

高产奶牛的饲料配方与饲养策略

Formulation and Feeding Strategy for High
Producing Dairy Cow

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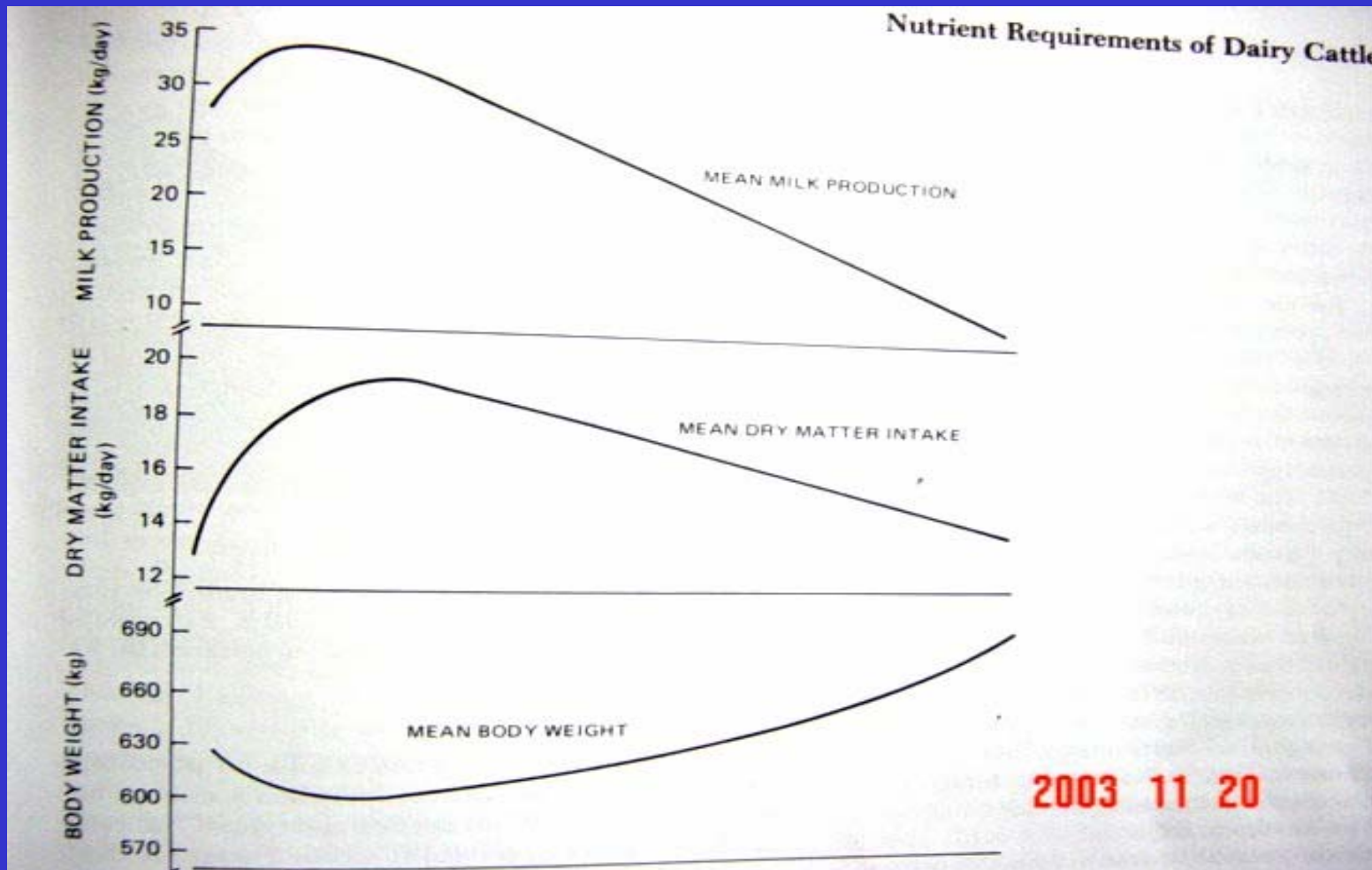
重要性

Importance

- 高产奶牛承受巨大的营养与代谢压力
High milking cows are under heavy nutritional/metabolic load
- 采食量高峰滞后于泌乳高峰加重了应激反应
The lag time between milking peak and intake peak exaggerates the stress

