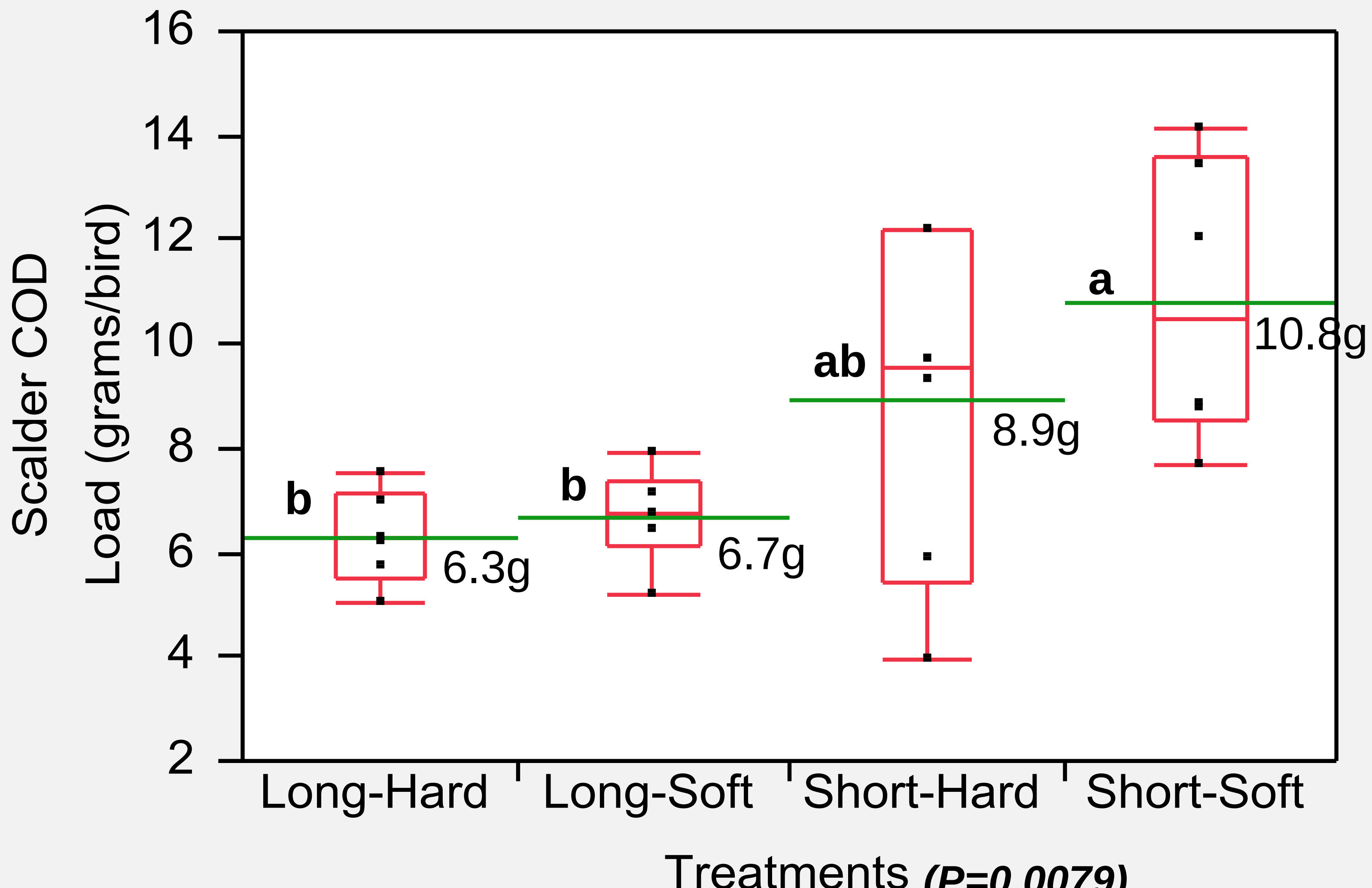
- Samples were also analyzed for chemical element content (i.e., **Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Si, Zn and Hardness**) using ICP (inductively coupled plasma method 3125B)

Wastewater Concentration / Loading

Regardless of the analytical test performed, all concentration data points received similar treatment:

1. If the background control sample concentration was at a detectable level, that background concentration value was subtracted from the data point. On the other hand, if the background control sample concentration was below detectable limit (BDL), the concentration data point remained as reported.
2. A load value in grams (g) was determined for each data point by multiplying the volume of scalder water (16L) by the concentration (mg/L) of that parameter. The result (mg) was divided by 1000 to determine the load in grams (g).

