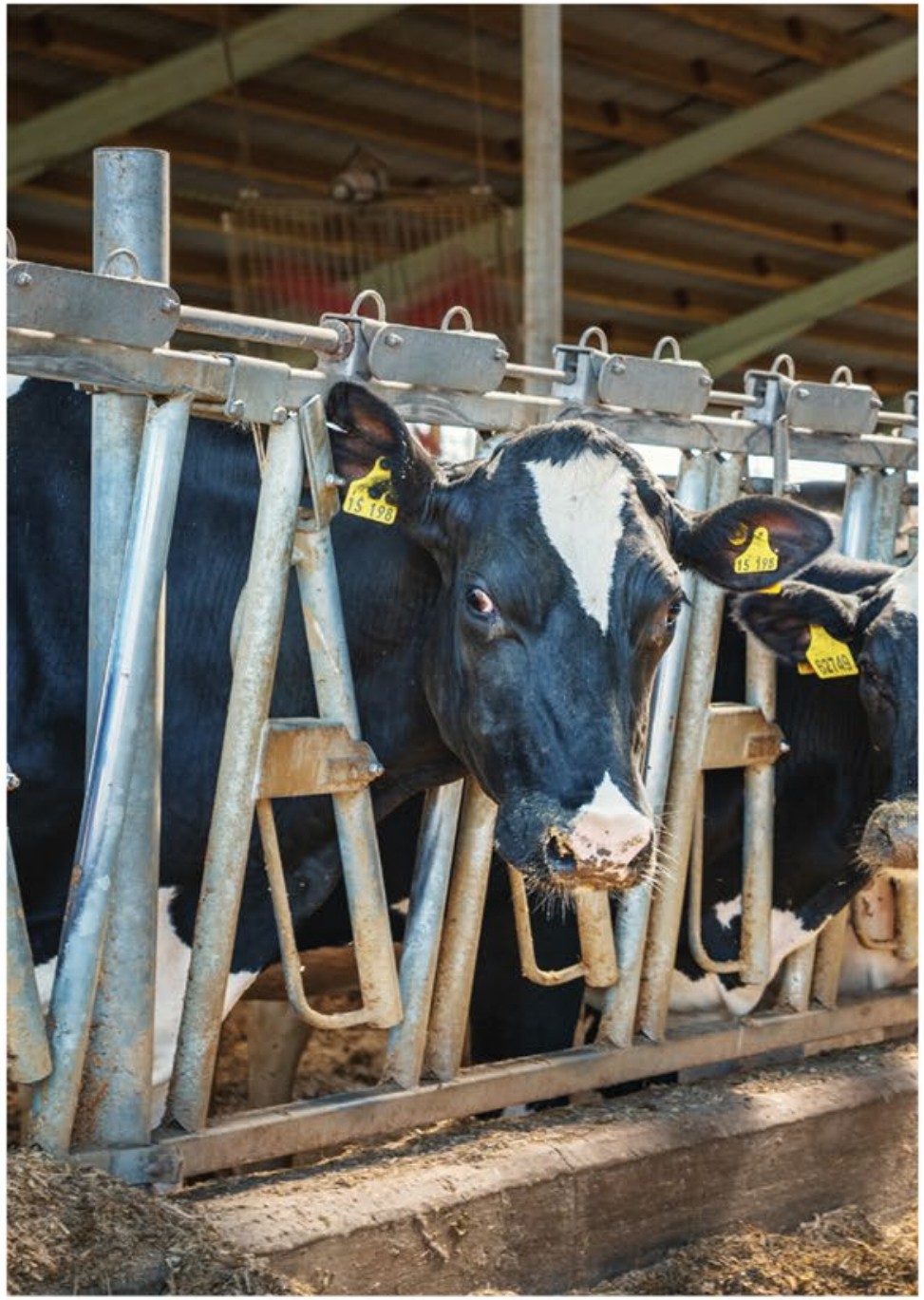
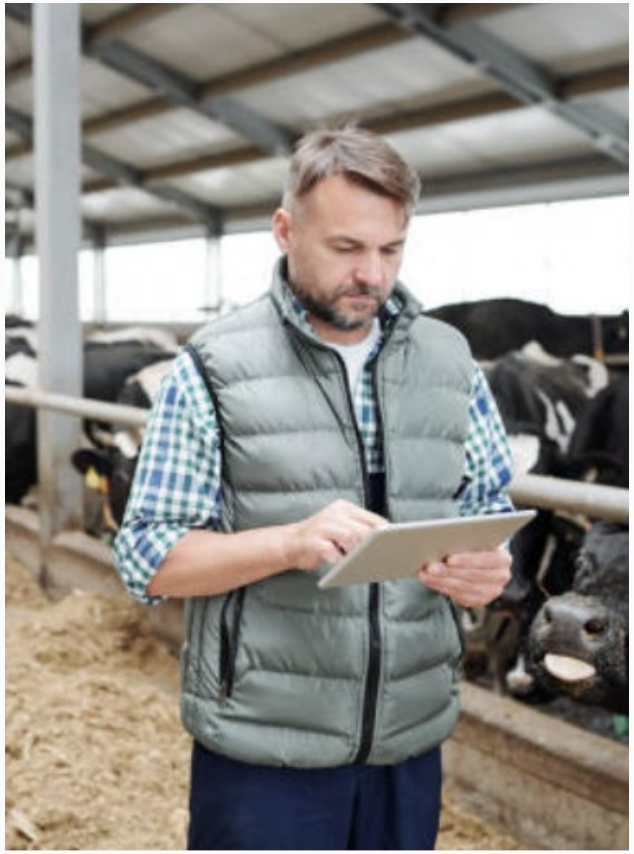