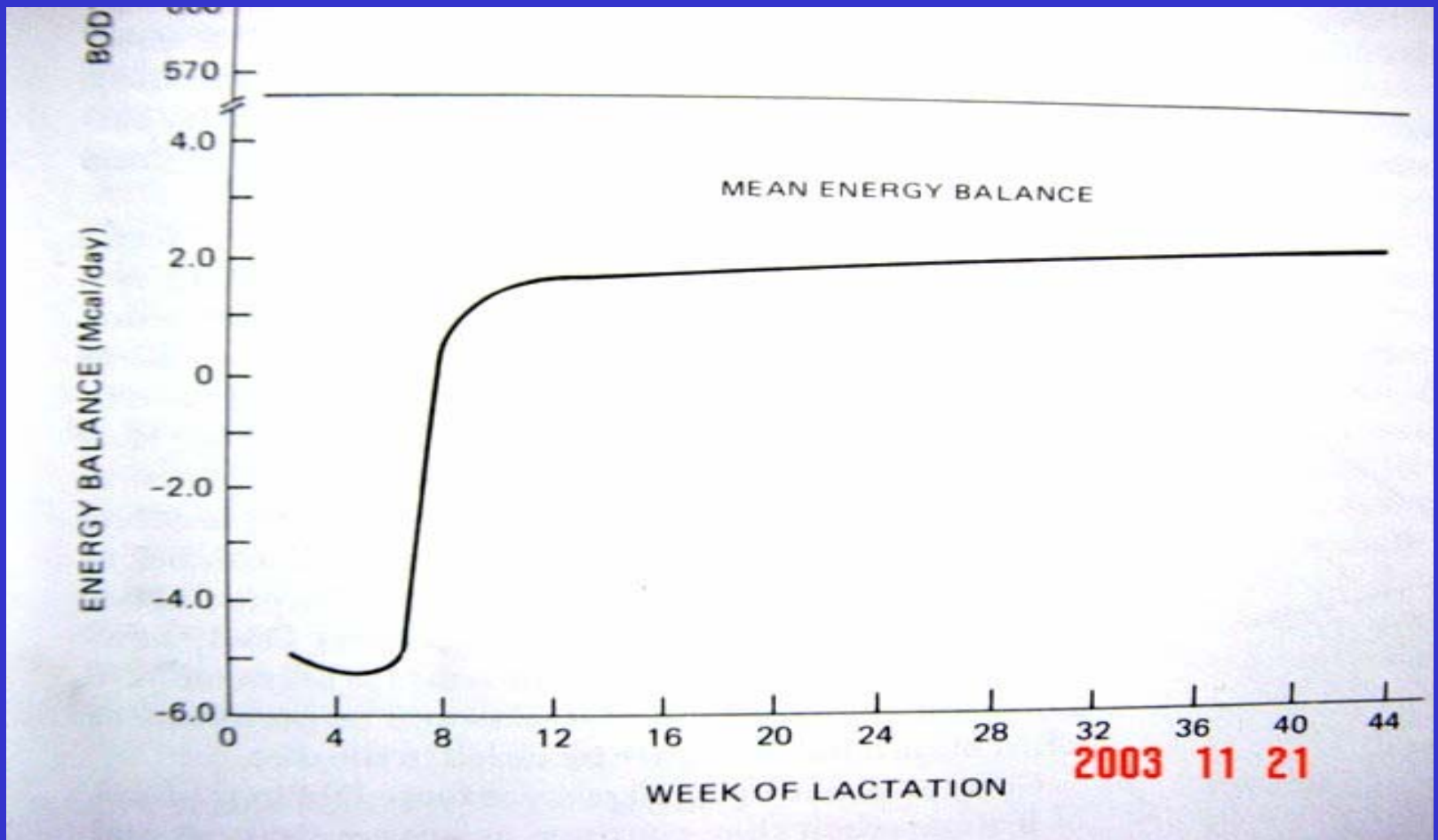
泌乳期间产奶量, 进食量和体重的变化

Milk Production, DMI and Body Weight Changes during Lactation



奶牛泌乳期的能量平衡

Energy Balance During Lactation

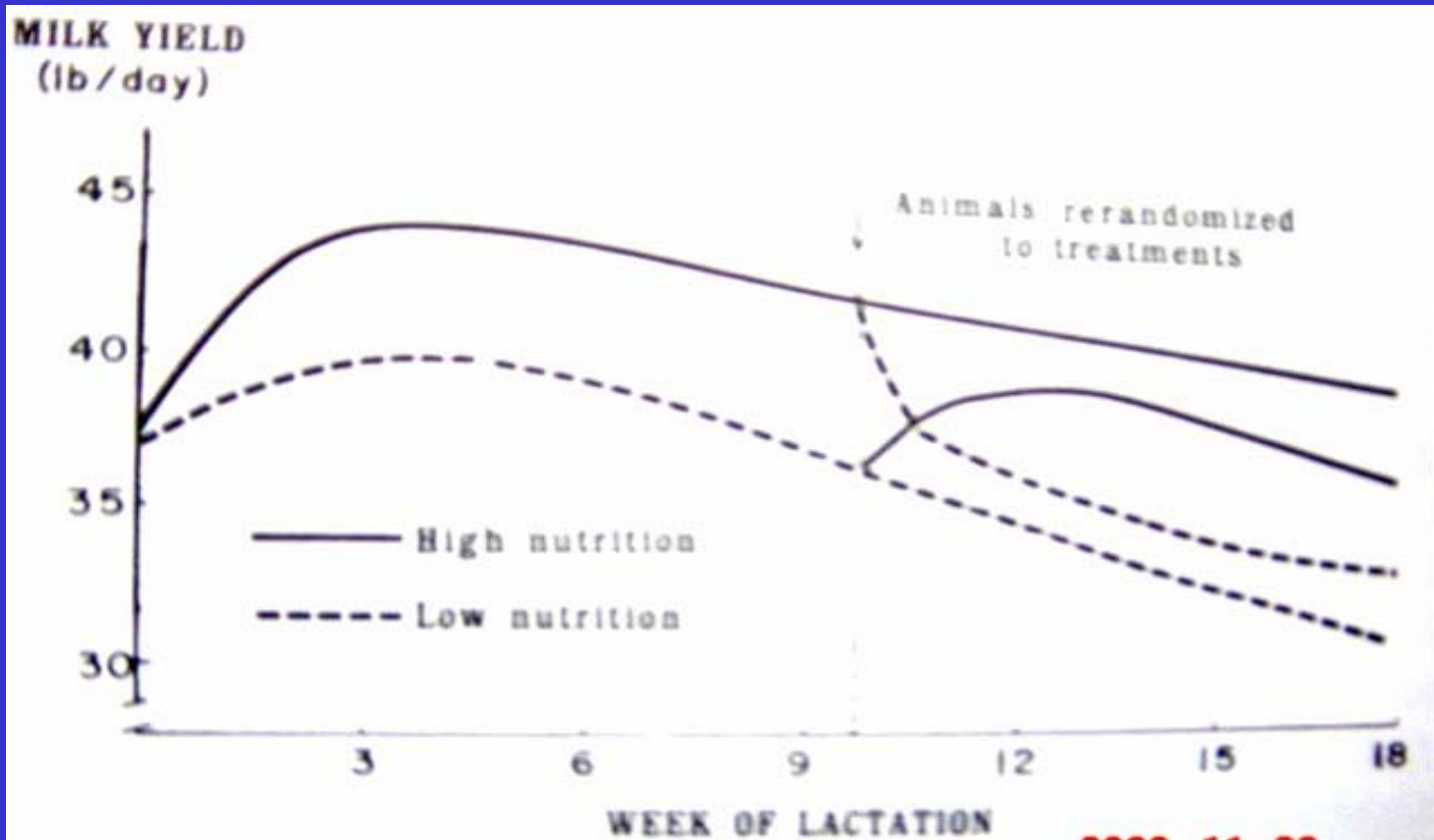


重要性

Importance

- 对代谢病抵抗力弱
Vulnerable to metabolic diseases
- 对收益影响巨大
Strong economical impacts

泌乳前期营养不足对产奶量的影响



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Cows underfed during the first 10 weeks of the lactation and subsequent weeks of lactation. (From Moe)

高产奶牛的主要代谢性疾病

Major Metabolic Diseases for High-producing Cows

– 酸中毒: 高淀粉摄入量 and 快速丙酸发酵导致瘤胃pH值下降

- **Acidosis: Low rumen pH due to high starch intake and rapid propionate fermentation.**

高产奶牛的主要代谢性疾病

Major Metabolic Diseases for High-producing Cows

- **奶牛酮病**：体液中酮含量高。主要原因可能是为满足泌乳高峰期间的营养需要，体脂肪代谢速度加快

Ketosis: High ketone bodies in body-fluid. Most likely due to rapid mobilizing body fat to meet energy requirement for peak lactation.