Results: Scalder Water **COD**



Economic Impact

- Average COD Load 60 seconds = 9.85 grams
- Average COD Load 120 seconds = 6.49
- Decrease of 3.36g of COD load to wastewater through a 60 second increase in bleed time
- For a typical broiler slaughter plant processing 250,000 birds per day (bpd), 260 processing days per year, and paying $0.30 per lb of COD in surcharges:

(250,000 bpd) (3.36g) = 840,000g/d or 840 kg/d

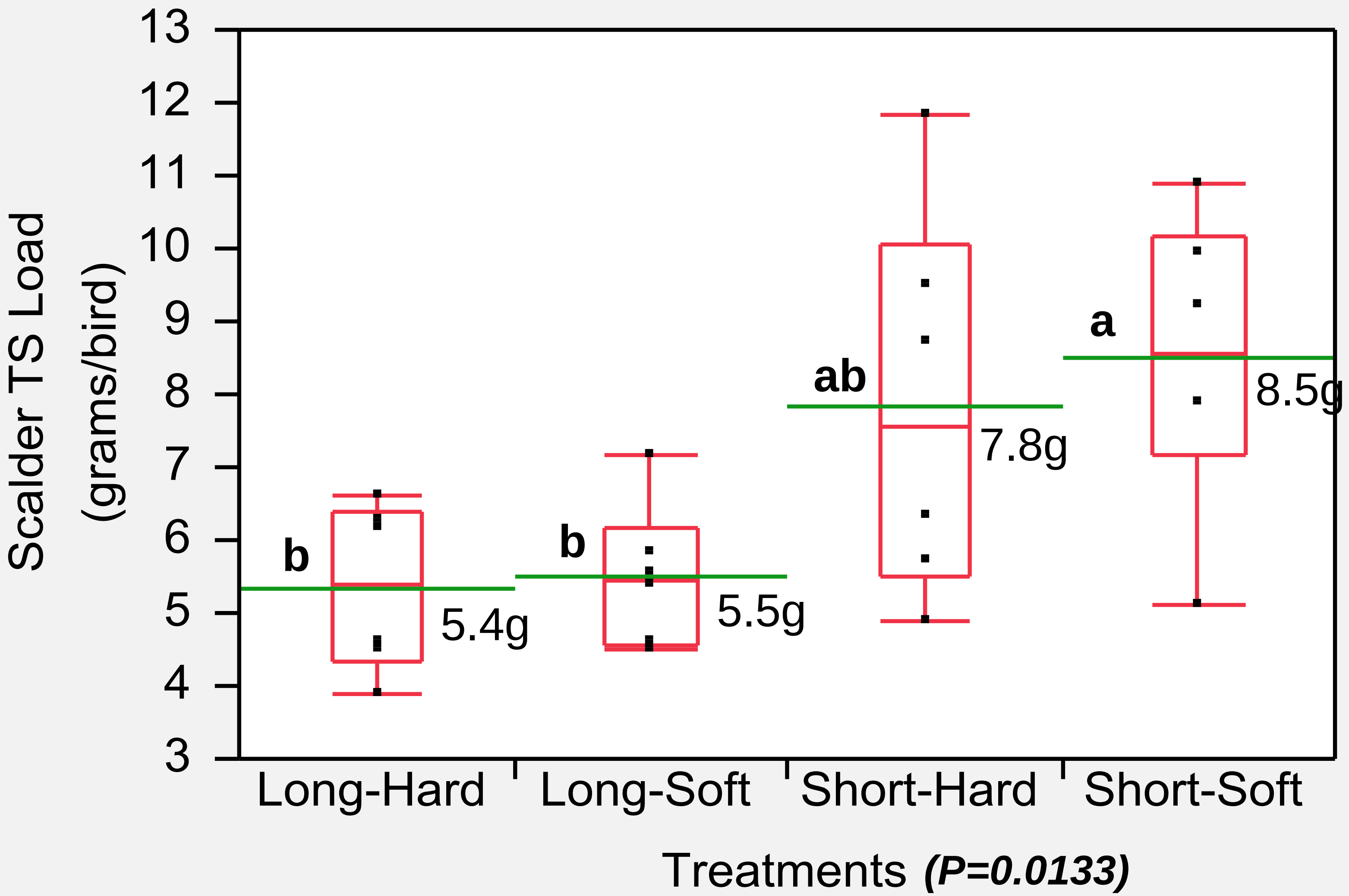
840 kg/d = 1852 lbs/d

(1852 lbs/d) ($0.30/lb) = $ 555.60 / day

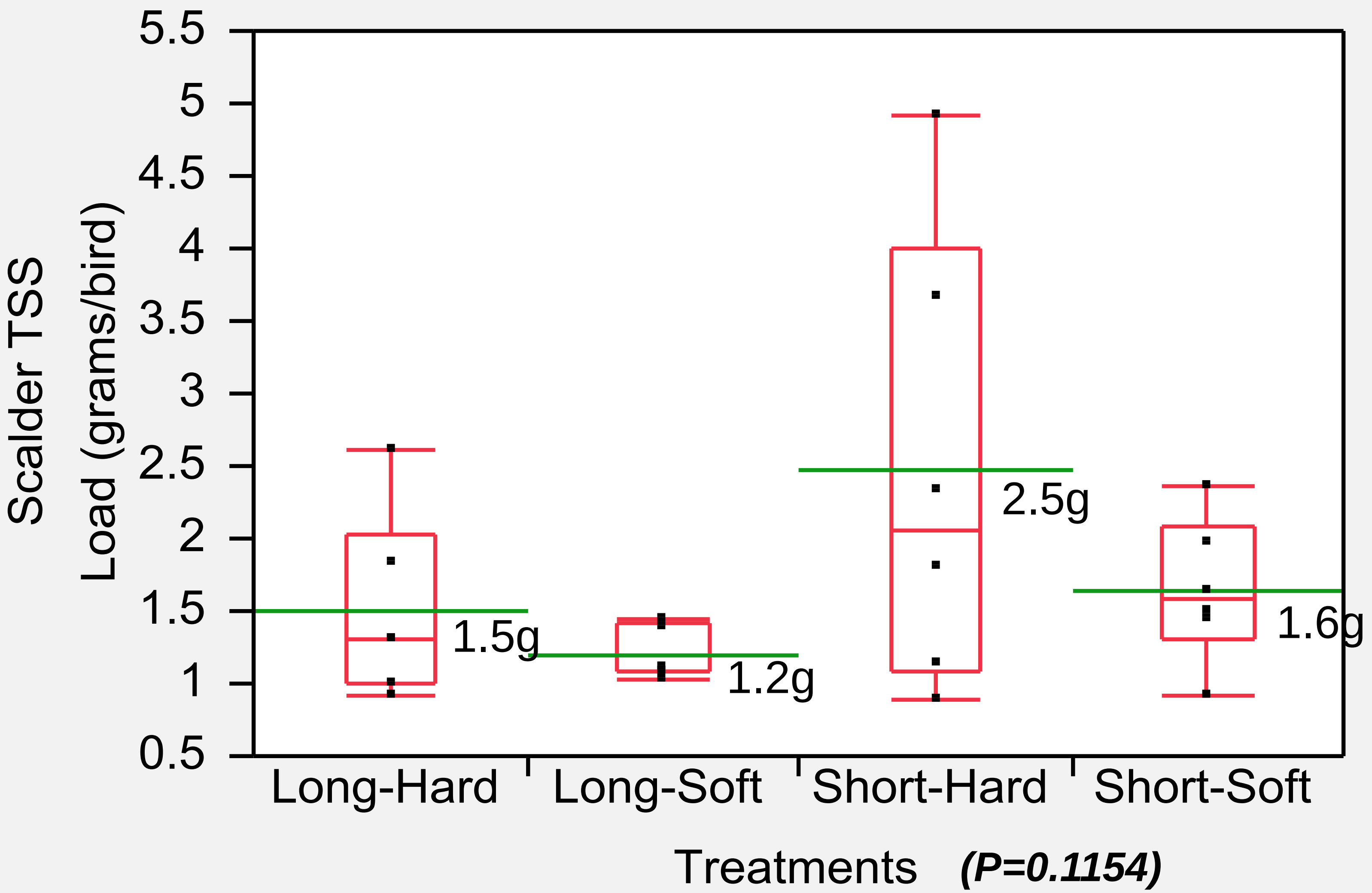
($ 555.60/d) (260 processing days/year)