Applying 35 Years of Roasting and Expelling Experience to HO Soybeans

Lynn Davis, Ph.D. Quality Roasting, Inc.,
Nutrition Professionals, Inc

Four State Dairy Nutrition Conference
June 3-4, 2026

U.S. Soy High-Oleic Soy in Dairy Initiative Objectives



- Secure impactful and long-lasting dairy industry demand
- Deliver heat-treated high oleic soy with consistent quality
- Enable dairy nutritionists to strategically advise dairy farmers on product quality control and nutritional value, while remaining flexible on feeding recommendations to their clients

U.S. Soy Dairy Advisory Team

High Oleic Soy

Core Advisors

Corwin Holtz, MS, PAS
Comsen Dairy Consultation

Jim Barmore, MS, PAS
Five-Star Dairy Consulting

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Adam Lock, Ph.D.
Michigan State

Kevin Harvatine, Ph.D.
Penn State

Greg Kneubuhler, CCA
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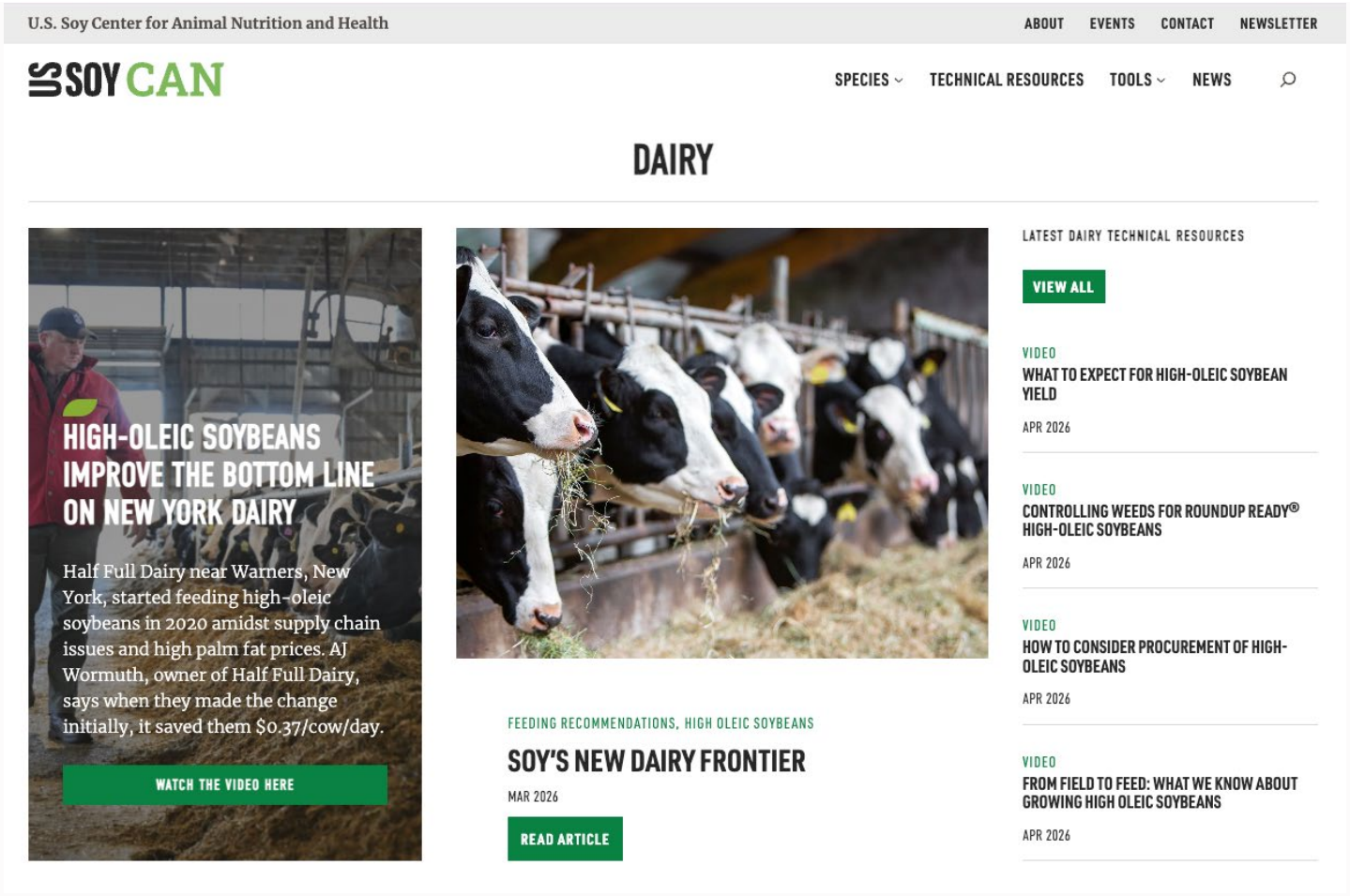
U.S. Soy High-Oleic Research Priorities

High Oleic Soy

- Product Standards and Quality Control
- Product Forms and Cow Performance
- Dietary Formulation Considerations
