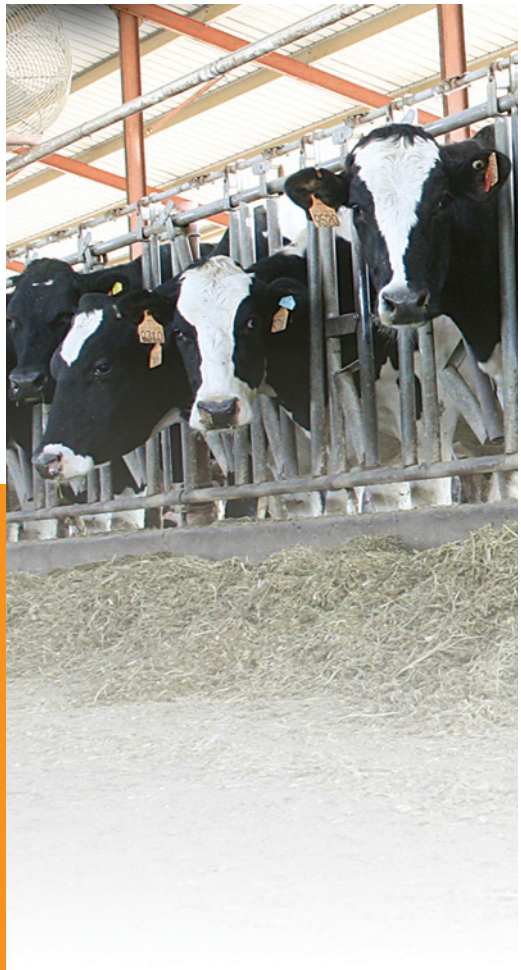
AminoShure™-L

Rumen-Protected Lysine



Technical Information

Note: Updates are expected. For the latest information, email anh@balchem.com

October 2008

BALCHEM™
ANIMAL NUTRITION & HEALTH

For more information contact:

Customer Relations & Marketing Specialists
Balchem Corporation
Animal Nutrition & Health
1-800-780-9233
anh@balchem.com
www.aminoshure-L.com
www.balchem.com

AminoShure™-L

Rumen-Protected Lysine

Nutrient Composition – 100% Dry Matter Basis

Nutrient	Quantity	Feed Fractions	Parameters
Dry Matter	99%	**NRC Model**	
Protein		Category	Plant Protein
Crude Protein %	38.0	Energy Equation Class	Concentrate
RDP % DM	5.7	PAF	1.0
RUP % DM	32.3	TDN % DM	150.50
RUP (%CP)	85	DE Mcal/kg	6.79
Soluble Protein (%CP)	15	Protein A % CP	0
ADICP %	0	Protein B % CP	20
NDICP %	0	Protein C % CP	80
Amino Acids		Protein Digestion Rate %/h	40
Lysine (%RUP)	100	RUP Digestion %	80
Methionine (%RUP)	0	CP Digestibility	1.0
Arginine (%RUP)	0	NDF Digestibility	0
Histidine (%RUP)	0	Fat Digestibility	0.80
Carbohydrates		Lysine % CP	100
ADF %	0	Methionine % CP	0
NDF %	0	Arginine % CP	0
peNDF (%NDF)	0	Histidine % CP	0
NFC %	0	**CPM and CNCPS Models**	
Fat		Protein A (%CP)	0
Ether Extract %	53	Protein B1 (% CP)	15
Energy Values		Protein B2 (% CP)	85
Metabolizable Energy – 3X	3.08 Mcal/lb	Protein B3 (% CP)	0
Net Energy Lactation – 3X	1.98 Mcal/lb	Protein A Rate (%/h)	1000
Net Energy Gain – 3X	1.55 Mcal/lb	Protein B1 Rate (%/h)	200
Net Energy Maintenance	1.98 Mcal/lb	Protein B2 Rate (%/h)	0.50
Minerals		Protein B3 Rate (%/h)	0.10
Ash %	9.0	Protein A Intestinal Digestibility	100
Chloride %	9.0	Protein B1 Intestinal Digestibility	100
		Protein B2 Intestinal Digestibility	80
		Protein B3 Intestinal Digestibility	80

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Guidelines for Balancing Diets for Amino Acids When Using CPM Dairy Software

When using CPM software to balance diets for lysine and methionine, it is necessary to make sure the program is set to the following parameters.

1. In the Cow screen, make sure that the box is checked for true protein rather than crude protein. This setting is recommended as most dairy producers are paid on pounds of true protein rather than pounds of crude protein produced.

2. It is suggested that you set milk true protein to 3.15% or 3.2% when balancing diets for Holstein cows. The average true milk protein content of Holstein cows is approximately 3.0%. When balancing diets for lysine and methionine, it is possible to increase milk protein content by 5% to 7%.

3. When using the Optimizer, the range for peptide balance should be 100% to 120%. The range for NH_3 balance should be 115% to 140%. By using these ranges, the optimizer should formulate diets between 16.8% and 17.8% crude protein. These settings prevent the optimizer from formulating diets containing greater than 19% CP.

4. To optimize milk protein yield and milk yield without overfeeding protein, the diets should be formulated to contain the following nutrients.

   Lysine as a % of MP = 6.8% to 7.2%
   Methionine as a % of MP = 2.2% to 2.4%
   Lysine: Methionine ratio = 3:1 to 3.2:1

5. When using the Optimizer to balance diets for lysine and methionine, set the Optimizer to either Percentage or Amount and Rulquin ratio.

The settings of "Percentage" + "Rulquin" let you formulate to set percentages of the desired Rulquin ratio.

The settings of "Amount" + "Rulquin" enable you to formulate to specific values of lysine and methionine as a percentage of the MP.

6. When using the Optimizer in CPM, with the settings of Percentage and Rulquin, the minimum and maximum constraints for lysine and methionine should be set as listed below.