= $ 144,456.00 /year

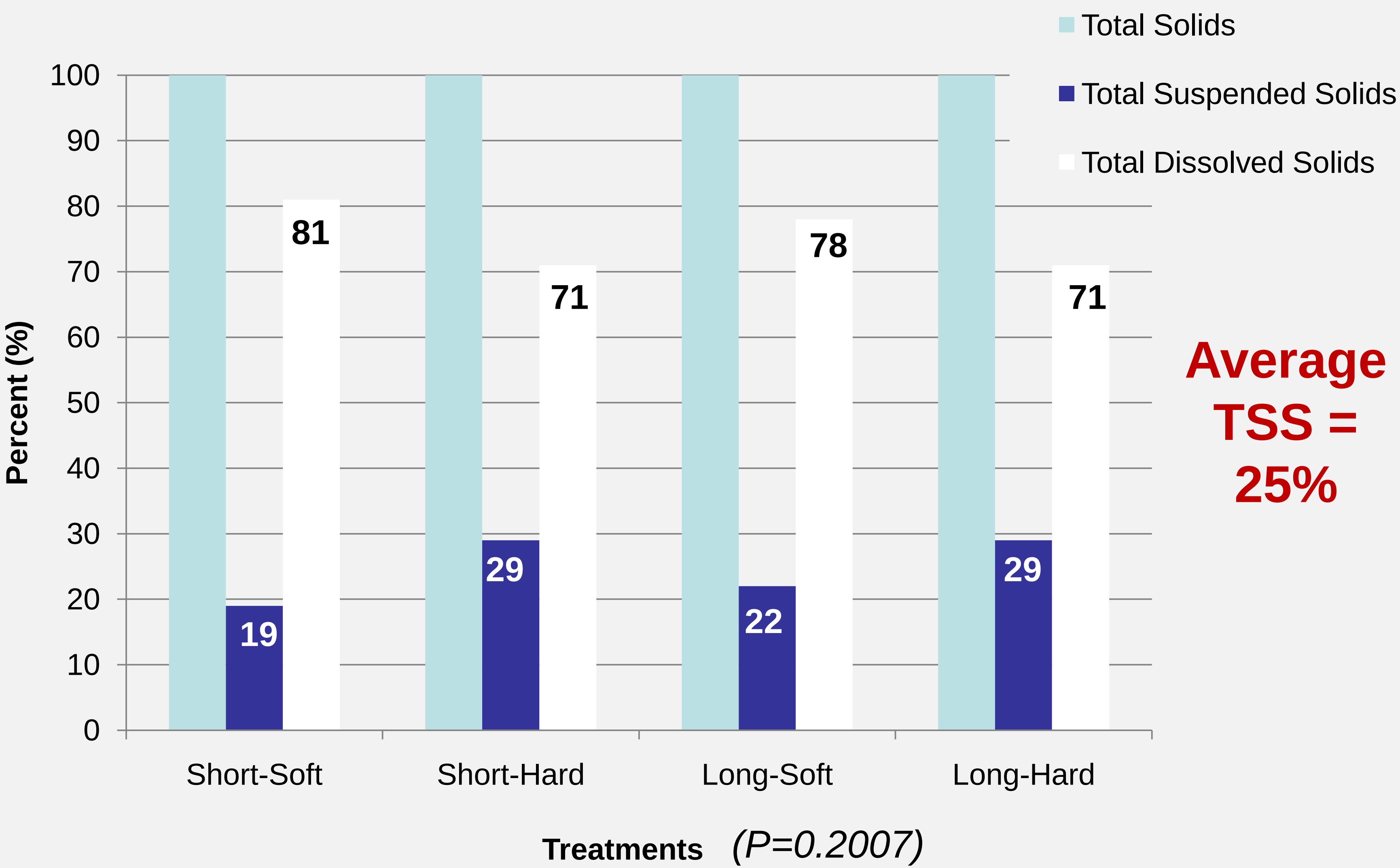
Results: Scalder Water **TS**



Results: Scalder Water **TSS**