- Economic and Procurement Considerations

U.S. Soy Resources

High Oleic Soy



https://can.ussoy.org/species/dairy/

QUALITY ROASTING

Feeding Heat-Treated Full Fat Soybeans to Cows in Early Lactation

M. A. FALDET and L. D. SATTER, Journal of Dairy Science 74:3047

US Dairy Forage Research center Agricultural Research Service, USDA
Department of Dalry Science University of Wisconsin Madison 53706

TABLE 1. Composition of diets.

Component	Soybean meal	Raw soybeans	Heated soybeans
Ingredients, % DM			
Alfalfa silage[1]	50.0	50.0	50.0
Shelled corn, ground	38.0	35.0	35.0
Soybean Meal	10.0	…	…
Raw soybeans, cracked	…	13.0	…
Heated soybeans, cracked	…	…	13.0
Dicalcium phosphate	1.0	1.0	1.0
Calcium carbonate	0.4	0.4	0.4
Trace-mineralized salt 2	0.5	0.5	0.5
Vitamin ADE premix3	0.1	0.1	0.1
Chemical analysis			
NEL, Mcal/kg	1.61	1.64	1.64
ADF, % DM	20.1	19.9	19.9
NDF, % DM	26.8	26.4	26.4
Ether extract, % DM	3.3	5.6	5.6
CP, % DM	17.6	17.6	17.4
UIP, % *of total CP*	34	31	42
Available lysine, % DM	0.82	0.84	0.78
PRAL, g/kg DM	2.8	2.6	3.3

Received January 14, 1991.
Accepted April 19, 1991.