	Min.	**Max.**
Lysine (%Rqd)	*93*	*100*
Methionine (%Rqd)	*90*	*100*

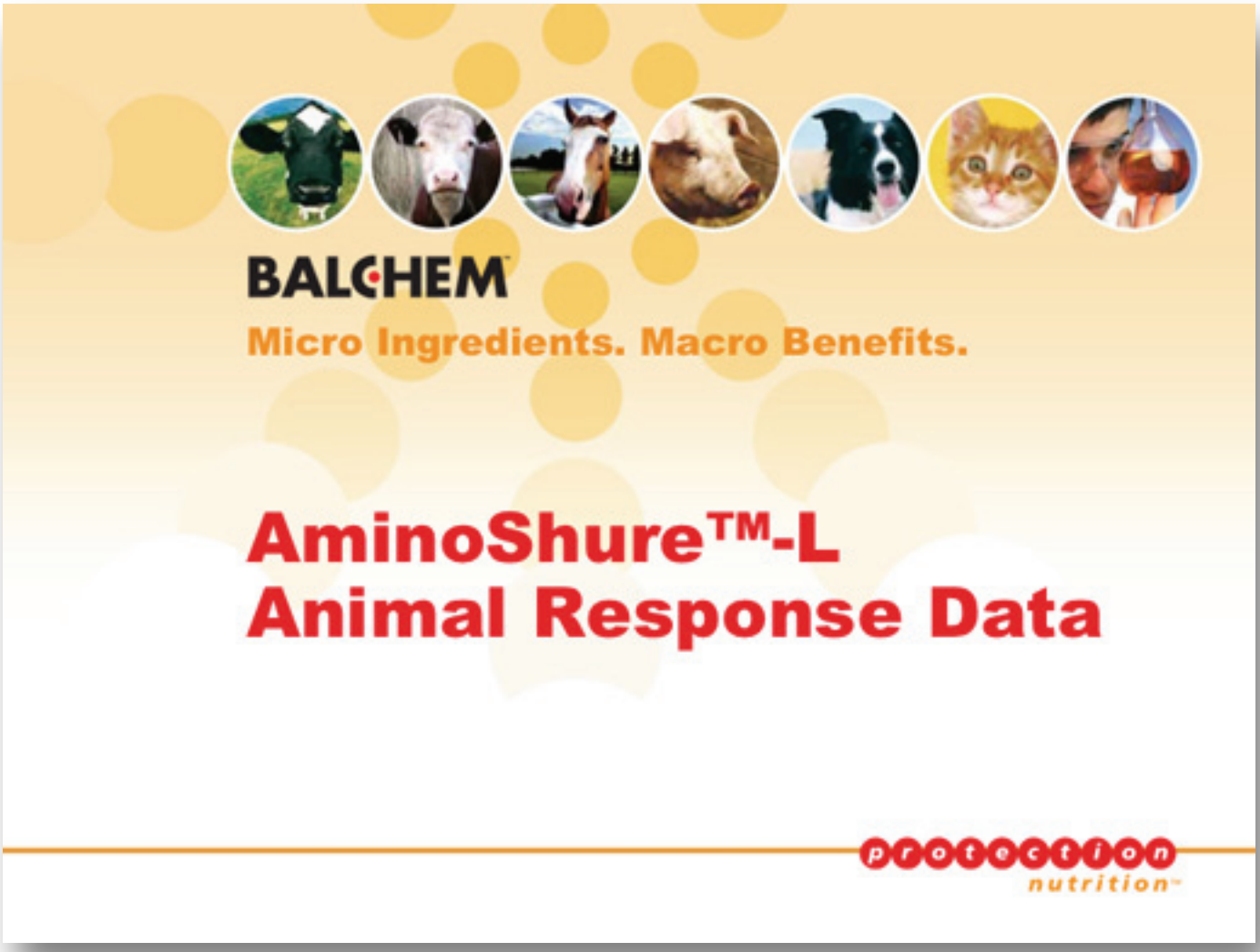
By using these settings, the ration will be formulated to contain a minimum of 6.79% lysine and 2.25% methionine as a percent of MP. The lysine to methionine ratio will be 3:1.

7. If you chose to use the factorial approach when balancing diets for lysine and methionine, set the Optimizer to "Percentage" and "Factorial." The minimum and maximum constraints for lysine and methionine should be set as listed below.

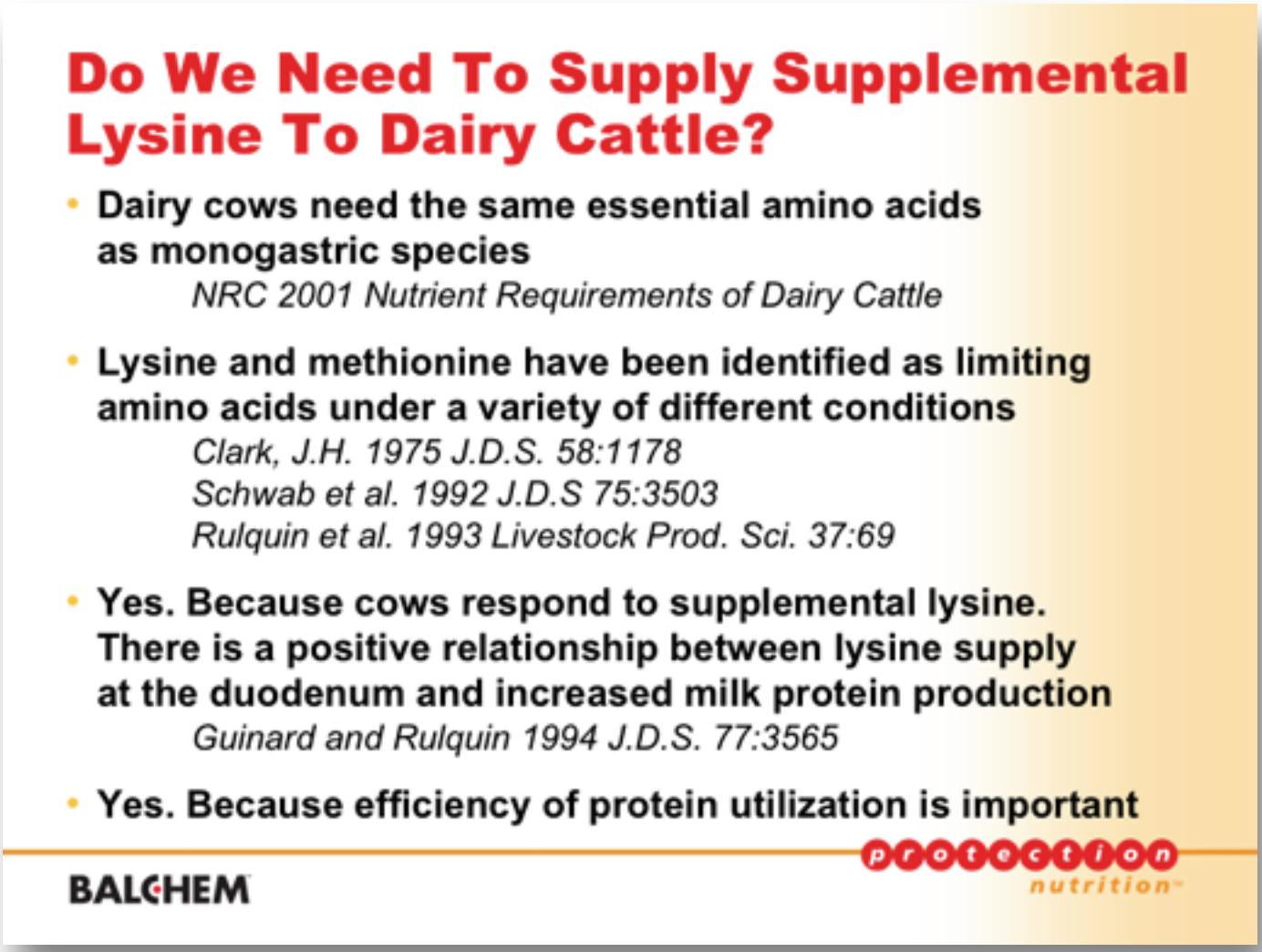
	Min.	**Max.**
Lysine (%Rqd)	*100*	*120*
Methionine (%Rqd)	*100*	*120*

8. Diets that have metabolizable protein or lysine and methionine as limiting nutrients will benefit most from amino acid balancing. Diets containing large excesses of metabolizable protein will not show a response to lysine in the CPM model.

9. You should formulate diets for both lysine and methionine. AminoShure-L is best used as a feed ingredient to achieve your targeted lysine content rather than as a feed additive. Consider using sources of methionine such as corn gluten meal or validated commercial products to ensure adequate levels of methionine are provided.