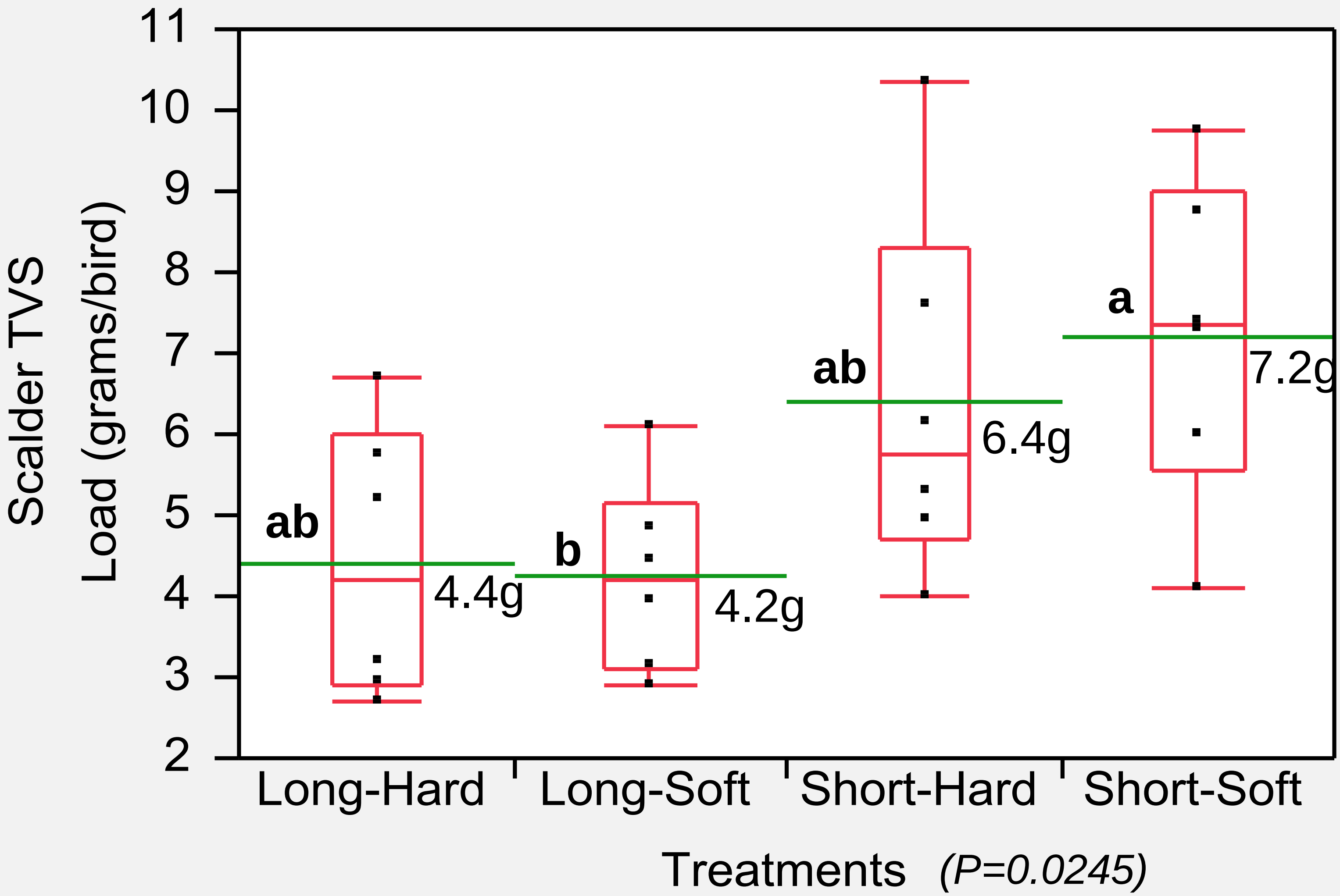
Results Scalder Water **TSS**



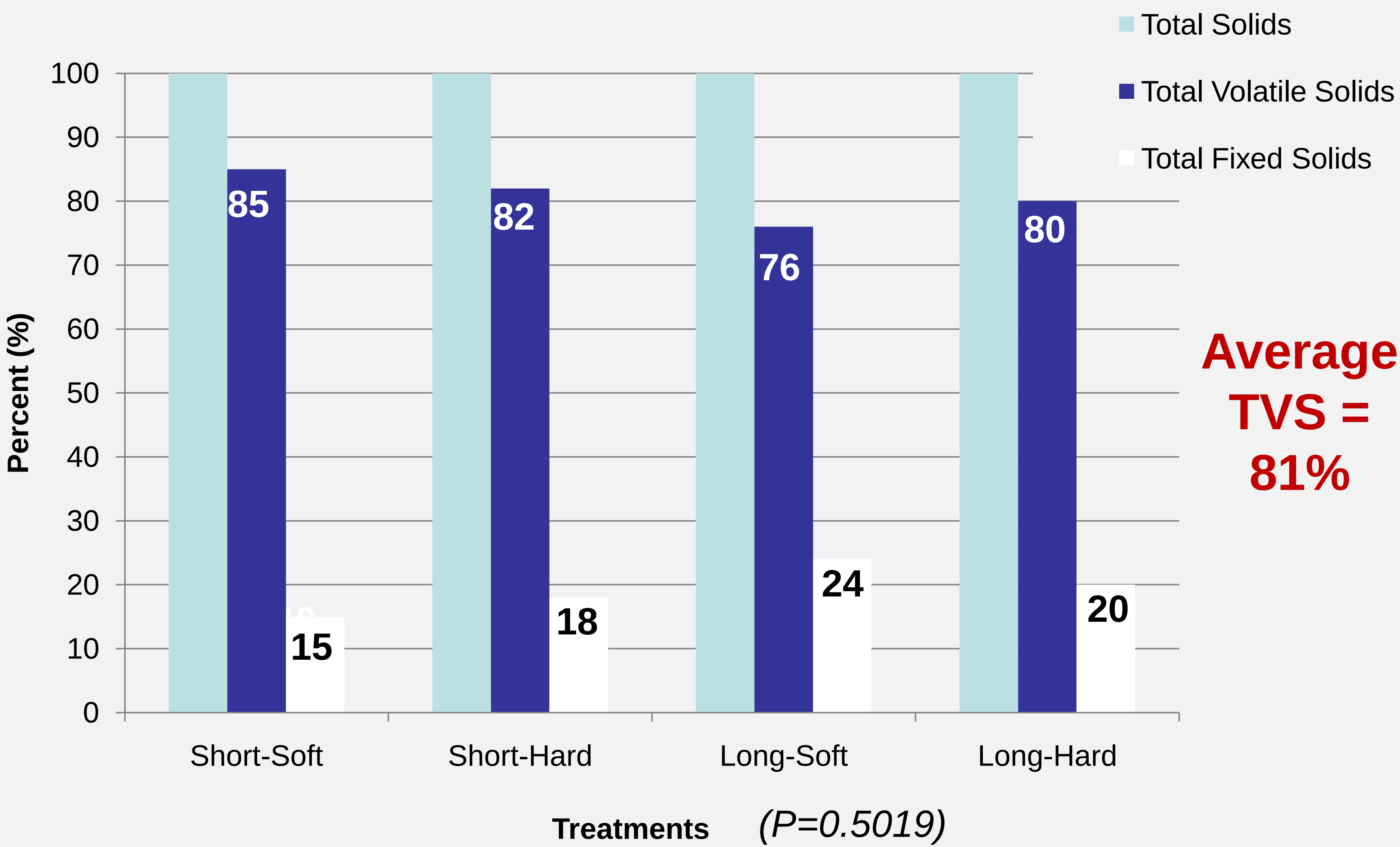
(P=0.2007)