QUALITY ROASTING

Feeding Heat-Treated Full Fat Soybeans to Cows in Early Lactation, Continued

M. A. FALDET and L. D. SATTER
US Dairy Forage Research center Agricultural Research Service, USDA
Department of Dalry Science University of Wisconsin Madison 53706

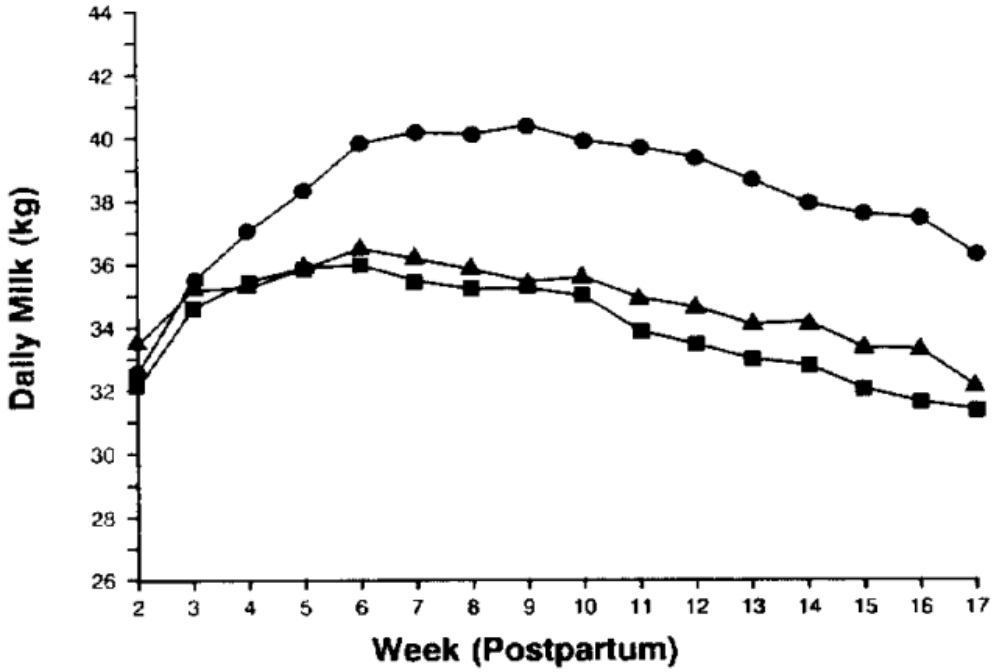


Figure 1. Unadjusted mean daily milk production of cows supplemented with soybean meal (SBM) or soybeans (SB) or heat-treated soybeans (HSB); SBM (■), SB (▲), HSB (●).

QUALITY ROASTING

Journal of Dairy Science

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Effects of raw and roasted high oleic soybeans on milk production of high-producing dairy cows