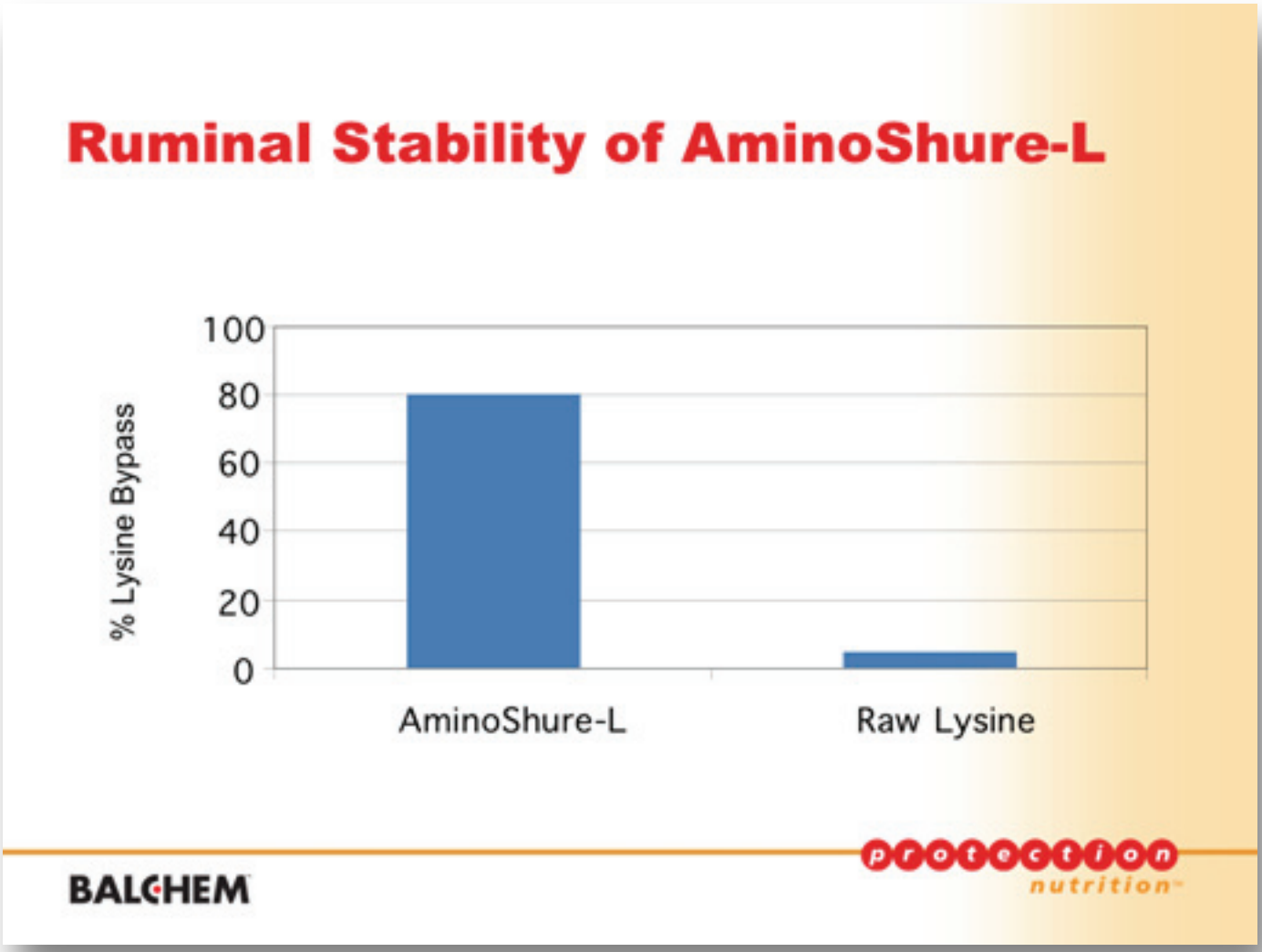


This short slide set briefly addresses the efficacy of AminoShure-L in effectively providing metabolizable lysine and the associated production benefits.



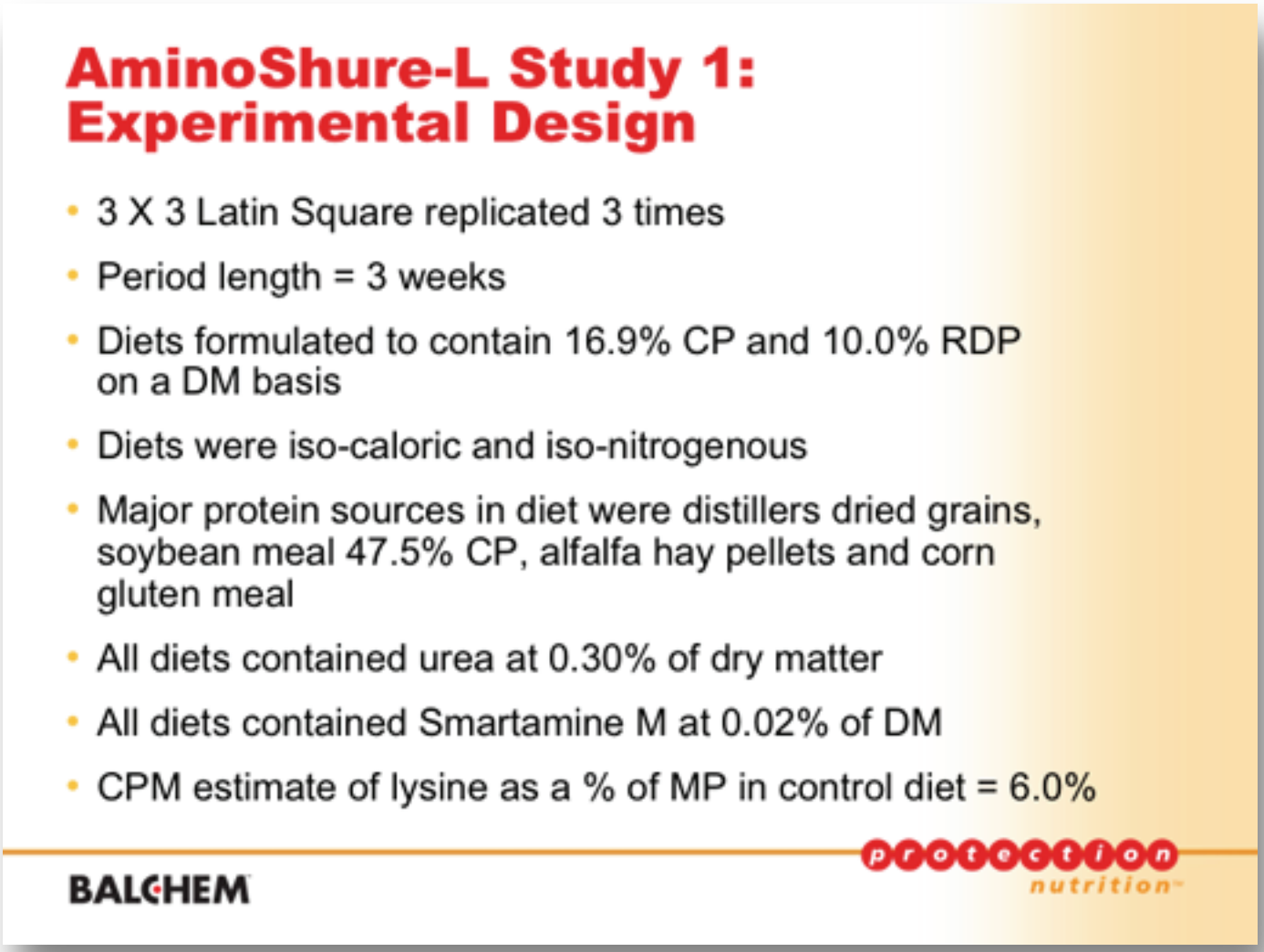
Key point is that there are four good reasons to supplement lysine to dairy cows.