Average TSS = 25%

Results: Scalder Water **TVS**



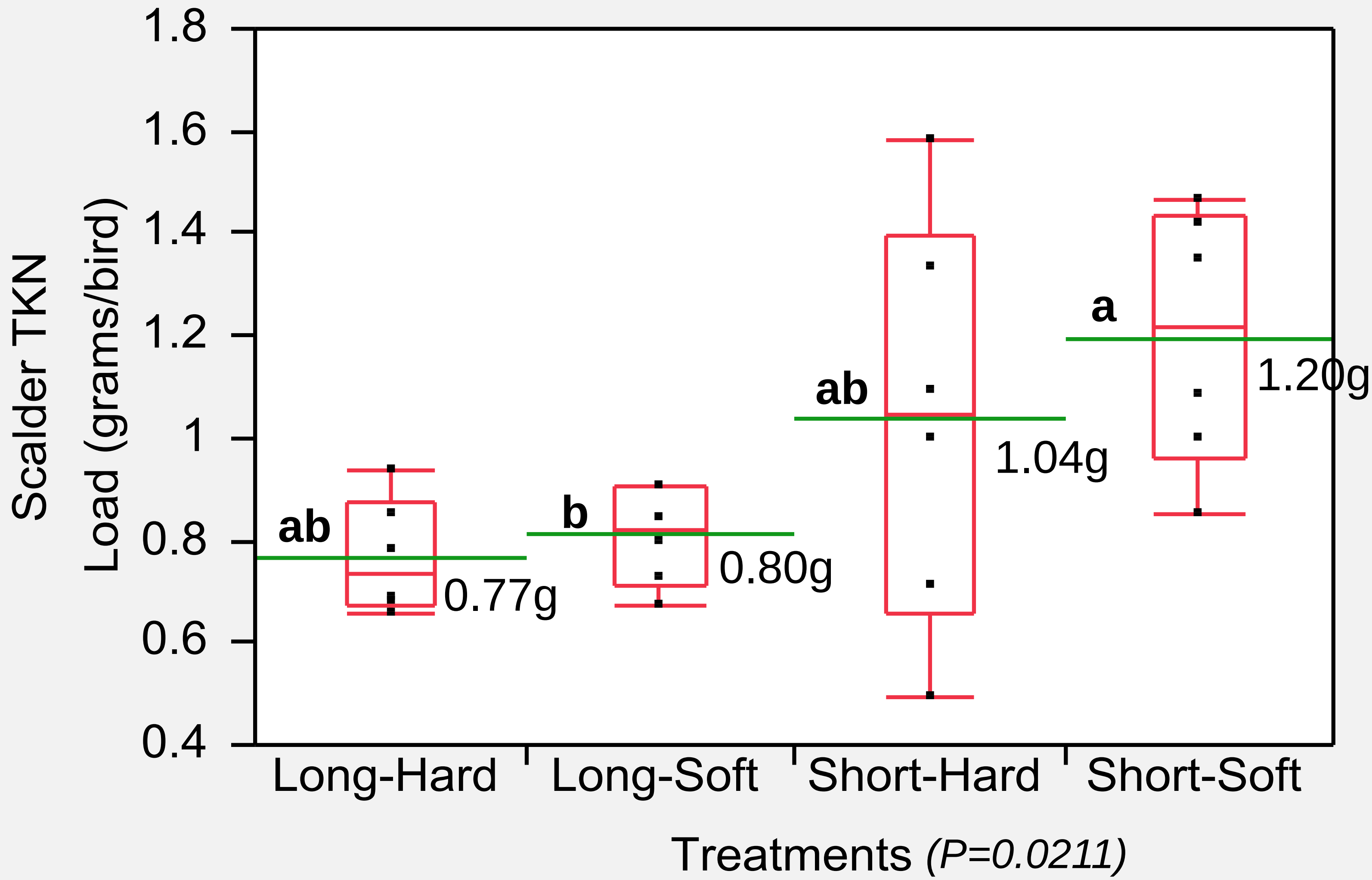