A.M. Bales and A.L. Lock

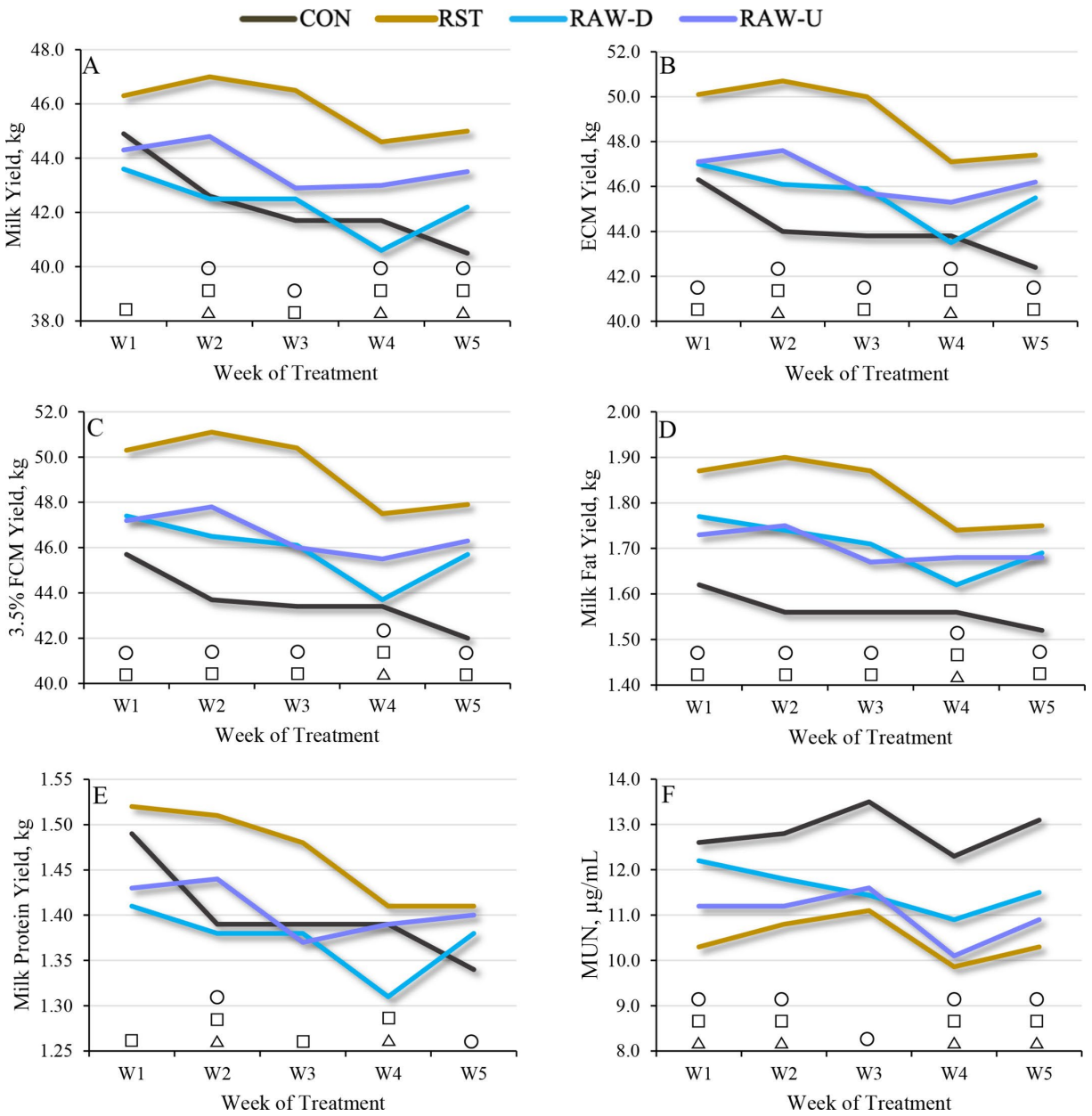
Table 1. Ingredient and nutrient composition of treatment diets

Item	CON	RST	RAW-D	RAW-U
Ingredient, % DM				
Corn silage	45.1	44.8	44.6	44.7
Alfalfa silage	8.06	8.02	7.98	8.00
Ground corn	11.3	11.2	11.2	11.2
Vitamin and mineral mix	2.00	1.99	1.98	1.99
Lactation mix	4.17	4.14	4.13	4.13
DCAD[3]	0.43	0.43	0.43	0.43
Soybean hulls	10.4	6.51	6.43	6.48
Soybean meal	18.6	6.12	6.32	—
Bypass protein	—	—	—	6.24
Roasted HOSB	—	16.7	—	—
Raw HOSB	—	—	16.9	16.8
Nutrient composition, % DM				
NDF	29.2	27.4	27.2	27.5
Forage NDF	19.4	19.3	18.9	19.0
Starch	24.9	24.9	24.5	24.6
CP	17.9	17.4	17.5	17.2
FA	1.61	4.30	4.36	4.34
16:0	0.25	0.36	0.36	0.36
18:0	0.04	0.14	0.14	0.14
cis-9 18:1	0.30	2.67	2.78	2.77
cis-9,*cis*-12 18:2	0.85	0.89	0.84	0.83
cis-9,*cis*-12,*cis*-15 18:3	0.13	0.16	0.15	0.15