高产奶牛的代谢失调

Major Metabolic Disorders for High-producing Cows

- **产乳热**：由于钙供应不足，或者无法有效地动用体贮存的钙，导致血钙含量过低

Milk fever: Low blood calcium due to insufficient supply of Ca from absorbed Ca or inability of mobilizing reserved calcium for milk production.

对策 - 饲料与饲养途径

Dealing with Challenge- Feed and Feeding Approach

- 许多代谢紊乱性疾病可通过良好的日粮配方和饲喂方法得到有效预防, 尽管有些代谢病与遗传有关

Many of the metabolic disorders of high producing dairy cow can largely be prevented via dietary formulation and proper feeding strategy, although some of them may be genetically related.

对策 - 饲料与饲养途径

Dealing with Challenge- Feed and Feeding Approach

- 主要目标: 保持最佳的瘤胃功能状态, 达到最高的采食量

Main objectives: Maintaining optimum rumen function and high feed intake.

高产奶牛的粗饲料

Forage and Roughage for High Producing Dairy Cows

- 泌乳高峰期间应使用最佳质量的粗饲料
Use best quality forage/roughage for peak lactation

高产奶牛的粗饲料

Forage and Roughage for High Producing Dairy Cows

- 通常情况下,粗饲料应不低于总日粮的40%, 尽管有时会抵制30% (全以干物质为基础).
 - Forage and roughage normally shall not less than 40% of the total diet (though in some cases may be as low as 30%, all on DM basis).

牧草-粗饲料评定

Forage-roughage evaluation

- 消化率和采食量几乎同等重要

Digestibility and intake are at least equally important.

- 消化速度以及通过速率很大程度上决定了粗饲料的采食量

Rate of digestion and rate of passage largely decide roughage intake.

牧草-粗饲料评定

Forage-roughage evaluation

- **动物试验: 消化率、进食量及动物生产表现。需要实验动物。时间长、费用高**
Animal trials: digestibility, intake and performance.
Need experimental animals, extended trial time, high costs
- **体外法和尼龙袋法:需要供体动物**
In vitro and *in sacco*, Needs donor animals

牧草-粗饲料评定

Forage-roughage evaluation

- 化学分析粗饲料的评价方法

Chemical analysis

NDF: Lignin in NDF, Silicon in NDF

ADF: insoluble N and resistance starch

**CP: may represents degree of maturity
within a variety or pieces**

Crude Fiber ?

牧草-粗饲料评定

Forage-roughage evaluation

- 粗饲料的感官评定:色泽、 气味、 叶茎比等。生产上十分重视。

Sensory evaluation of forage-roughage:
Appearance, color, leave/stem ratio etc. Given
great attention in the field

粗饲料的收获与贮藏

Harvest-storage of forage/roughage

- 青贮：短、快、实。

Silage: cutting short, quick, press firm

最佳收获期：腊熟-完熟初，水分70%(65-75%)

Optimum harvest stage: Dough-early dent
: moisture 70% (65-75%).

- 干草：收获期，水分。

Hay: harvest time and moisture.

- 半干青贮 haylage 水分50%(40-60%)，可考虑添加剂。

Optimal moisture: 50% (40-60%), May need preservatives.