Results Scalder Water **TSS**



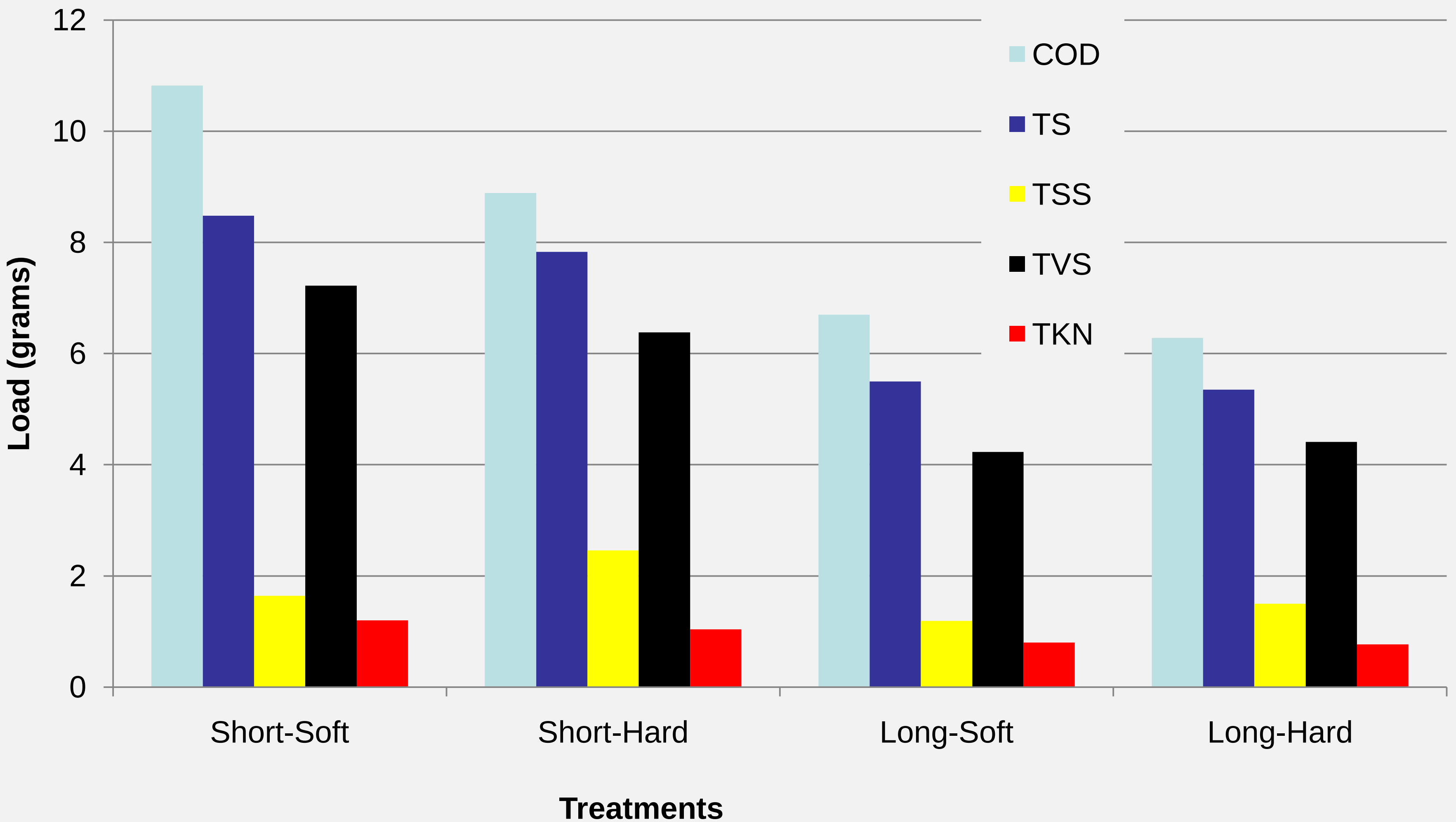
(P=0.5019)