QUALITY ROASTING

Effects of raw and roasted high oleic soybeans on milk production of high-producing dairy cows, Continued

A.M. Bales and A.L. Lock



Soy Products Used in Dairy Diets

Solvent Derived Soybean Meal
1-2% Fat with minimal HO impact
30-35% RUP
400-800 microns

Roasted Soybeans (steeped and cooled)
18-20% Fat with oil cell intact
45-60% RUP
Whole to finely ground (700 – 1800 microns)

Extruded Soybeans
18-20% Fat with oil cell ruptured
35-45% RUP
700-800 microns

Insta-Pro Express Soy (extruded and expelled)
7-8% Fat with oil cell ruptured
40-50% RUP
700-800 microns

Expeller Meals (Exceller Pro, Soy Plus, Soy Best)
7-8% Fat with oil cell ruptured
50-75% RUP
Expelled - may be roasted and extruded 600-800 microns

Treated Solvent Derived Soybean Meal (Amino Plus, Sure Pro, Soy Pass)
1-2% Fat with minimal HO impact
70-75% RUP
Solvent soy conditioned with moisture and heat to create Maillard reaction or chemically treated to increase RUP 400-800 microns

QUALITY ROASTING

HO Soybean Roasting Objective

- Optimize protein and functional fat
- Maximize milk and components
- Control protein and fat behavior in rumen by protecting protein while controlling fat release
- Consider soybean moisture and ambient temperature when setting roaster temperature

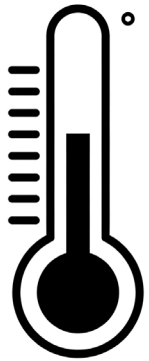
<u>Under-processing</u> = poor ruminal protein protection
<u>Over-processing</u> = protein damage

QUALITY ROASTING

Types of Soybean Roasters

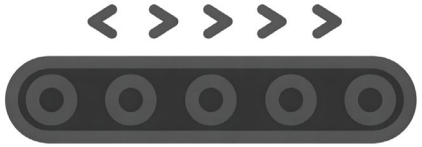
System	Heat Transfer	RUP Control	PDI Consistency	Lys Damage Risk	Throughput
Flame	Flame	Poor	Variable	High	High
Hot Air	Convective Air	Good	Good	Moderate	Very High
Drum	Indirect	Good	Good	Moderate	Moderate
Oil Jacketed Auger	Thermal Oil	High	High	Low	Low-Moderate
Electric	Infrared	Moderate	Moderate	High	Low

Three Critical Steps for an Effective Roasting Process



Heat to 300°F for 2 Minutes

Steep for 30 Minutes



Cooling

High Oleic Soy in Dairy Rations FAQ
Roasting & Heating of High Oleic Soybeans Questions #17–#22

QUALITY ROASTING

Critical Control Points

Roasting

Type of roaster dictates operations

Hull Management

Steeping

Holding temperature within 20-30F of roaster exit temperature is essential to assure even heating regardless of roaster type

Batch or continuous flow

Cooling

Essential to abruptly stop Maillard reaction

Water plus air

Test	What It Measures	Primary Use	Strengths	Limitations	Relation to RUP	Relation to RUP Digestibility (dRUP)
PDI (Protein Dispersibility Index)	Protein solubility in water	Heat treatment indicator	Fast, inexpensive, widely used	Poor predictor of actual RUP; highly variable	**Indirect** (lower PDI = more heat → more RUP, to a point)	Does NOT indicate digestibility; can't detect heat damage
Urease Activity	Residual urease enzyme activity	Detect under processing	Very sensitive to insufficient heat	Useless for overprocessing; binary-type signal	No direct relationship	No relation
KOH Protein Solubility	Protein solubility in KOH solution	Detect overprocessing/ heat damage	Better than PDI for heat damage	Still indirect; influenced by multiple factors	Indirect (low solubility may indicate high RUP or damage)	Some indication of damage → reduced digestibility
16 Hr. in Vitro RUP	% of protein escaping rumen degradation after 16 hrs.	Direct estimate of RUP	A more biologically relevant estimate of RUP compared to solubility tests	Highly variable, sensitive to donor rumen fluid, particle size, rate of passage assumptions	Direct estimate of RUP	Does not measure intestinal digestibility
Ross MSPE (Modified Streptomyces Protease Enzyme)	Enzymatic protein degradation post-rumen simulation	Estimate digestible RUP fraction	Good proxy for intestinal digestibility; faster than in vivo	Still a model; depends on lab calibration	Indirect RUP (used with other data)	**Strong indicator of dRUP** (this is its key value)
Stern 3-Step (In vitro/in situ hybrid)	Rumen bypass + intestinal digestibility	Estimate RUP and dRUP	More biologically relevant; widely respected	Expensive, variable, lab-dependent	Direct estimate of RUP	Direct estimate of dRUP