加工方法与物理状态对粗饲料的影响

Effects of physical forms and processing on Roughage

- 粉碎,制粒与铡短比较：粉碎,制粒提高进食量,降低消化率降低乳脂率

Ground, pelleted vs chopped

- 青贮与干草比较

Silage vs hay

以纤维含量为基础的配方原则

Formulation guidelines based on fiber content

- **NDF >25%, ADF>19%, CF?>17%**
- **NDF来源及粗饲料粒度的影响**
Effect of NDF source and particle size
- **有效NDF (eNDF) : 需要可靠的数据库**
Effective NDF (eNDF) : need good data base

奶牛日粮NDF、ADF（%DM）的推荐量

粗饲料NDF	日粮最低NDF	日粮最低ADF
19	25	17
18	27	18
17	29	19
16	31	20
15	33	21

奶牛NRC (2001)

一些饲料原料的eNDF值(占NDF%)

干玉米秸	100%	整粒玉米	34%
小麦秸	98%	棉籽粕	23%
干草	98%	大豆粕	23%
苜蓿干草	92%	大豆皮	10%
青贮玉米秸	60%	小麦麸	4%
		酒糟	4%

谷物和其他能量原料

Grain and Other Energy Ingredients

- 谷物是主要能量饲料，淀粉是谷物的主要成分。
- 淀粉消化的部位：瘤胃，小肠、大肠
- 瘤胃发酵速度、流通速度 - 进食量决定淀粉在个部位消化的比例。
- 高精料日粮淀粉在瘤胃发酵过快，易导致酸中毒。
- 淀粉在瘤胃发酵过慢，流通速度过快，粪中流失增加。