1. Lysine is a required essential nutrient.
2. Lysine has been recognized as one of the amino acids that can limit milk yield and milk protein when dietary intake is less than the dietary requirement.
3. There is a direct relationship between lysine supply at the small intestine and milk protein production. As you increase the supply of lysine at the small intestine, milk protein production will increase.
4. The average dairy cow puts 25% of her dietary protein intake into milk as milk protein. The amount of dietary protein intake that is transferred into milk can be improved to 30 – 35%. This will result in a significant increase in milk revenue.



AminoShure-L uses encapsulation technology to protect lysine from degradation in the rumen. The stability of AminoShure-L in the rumen was tested using the Dacron bag technique.

The Dacron bag technique: Samples were weighed, placed in Dacron bags and then suspended in the rumens of cows for a period of 24 hours. Samples were then removed, rinsed and analyzed for residual lysine content. On average, 80% of the lysine in AminoShure-L was protected from ruminal degradation.



AminoShure-L Study 1 was a three by three Latin Square design replicated three times which gives the study strong statistical strength.

Diets were formulated to have equal energy and protein levels. Diets were also formulated with 0.30% urea to provide adequate RDP to support microbial protein production and contained Smartamine M to ensure that methionine was not limiting. Evaluation of the control diet by CPM indicated that lysine was 6.0 percent of metabolizable protein which is well below the targeted level of 6.6%. The formulated diets were designed to test the ability of AminoShure-L to effectively deliver metabolizable lysine.

AminoShure-L Study 1: Nutrient Profile of Diets (DM Basis)

Nutrient	Control diet	AminoShure-L 30 g/cow	AminoShure-L 60 g/cow
Crude Protein, %	16.9	16.54	16.54
RDP, % DM	10.1	10.0	10.0
RUP, % DM	6.8	6.5	6.5
ME, mcal/lb CPM estimate	1.25	1.25	1.25
NEl, mcal/lb CPM estimate	0.80	0.80	0.81
ADF, %	21.1	20.5	20.7
NDF, %	34.1	34.1	34.0
Forage NDF, %	23.8	23.7	23.7
Ether Extract, %	5.74	5.80	5.86
NFC, %	41.0	41.0	40.9

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This slide gives the nutrient breakdown of the three treatments:

Control, AminoShure-L at 30 g/cow/day and AminoShure-L at 60 g/cow/day. The key point for this slide is that diets were identical except for the level of rumen-protected lysine.

AminoShure-L Study 1: Nutrient Profile of Diets for Amino Acids as Estimated in CPM 3.08 (DM basis)

Nutrient	Control diet	AminoShure-L 30 g/cow	AminoShure-L 60 g/cow
Lysine, % MP	6.02	6.32	6.64
Methionine, % MP	2.17	2.16	2.16
Lysine: Methionine ratio	2.77	2.93	3.07
Metabolizable Lysine[1] grams/d	172	180	192
Metabolizable Methionine[1], grams/d	58.4	61.4	62.0
Predicted ME Milk[1] , lb/d	98.5	104.0	105.6
Predicted MP Milk[1] , lb/d	84.3	91.0	93.7
Predicted True Milk Protein, %	3.04	3.10	3.19
Predicted True Milk Protein Yield, lb/day	2.56	2.82	2.99

[1]Prediction based on actual dry matter intake measured

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This slide indicates the amino acid profiles of the three treatments as reported out of CPM.

Lysine as a percent of metabolizable protein increased as the AminoShure-L feeding rate increased as expected while methionine as a percent of metabolizable protein remained steady. As a result, the ratio of lysine to methionine increased with increasing AminoShure-L and achieved the target ratio of 3:1. Predicted MP milk, milk protein percent and milk protein yield were all predicted to increase with the addition of AminoShure-L. Predicted grams of metabolizable lysine content increased as the amount of AminoShure-L in the diet increased. It is also important to note that the diets were formulated such that energy was not limiting.

AminoShure-L Study 1: Performance Results

	AminoShure-L 0 g/d	AminoShure-L 30 g/d	AminoShure-L 60 g/d
DMI, lb/d	52.1[a]	54.1[b]	55.0[b]
Milk yield, lb/d	84.9[a]	90.6[b]	90.0[b]
4% FCM yield, lb/d	70.6[a]	78.1[b]	77.9[b]
Milk Fat %	2.91[a]	3.10[b]	3.15[b]
Milk fat yield, lb/d	2.45[a]	2.81[b]	2.80[b]
Milk protein yield, lb/d	2.63[a]	2.73[ab]	2.75[b]
Milk nitrogen efficiency	29.9%	30.5%	30.2%