Average TVS = 81%

Results Scalder Water **TKN**



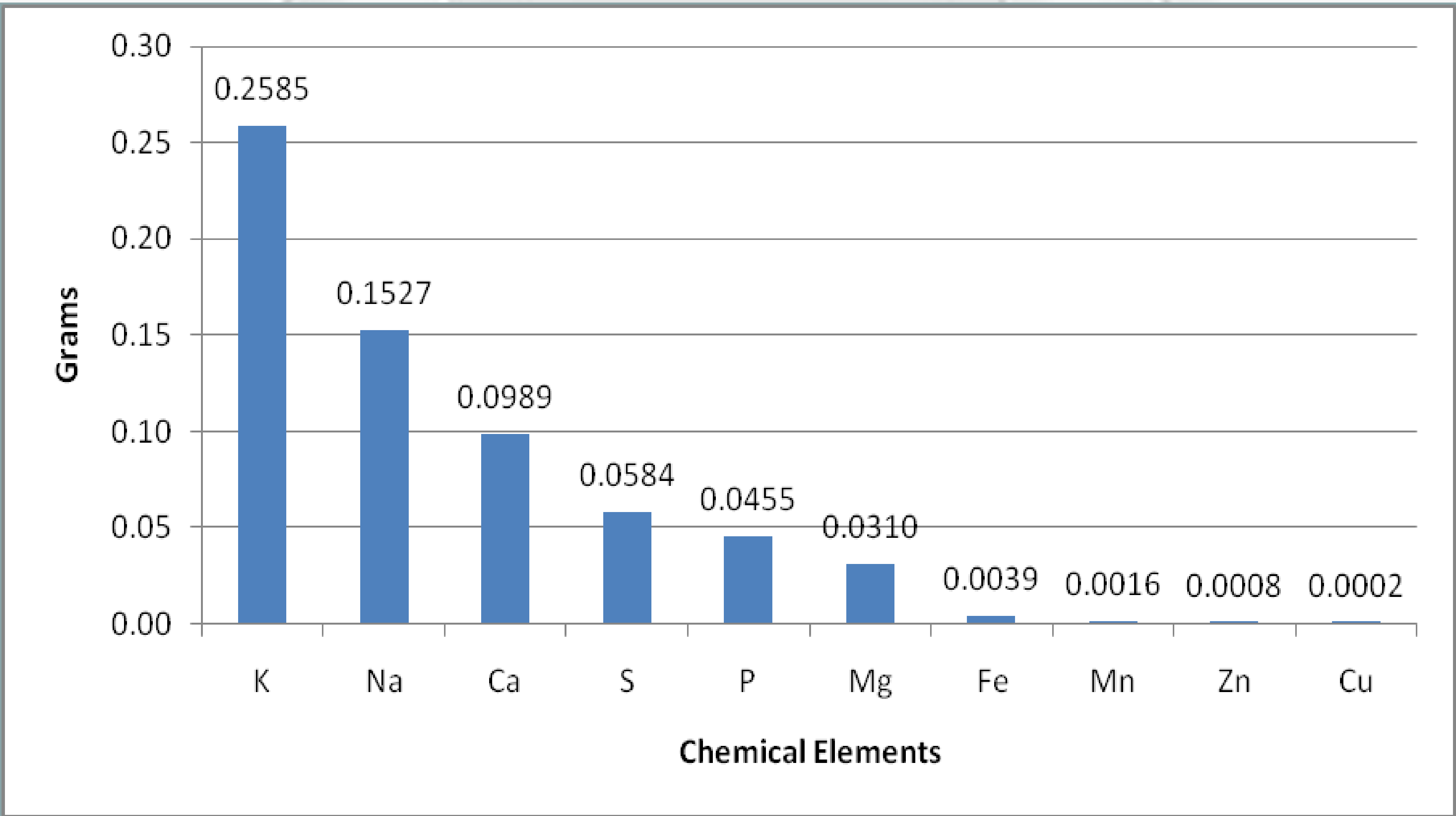
Relative Loadings



Chemical Elements

- Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Si, Zn
- Of the 18 elemental minerals analyzed, 8 had results of below detectable limit (BDL) for <75% of the scalder samples. These 8 elements were designated BDL and were not analyzed further
- The designated elements (and associated BDL%) were Al (92%), B (96%), Cd (100%), Cr (100%), Mo (100%), Ni (100%), Pb (79%), and Si (75%).

Chemical Elements



Questions?

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