影响淀粉瘤胃发酵速度的因素

Factors effecting ruminal starch fermentation rate

- 谷物类型：燕麦>小麦>大麦>玉米>高粱

Types of grains: Oats>wheat>barley>corn>grain
sorghum

影响淀粉瘤胃发酵速度的因素

Factors effecting ruminal starch fermentation rate

- 加工方法(与程度)：

Processing methods and degree

辊压

rolling

粉碎

grinding

蒸汽压片

steam flaking

浸润

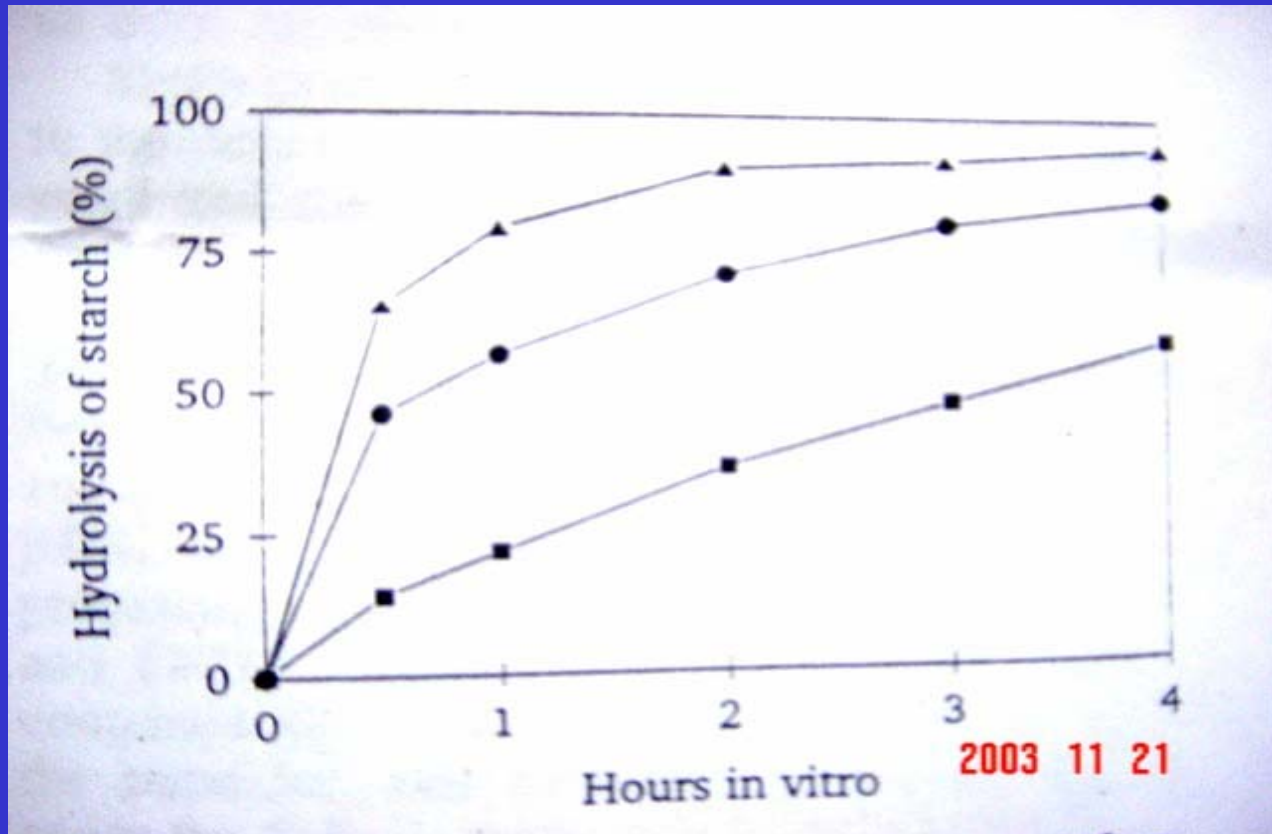
reconstitution

高水分贮存

high moisture grain

蒸汽压片对淀粉水解的影响

Effect of steam Flaking on Starch hydrolysis



蒸汽压片对奶牛产奶量的影响

Effect of steam Flaking on Starch hydrolysis

项目	DR	SF40	SF27
DMI , kg/d	25.7	25.4	23.8
产奶 , kg/d	31.0	33.3	31,7
3.5FCM,kg/ d	30.4	31.7	29.4
产奶/DMI	1.22	1.31	1.35
FCM/DMI	1.18	1.24	1.26

蒸汽压片对奶牛产奶量的影响

Effect of steam Flaking on Starch hydrolysis

- 提高了淀粉利用率
- 过快的瘤胃发酵会降低乳脂率，影响进食量
- 最佳加工程度的确定

高水分谷物和着水处理谷物

High High moisture and reconstituted grains

- 具有蒸汽压片相似的效果但机理不同
- 高水分储藏谷物(玉米)节省干燥能源
- 需要就地转化，经营上缺乏灵活性

脂肪

Fat

- 高产奶牛日粮中的脂肪不应超过6%
Dietary fat for high producing cows: normally shall not exceed 6%
- 全脂大豆和全棉籽的应用
The use of full fat soybeans and whole cotton seeds
- 惰性或保护性脂肪
Inert fat or protected fat

豆皮以及其它富含可消化纤维的原料

Soyhulls and Other Highly Digestible Fibrous Ingredients

- 反刍动物的良好能量原料
Good energy feeds for ruminants
- 具备粗饲料因素
Roughage factor in nature
- 促进粗纤维消化
Positive associate effect for fiber digestion

豆皮以及其它粗饲料的成分

Composition of Soyhulls and Some Other by-Products

Item	豆皮 Soyhulls	甜菜渣 Beet pulp	酒糟 Distillers grain	啤酒糟 Brewers grain
CP	12.0	8.7	24.7	25.9
ADF	47.0	18.8	19.7	19.0
NDF	63.0	35.8	39.2	50.8
Lignin (L)	1.9	1.5	4.7	4.9
L/NDFx100	3.0	4.2	12.0	9.6
NDF dig. ^a	100	96	83	63

^ain sacco.

用豆皮替代泌乳牛日粮中的精饲料

Soyhulls Replacing Concentrate for Lactating Dairy Cows

指标 Measurements	SH Replacement, %		
	0	25	50
采食量 Feed Intake, kg/d	18.4	18.6	18.5
泌乳量 Milk, kg/d	27.7	28.4	27.6
4% FCM kg	26.2	27.6	27.3
乳脂率 milk Fat, %	3.63	3.85	3.90
饲料成本 Feed Costs, \$			
头/日 Head/d	2.47	2.45	2.38
与对照比较 Vs Control		-.02	-.09
FCM/100 kg	9.42	8.88	8.73
与对照比较 Vs Control		-.54	-.69

豆皮用于生长牛高粗料日粮

Soyhulls in High Roughage Diets for Growing Cattle

日粮类型 Diet	日增重 Gain (kg/d)	每百公斤饲料 增重 Gain/100 feed
100% roughage	.48	7.7
12% conc. (corn)	.66	10.9
12% conc. (soyhulls)	.68	10.0
25% conc. (corn)	.76	11.5
25% conc. (soyhulls)	.78	11.2
50% conc. (corn)	.98	13.1
50% conc. (soyhulls)	.90	12.0