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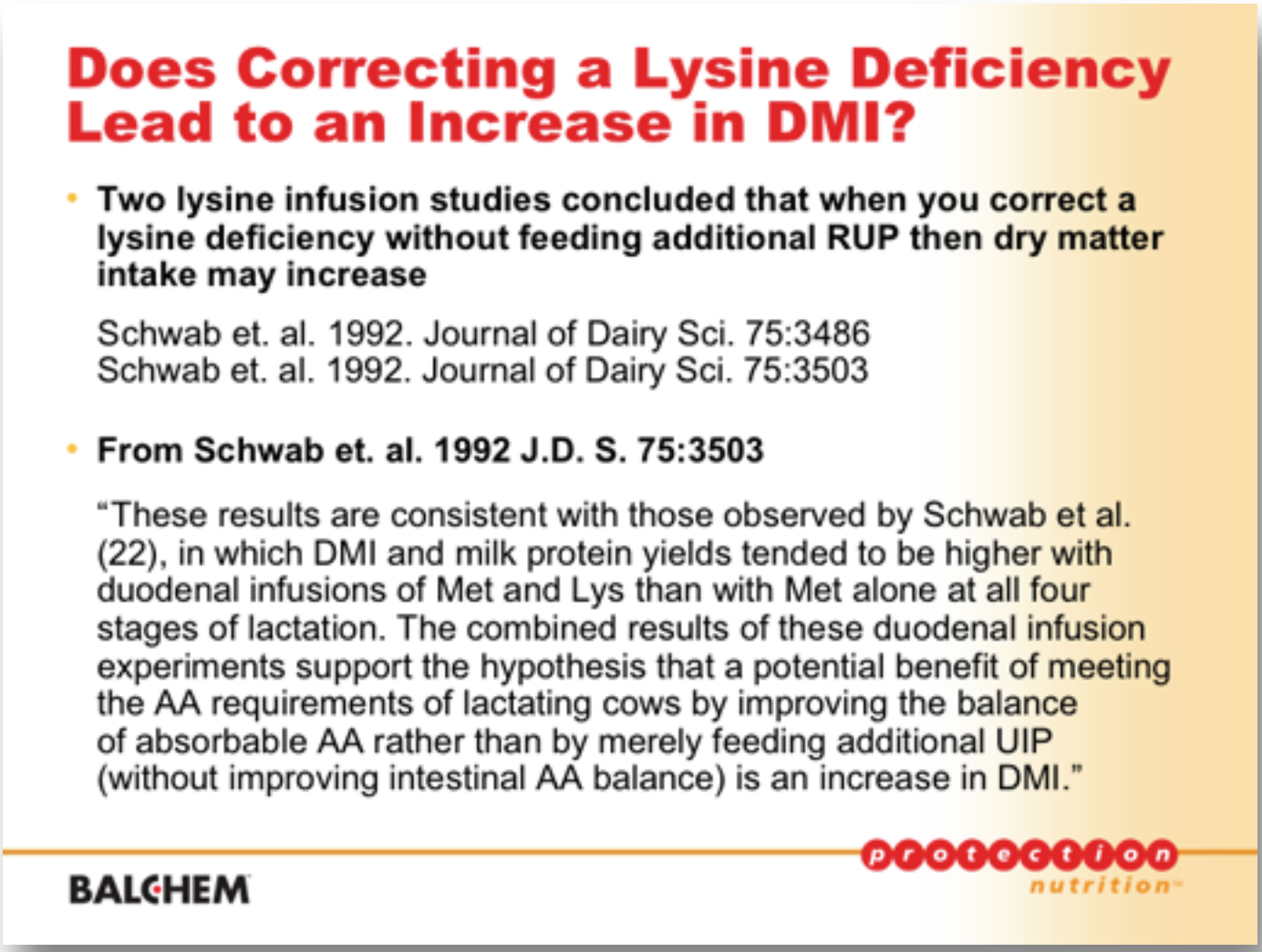
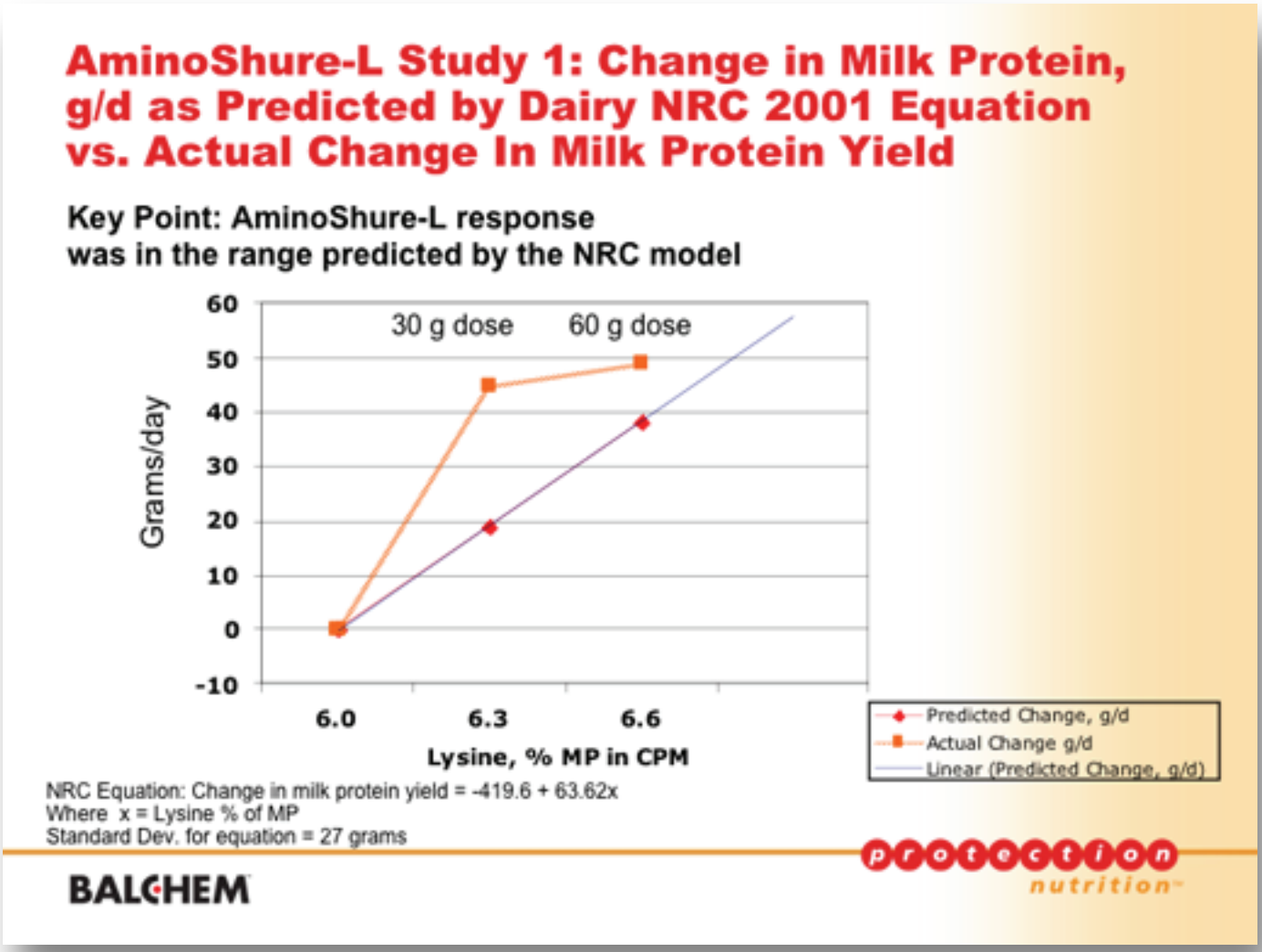
Responses to AminoShure-L inclusion are shown in this slide.

Dry matter intake increased with the addition of AminoShure-L. This response is most likely driven by the increased energy demand associated with the increase in milk yield due to AminoShure-L. In addition to the increase in milk yield, cows fed AminoShure-L had higher milk fat percentages and milk fat yield. The exact mechanism of this response is not understood, but the effect has been noted in other trials where supplemental lysine has been delivered to the small intestine. Milk protein yield increased with AminoShure-L as well. There is a very strong correlation between absorbable lysine and milk protein yield. The increase in protein yield in this study suggests that AminoShure-L did in fact raise metabolizable lysine as predicted. Energy corrected milk yields were calculated to be 78.6, 85.7 and 86.0 for the 0 gram, 30 gram and 60 gram AminoShure-L diets, respectively. Feed efficiency values (milk lb/feed lb) were determined and were 1.64 for the 0 gram, 30 gram and 60 gram AminoShure-L diets, respectively. MUN (mg/dl) were 14.8, 14.7 and 14.7 for the three diets respectively.



These studies published in the Journal of Dairy Science clearly show that an increase in dry matter intake are not uncommon when amino acid imbalances are corrected in the diet.

Based on comments (above) from Schwab, it is more likely to see an increase in dry matter intake when you correct a deficiency in lysine and methionine than just methionine. Hence, the increase in dry matter intake seen in Study 1 is not unexpected.