QC Target Ranges & Interpretation – HO Roasted Soybeans

Test	Target Range	What It Measures	Strengths	Limitations / Interpretation
PDI	9–11	Protein solubility (heat severity)	Fast, inexpensive, excellent process control tool	Weak predictor of RUP/digestibility; <9 = overheat risk, >14 = under processed
Urease Activity (ΔpH)	0.05–0.10	Residual enzyme activity (underprocessing indicator)	Confirms destruction of anti-nutritional factors	Does not detect overprocessing; only flags underheated product
KOH Protein Solubility	70–85%	Nitrogen solubility in alkali (heat damage proxy)	Useful for overprocessing detection in some feeds	Less reliable for full-fat soybeans; weaker relationship to biological value
16 hr. In Vitro RUP	45–55% of CP	Estimated rumen bypass protein	Better biological relevance than solubility tests	Sensitive to method; may not capture digestibility of heat-damaged protein
Ross MSPE	~45–55% RUP equivalent	Enzymatic estimate of rumen escape protein	Repeatable, practical for routine lab use	Can overestimate RUP in heat-damaged samples; limited digestibility insight
Stern 3-Step	Intestinal dRUP ~85–95%	RUP + intestinal digestibility	Best estimate of metabolizable protein supply	More complex, higher cost, lab variability

Key Takeaways

PDI (9–11) defines optimal range, but lacks precision

Urease Activity (<0.05) ensures no under-processing

KOH (75–85) improves resolution in optimal zone

Ross MSPE (60–70) reflects rumen escape and digestibility

Stern 3-step (88–93%) measures RUP and intestinal digestibility of RUP

Routine Test Approach: PDI + Urease + KOH

In Depth Testing: 16 hr. RUP, Ross MSPE, Stern 3- Step

QUALITY ROASTING

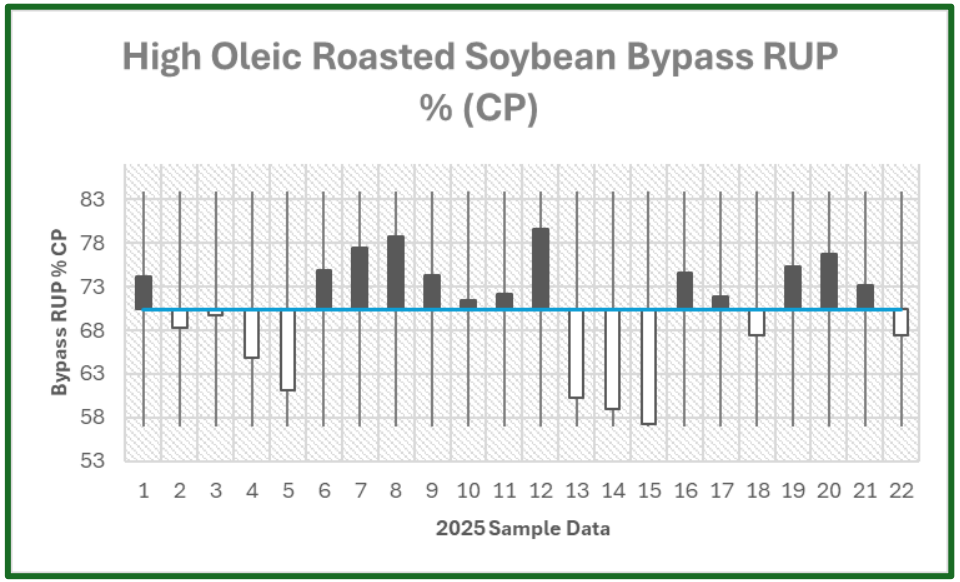
High Oleic Roasted Soybeans – 2025 Results