防止高产奶牛在泌乳高峰期的酸中毒

Preventing Acidosis in High Producing Cows at Peak Lactation

- 引导饲喂：产犊前（2-4周）给予中等精料日粮并逐渐增加精料量

Challenge or lead feeding: feeding moderate,
increasingly

amount of concentrate (2-4 wks) prior to calving

- 采用TMR或TMR概念

Using TMR or the TMR concept

防止高产奶牛在泌乳高峰期的酸中毒

Preventing Acidosis in High Producing Cows at Peak Lactation

- 用豆皮等高能量的纤维性原料部分代替谷物 Partially replace grain with soyhulls or other high energy fibrous ingredients
- 缓冲剂的使用
Use of buffers (0.8-1.2% of DMI)

防止高产奶牛在泌乳高峰期的酸中毒

Preventing Acidosis in High Producing Cows at Peak Lactation

- 产前3周至泌乳第70天饲喂DFM

Feeding direct fed microorganism (DFM) 3 wks prior to calving and continuing through day 70 of lactation

DFM包括：Bacillus, Lactic acid bacteria, Yeasts.

- 使用离子载体(?)

Use of ionophores (?)

满足高产奶牛的蛋白质(氨基酸)需要

Meeting Protein (AA) Needs of High Producing Cows

$$\text{MP} = \text{MCP} + \text{UCP} + \text{ECP}$$

MP: 进入小肠的蛋白质 Metabolism protein entering in small intestine

MCP: 微生物蛋白 Microbial protein

UCP: 瘤胃未降解蛋白 Ruminal un-degradable protein

ECP: 内源性粗蛋白 Endogenous crude protein

满足高产奶牛的蛋白质(氨基酸)需要

Meeting Protein (AA) Needs of High Producing Cows

- 日粮蛋白质 Dietary protein :
 - 瘤胃可降解蛋白(RDP): 非蛋白氮和天然蛋白
ruminal degradable protein: NPN and Natural protein
 - 瘤胃未降解的蛋白UCP(过瘤胃蛋白) :
小肠消化与未消化组分。
ruminal un-degradable protein (by-pass protein) : small intestine digestible and undigestible fractions

满足高产奶牛的蛋白质(氨基酸)需要

Meeting Protein (AA) Needs of High Producing Cows

- 提供充足（但不过量）的天然RDP以使MCP的合成量最大
Providing sufficient (but not in excess) natural RDP for maximum MCP syntheses
- 给高产奶牛饲喂尿素或其他非蛋白氮经常是一种浪费（Starea可能例外）
Feeding urea or other NPN to high producing lactating cows is often a waste (Starea may be an exception).

满足高产奶牛的蛋白质(氨基酸)需要

Meeting Protein (AA) Needs of High Producing Cows

- 提供足够的（但不过量）过瘤胃蛋白(氨基酸)以补足对代谢蛋白(氨基酸)的需要
Providing enough (but not in excess) UCP (AA) for the balance of MP (AA) needs.

某些饲料原料中的过瘤胃蛋白

UDP of Some Feed Ingredients

	<u>CP</u>	<u>UDP (as CP%)</u>
血粉 Blood Meal	95	71-77
玉米蛋白粉 Corn Gluten Meal	65	64-75
棉籽粕 Cotton Seed Meal	45	40-48
花生粕 Peanut Meal	52	9-13
豆粕 SBM	54	31-48
螺旋压榨豆粕 SBM screw pressed	46	58-69

高过瘤胃蛋白高脂肪的特种奶牛饲料

High By-pass Protein High Fat Special Dairy Feeds

- 蒸炒或热气流爆炒的全脂大豆，含有高过瘤胃蛋白
 - Roasted or jet-sploded full fat soybeans with high by-pass protein
- 挤压膨化高过瘤胃蛋白-高脂肪的奶牛浓缩料
 - Extruded high fat – high by-pass protein concentrate for dairy cows.