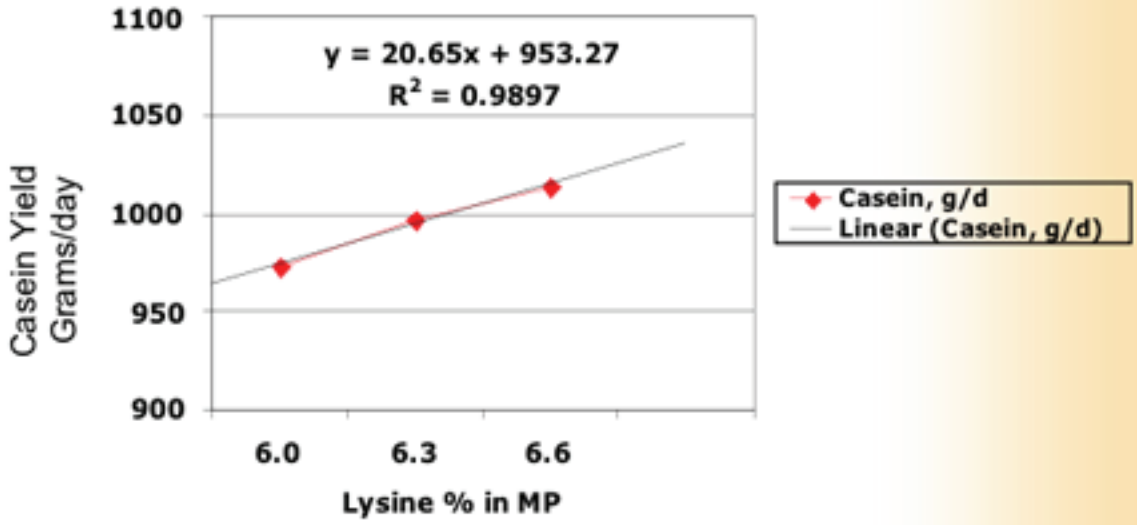


This slide clearly demonstrates the ability of AminoShure-L to effectively deliver lysine to the small intestine and that the lysine has high bioavailability.

The red dots and associated regression line are what the Dairy NRC 2001 equation predicts would be the milk protein response to increasing levels of lysine expressed as a percent of MP. The orange dots show the actual response. Importantly, the actual data falls within the expected normal variation around the response predicted by the NRC equation. This clearly validates that AminoShure-L provides both adequate protection of lysine from ruminal degradation and effective release within and absorption from the small intestine. If AminoShure-L were either extensively degraded in the rumen or not effectively released in the small intestine, the actual data points would lie consistently and significantly below the predictive line.

AminoShure-L Study 1: Casein Yield (Grams/day) in Response to AminoShure-L Supplementation

Key point: Cheese yield increases as casein content of milk increases.



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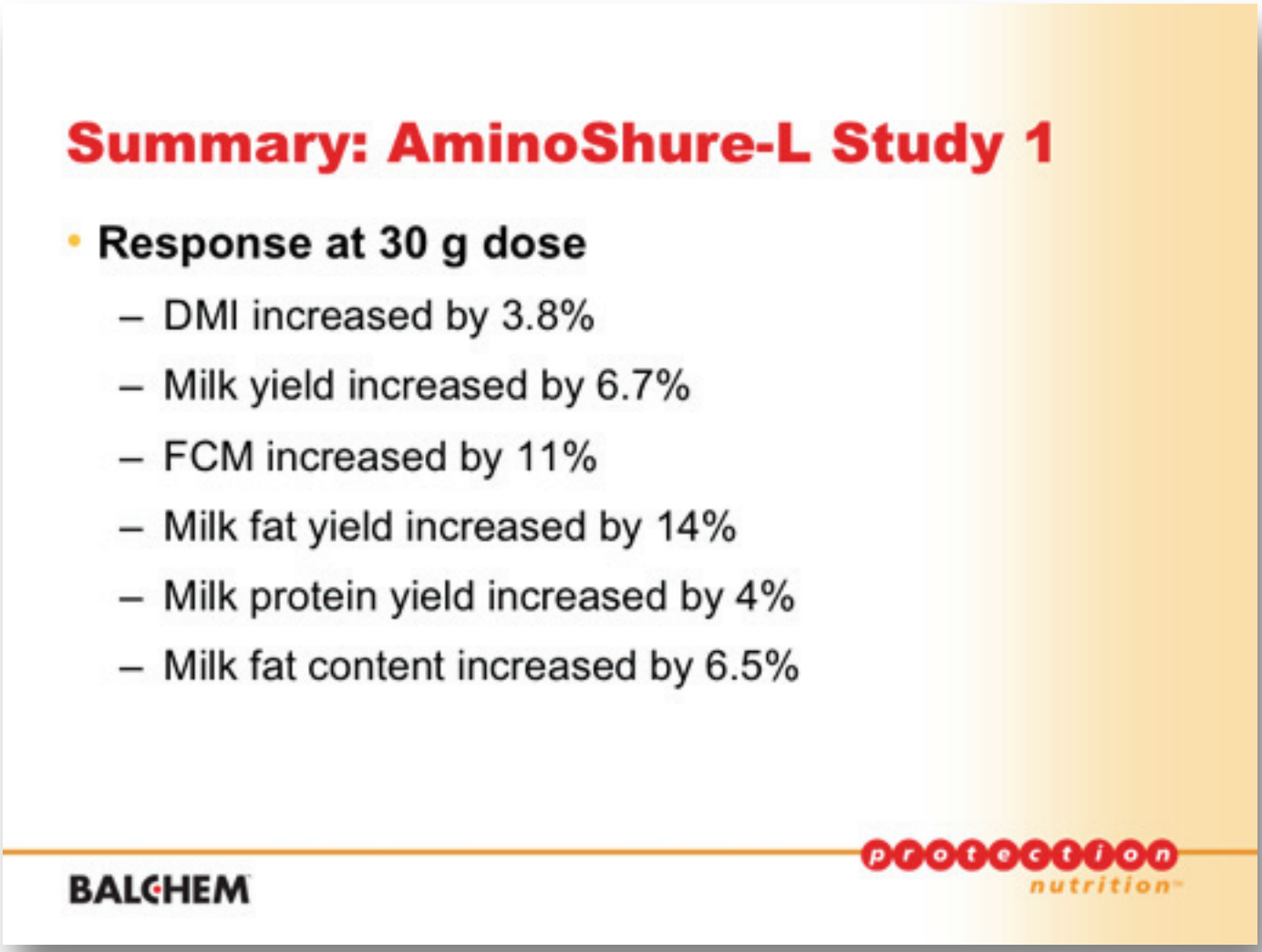
As further substantiation of the ability of AminoShure-L to effectively deliver metabolizable lysine, we looked at casein yield.

Casein yield is a sensitive measure of improved amino acid status of the cow. As with the previous data on milk protein yield, milk casein levels increased with increasing metabolizable lysine supplementation from AminoShure-L and did so in a consistent and predictable way. Again this validates the ability of AminoShure-L to effectively deliver metabolizable lysine. This has significant potential economic impact as cheese yield increases with increased levels of casein in milk.



This slide summarizes the significant benefits noted in the first trial.

Milk yield increased by 7%, and this increase is most likely responsible for the associated increase in dry matter intake. Both fat and protein percentages and yields increased in response to AminoShure-L. This data is consistent with other studies where MP lysine has been increased.

Summary: AminoShure-L Study 1

- **Response at 60 g dose**
  - DMI increased by 5.6%
  - Milk yield increased by 6.0%
  - FCM increased by 10.3%
  - Milk fat yield increased by 14%
  - Milk protein yield increased by 4.6%
  - Milk fat content increased by 8.2%

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Economic Analysis for Study 1

	Control Diet AminoShure-L 0 g/day	Trt. 1 AminoShure-L 30 g/day	Trt. 2 AminoShure-L 60 g/day
Value of Protein, $/lb	3.08	3.08	3.08
Value of Fat, $/lb	1.74	1.74	1.74
Change in fat yield (lbs.) versus control diet		0.36	0.35
Change in protein yield (lbs.) versus control diet		0.10	0.12
Value of additional protein, $		$0.31	$0.37
Value of additional fat, $		$0.63	$0.61
Total additional revenue from components, $		$0.94	$0.98
Return on Investment		4.1: 1	2.1:1

Average ROI for amino acid balancing of diets = 3.3:1 (Chuck Schwab)

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ROI for Study 1 indicates that balancing a diet for lysine and methionine and correcting an imbalance of lysine and methionine can lead to greater profitability.