Averages

Fat %	Fiber %	Moisture %	Crude Protein %	Bypass RUP % CP	PDI	Intestinal Digestibility as % RUP
21.97 (0.137)	6.27 (0.267)	7.99 (0.191)	40.15 (0.045)	70.43 (0.095)	9.49 (0.147)	82.59 (0.069)

% Dry Matter (Coefficient of Variation)

	Crude Protein % DM	Bypass RUP % CP	PDI	Intestinal Digestibility as % RUP
Q1	39.90	70.73	9.53	87.00
Q2	40.48	71.42	10.07	82.86
Q3	40.66	68.76	8.91	80.29
Q4	39.56	72.00	9.81	84.20



QUALITY ROASTING

HO Roasted Soybean Particle Size – The Driver of Protein and Fat Value

Too Fine (<750 microns??)

↑ **Surface Area** = ↑ **Rumen Degradation**

↓ **RUP** (even if roasting process was ideal

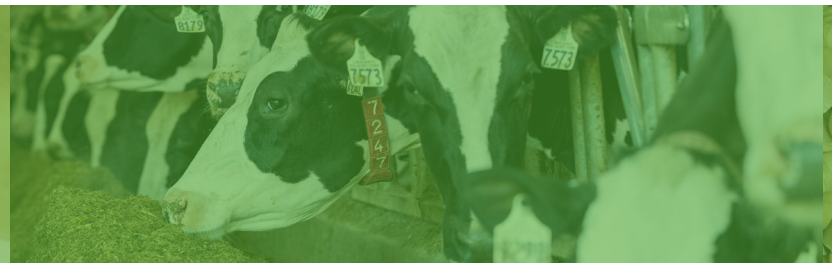
More rapid fat release = Biohydrogenation

Possible loss of some high oleic advantages

Too Coarse (whole or half beans??)

↓ **Total Tract Digestibility** = **Some of value left in the manure**

Roasting Process Sets the Potential but **Particle Size Can Determine If It is Captured**



QUALITY ROASTING

Optimizing HO Roasted Soybean Value

1 Heat Processing Must Be Right

Target: Proper Protein Protection Without Overprocessing

Combine Metrics:

- **PDI** (target = 9-11 but interpret cautiously near optimum)
- **KOH Solubility** (target = 70-85% or 0.2% KOH solubility) <70% = overheated and possibly damaged protein
- **Urease Activity** (target = 0.00 – 0.05 Δ pH) >0.05 = underheated/excess RDP/low RUP
- **16 hr. in vitro RUP/Ross MSPE/Stern 3 step** (more in-depth measures of RUP and intestinal digestibility)

2 Particle Size

- RUP Utilization
- Fatty Acid Digestibility
- Too Coarse (whole or half beans) ↓ digestibility of RUP and fat
- Too Fine (<750 microns) ↓ RUP ↑ RDP

  Risk of fat interfering with fiber digestibility
- Practical Target = 750 microns – 3000 microns???

Optimizing HO Roasted Soybean Value

3 Processing + Particle Size = Functional Protein

- Heat treatment defines potential RUP
- Particle size determines how much is actually realized

Interaction effect:

- Properly roasted + poorly sized = lost value
- Moderately roasted + optimally sized = could result in better performance

4 Maximum ROI From HO Roasted Soybeans Requires Alignment Of:

1. Heat Processing (PDI, KOH, urease)

2. RUP and RUP digestibility validation

(16 hr. in vitro, Ross MSPE, Stern 3-Step)

3. Particle Size Control

(research pending)

QUALITY ROASTING

Questions/Discussion

QUALITY ROASTING

Thank You

Brought to you by U.S. Soy. Funded by the Soy Checkoff.