加热温度与时间对全脂大豆蛋白瘤胃降解率的影响

大豆 温度 C	保温时间, H				
	0	0.25	0.50	0.75	14
103	100	81.1	75.9	71.6	59.5
110	72.7	71.3	66.8	62.2	43.6
116	71.0	65.9	58.5	51.6	41
122	65.1	59.7	44.6	61.6	37.7

加热温度与时间对全脂大豆蛋白胃蛋白酶体外消化率的影响

大豆 温度 C	保温时间, H				
	0	0.25	0.50	0.75	14
103	88.4	87.3	84.6	85.9	80.5
110	86.7	85.9	85.7	85.3	81.9
116	85.6	86.6	85.4	82.9	85
122	85.2	84.6	85.5	84.8	82.6

干奶期和过渡期(围产期)的饲养

Feeding Dry Cow and Transition Cow

- 过渡期(围产期)：产前3周 – 产后2周
Transition Period: 3 wk pre-and 2 wk post- calving
- 干奶期依据体况评分来调整日粮达到预期增重
Adjust diet according to body score and reach target BWt gain during dry period

体况评分

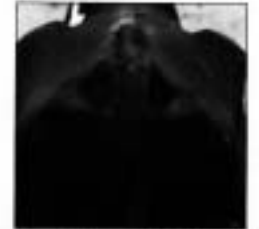


Figure 1. Correct hand placement for feeling fat covering over pin bones.

BODY CONDITION SCORE 1

Rump Area Deep cavity around tailhead. No fatty tissue felt between pins. Pelvic bone easily felt. Skin is supple.

Loin Area Ends of short ribs sharp to touch. Upper surfaces can easily be felt. Deep depression in loin.



BODY CONDITION SCORE 2

Rump Area Shallow cavity lined with fatty tissue at tailhead. Some fatty tissue felt under pin bone. Pelvis easily felt.

Loin Area Ends of short ribs feel rounded. Upper surface felt with slight pressure. Depression visible in loin.



BODY CONDITION SCORE 3

Rump Area No visible cavity around tailhead. Fatty tissue is easily felt over whole rump. Skin appears smooth. Pelvis is felt with slight pressure.

Loin Area Ends of short ribs can be felt with pressure. There is a thick layer of tissue on top. There is only a slight depression in the loin.



BODY CONDITION SCORE 4

Rump Area Folds of fatty tissue are visible around tailhead. Patches of fat are present around the pin bones. Pelvis is felt only with firm pressure.

Loin Area Short ribs can't be felt even with firm pressure. No depression is visible in loin between backbone and hip bone.



BODY CONDITION SCORE 5

Rump Area Tailhead is buried in fatty tissue. Skin is distended. No part of pelvis can be felt even with firm pressure.

Loin Area Folds of fatty tissue over short ribs. Bone structures can't be felt.



干奶期和过渡期(围产期)的饲养

Feeding Dry Cow and Transition Cow

- 产犊前(2-4周)给予中等精料日粮并逐渐增加精料量

Feeding moderate, increasingly amount of concentrate (2-4 wks) prior to calving

干奶期和过渡期(围产期)的饲养

Feeding Dry Cow and Transition Cow

- 产犊前(10-14 d)饲低钙日粮以促进旁甲状腺素(PTH)分泌
 - Low calcium diet (10-14 d) prior to calving

PTH的功能

- 减少尿中钙流失
- 促进骨骼中钙释放
- 增加1,25 dihydroxyvitamin D (促进钙吸收) 合成

产前二周饲喂不同水平日粮对 产乳热发生的影响

牛群	处理	Ca, g/d	发病	发病%
1	高钙	40	2/17	12
	低钙	18	0/14	0
2	高钙	46	6/14	43
	低钙	15	0/10	0
3	高钙	162	7/11	64
	低钙	14	0/6	0
4	高钙	173	5/18	28
	低钙	13	0/7	0

干奶期和过渡期(围奶期)的饲养

Feeding Dry Cow and Transition Cow

- 调整日粮阳离子 - 阴离子差(DCAD)：产犊前降低日粮中的钠/钾(KCl, NaCl..)含量并增加阴离子(MgCl₂, NH₄Cl, HCL..)的含量以创造短暂的生理酸性状态激发PTH分泌

Adjust dietary cation-anion difference (DCAD): Reduce sodium/potassium and increase anions in the diet prior to calving to create a temporary acidic physiological condition to stimulate secretion of PTH

调控 DCAD

- $DCAD = \text{日粮}(\text{Na}^+ + \text{K}^+) - \text{日粮}(\text{Cl}^- + \text{S}^-)$
- 调控目标： $DCAD \leq 0$
- 生理酸性状态的判断：尿 pH 6.2-6.8

谢谢！

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