AminoShure-L Study 2

Treatments:

- **Positive control** – CP higher than other treatments, amino acids supplied at 100% of requirements with blood meal
  - Based upon model prediction
- **Negative control** – Lower CP, no additional amino acids
- **AminoShure-L** – Lower CP, balanced for lysine using AminoShure-L

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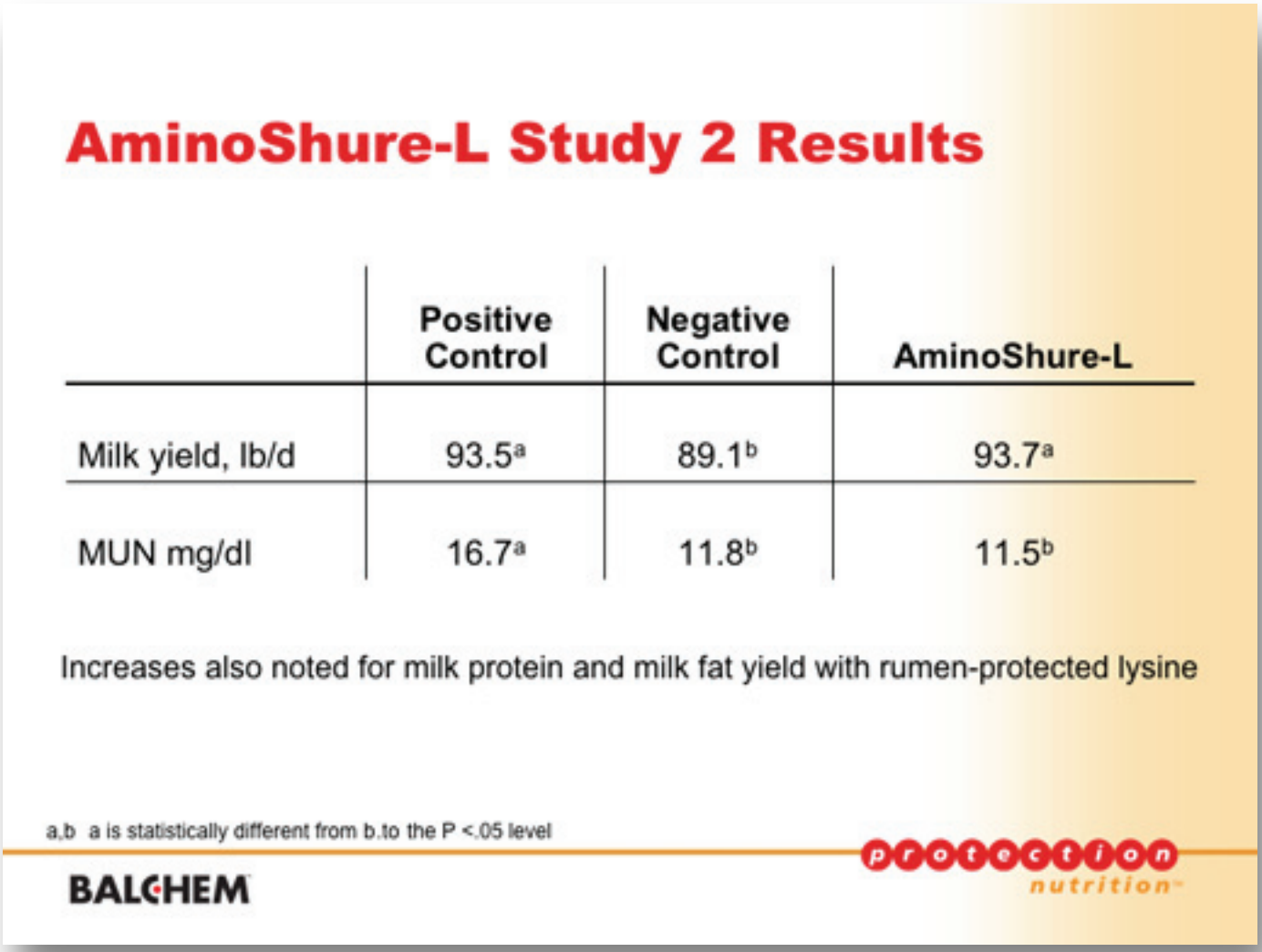

Milk yield in the positive control and AminoShure-L diets were not different, but were significantly greater than the negative control, indicating that the negative control diet was deficient in lysine.

Keeping in mind that the positive control diet had a higher protein level but the same milk production level as the AminoShure-L diet, it is clear that dietary protein in the AminoShure-L diet was more efficiently utilized for production performance. This is further evidenced by the significantly elevated milk urea nitrogen level observed in the positive control diet. In addition to the increased milk yield, increases in milk protein and milk fat were also observed which is consistent with Study 1. This study demonstrated that AminoShure-L can be used to formulate lower protein diets that are more efficient in utilizing dietary protein by effectively providing precise levels of metabolizable lysine.

Impressions

- Same basic production improvement as Study 1
- Study 1 milk increase = 5.7 pounds and
  Study 2 milk increase = 4.6 pounds
  - No change in DMI
  - Response due to improvement in amino acid supply
- Consistent with field trial results showing that fish meal could be effectively replaced by a combination of bypass SBM/RP lysine

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Practical Guidelines for Metabolizable Lysine and Methionine Using NRC, CPM or CNCPS Models

Model		Optimal (% MP)	Practical (% MP)	Optimal Lys:Met
NRC	Lysine	7.2	6.7	3.05
NRC	Methionine	2.4	2.2	
CPM 3.08 CNCPS 5.0	Lysine	7.2	6.8	3.05
CPM 3.08 CNCPS 5.0	Methionine	2.4	2.23	
CNCPS V. 6.1	Lysine	6.68	6.14	2.77
CNCPS V. 6.1	Methionine	2.41	2.2	

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This slide presents the guidelines for balancing diets in four different modeling programs.

CPM 3.08 and CNCPS 5.0 are similar programs, and you should balance diets to the same concentration of lysine and methionine in the metabolizable protein. CNCPS V. 6.1 is very different from CNCPS 5.0, and hence there are different values for lysine and methionine in the metabolizable protein.

AminoShure-L Nutrient Profile (DM Basis)

Nutrient	Quantity
Dry Matter	99%
Protein	
Crude Protein %	38.0
RDP % DM	5.7
RUP % DM	32.3
RUP (%CP)	85
Soluble Protein (%CP)	15
ADICP %	0
NDICP, %	0
Amino Acids	
Lysine (%RUP)	100
Methionine (%RUP)	0
Arginine (%RUP)	0
Histamine (%RUP)	0
Carbohydrates	
ADF %	0
NDF %	0
peNDF (%NDF)	0
NFC %	0

Nutrient	Quantity
Fat	
Ether Extract %	53
Energy Values	
Metabolizable Energy – 3X	3.08 Mcal/lb
Net Energy Lactation – 3X	1.98 Mcal/lb
Net Energy Gain – 3X	1.55 Mcal/lb
Net Energy Maintenance	1.98 Mcal/lb
Minerals	
Ash %	9.0
Chloride %	9.0

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AminoShure-L Nutrient Profile (DM Basis)

Feed Fractions	Parameters
NRC Model	
Category	Plant Protein
Energy Equation Class	Concentrate
PAF	1.0
TDN % DM	150.50
DE Mcal/kg	6.79
Protein A % CP	0
Protein B % CP	20
Protein C % CP	80
Protein Digestion Rate %/h	40
RUP Digestion %	80
CP Digestibility	1.0
NDF Digestibility	0
Fat Digestibility	0.80
Lysine % CP	100
Methionine % CP	0

Feed Fractions	Parameters
CPM and CNCPS Models	
Protein A (%CP)	0
Protein B1 (% CP)	15
Protein B2 (% CP)	85
Protein B3 (% CP)	0
Protein A Rate (%/h)	1000
Protein B1 Rate (%/h)	200
Protein B2 Rate (%/h)	0.50
Protein B3 Rate (%/h)	0.10
Protein A Intestinal Digestibility	100
Protein B1 Intestinal Digestibility	100
Protein B2 Intestinal Digestibility	80
Protein B3 Intestinal Digestibility	80

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Conclusions

- Using **AminoShure-L** in combination with a good methionine source to balance diets for metabolizable lysine and methionine will make it possible to increase milk protein yield and milk yield without overfeeding crude protein.
- Using **AminoShure-L** rumen-protected lysine will make it possible to feed less crude protein and maintain performance.
- Using **AminoShure-L** in diet formulation enables you to feed cows more precisely and improve nitrogen efficiency.
- Diets containing less than 6.6% metabolizable lysine will benefit from amino acid balancing using **AminoShure-L**
- Most common animal response to increasing the supply of metabolizable lysine is an increase in milk protein % and milk protein yield, milk yield and milk fat yield.
- Return on Investment (ROI) for balancing diets for metabolizable lysine and methionine is variable, but the average ROI is 3.3:1.

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AminoShure™-L

Rumen-Protected Lysine

Product and Handling Information

Activity: 38% lysine, equivalent to 47% lysine HCl
Coating: 53% fat product – feed grade

Color: Tan to off-white
Shape: Spherical

Product Storage: AminoShure-L should be stored in unopened original packaging. Product is non-hygroscopic. Storage conditions of less than 120°F is recommended. Once opened, close bags tightly and store in dry place. Under these conditions, product is stable for at least 1 year from manufacturing date.

Feed Stability: AminoShure-L is stable in typical feeds of up to 10% moisture content and water activity up to 0.5. After four weeks storage in typical feeds the rumen stability >70%.

Mixing: The product is uniform and it mixes well and does not stratify. AminoShure-L can be mixed in mineral, grain, and protein supplements containing up to 10–12% moisture for a 3–5 minute mixing time.

Pelleting: Pelleting of feeds containing AminoShure-L is not recommended at this time.

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Material Safety Data Sheet

SECTION I - Chemical Product and Company Identification

Product Name: **AminoShure™-L**

Manufacturer's Name: BALCHEM CORPORATION
52 Sunrise Park Road
PO Box 600
New Hampton, NY 10958

Information Telephone: (845) 326-5600
Emergency Telephone: (800) 424-9300 (CHEMTREC - within US & Canada)
Emergency Telephone: (703) 527-3887 (CHEMTREC - outside continental US)

SECTION II - Composition/Information on Ingredients

Name	CAS #	Exposure Limits
Lysine Hydrochloride	657-27-2	15 mg/m3 total & 5 mg/m3 respirable fraction (OSHA 8-hr TWA PEL for nuisance dust 10 mg/m3 inhalable particulate (ACGIH 8-hr TWA TLV)
Foodgrade Lipids		

SECTION III - Hazards Identification

Signs and Symptoms of Overexposure:

Skin Contact: No adverse health effects expected.
Eye Contact: No adverse health effects expected. Dust may cause mechanical irritation.
Ingestion: No adverse health effects expected. Large quantities may cause gastrointestinal disturbances including irritation, nausea, vomiting and diarrhea.
Inhalation: No adverse health effects expected. Product may cause irritation. Breathing large amounts of dust may cause injury. Chronic exposure to dust may result in delayed lung injury.

SECTION IV - First Aid Measures

Emergency and First Aid Procedures

Eye Contact: Flush with water for 15 minutes. Get medical attention if irritation persists.
Skin Contact: Wash skin thoroughly. Remove clothing and launder before reuse. Get medical attention if irritation persists.
Inhalation: Move individual to fresh air. Get medical attention.
Ingestion: Get medical attention.

SECTION V - Fire Fighting Measures

Flash Point:	Lipids have a flash point > 100 °C (212 °F).
Flammable Limits:	Unknown.
Autoignition Temperature:	Unknown.
Extinguishing Media:	Water, foam, carbon dioxide, dry powder
Special Fire Fighting Procedures:	Treat as burning fat and do not use water jet.
Unusual Fire & Explosion Hazards:	Toxic gases may form similar to normal combustible materials. Rags and other materials containing lipids could potentially heat and spontaneously ignite if exposed to air.

SECTION VI - Accidental Release Measures

CAUTION: Spilled material may cause floors to be slippery. Prevent large quantities from contacting vegetation or waterways and carefully sweep spilled material into containers for disposal. Wear appropriate personal protective equipment. Flush area with water to remove any trace material. Dispose according to Federal, State and Local regulations.

SECTION VII - Handling and Storage

Keep containers tightly closed. Store in a cool, dry, well ventilated area. Handle with care and avoid all possible sources of contamination.

SECTION VIII - Exposure Controls/Personal Protection

Provide adequate ventilation to minimize dust or vapor buildup. When dust or vapors may be present, use a respirator approved for protection by National Institute for Occupational Safety and Health (NIOSH) against nuisance dust and organic vapors. Protect against skin exposure by wearing appropriate clothing and gloves. At a minimum wear safety glasses. Contact lenses should not be worn when working with this product.

SECTION IX - Physical and Chemical Properties

Appearance and Odor:	Tan to off-white, free-flowing granules with fermentation odor.
Melting Point:	Lysine HCl: 260 °C (500 °F); Lipids: 57 – 71 °C (135 – 160 °F)
Solubility in Water:	Partially soluble
pH:	Neutral
Boiling Point:	Lipids: > 250 °C (482 °F)
Specific Gravity/Density:	Lysine: 38-42 lb/cu.ft.; Lipids: 0.9
Bulk Density:	Data not available
Vapor Pressure:	Data not available
Vapor Density:	Data not available

SECTION X - Stability and Reactivity

Stability:	Stable under normal conditions.
Conditions to Avoid:	Keep containers tightly closed to avoid contamination.
Materials to Avoid:	Strong acids, bases or oxidizers.
Hazardous Polymerization:	Will not occur.
Hazardous Decomposition Products:	Carbon monoxide and carbon dioxide may form as well as other irritating or poisonous gasses.

SECTION XI - Toxicological Information

No data available.

SECTION XII - Ecological Information

Lysine: LD50 = 10,000 mg/kg oral rat
LD50 = 4,019 mg/kg ipr rat.

SECTION XIII - Disposal Considerations

Dispose according to Federal, State and Local regulations.

SECTION XIV - Transport Information

As produced, the product is not regulated.

SECTION XV - Regulatory Information

No data available.

SECTION XVI - Other Information

Reason for update: New product.

If used as a flow agent in this product, silica gel is synthetic amorphous silica not to be confused with crystalline silica. Epidemiological studies indicate low potential for adverse health effects.

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