# THE USE OF SOY PRODUCTS IN THE NUTRITION OF HIGH PRODUCTION DAIRY COWS: FOCUSING ON SOYBEAN OIL AND FULL FAT SOYBEAN MEAL

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## THE USE OF SOY PRODUCTS IN THE NUTRITION OF HIGH PRODUCTION DAIRY COWS:

SUMMARY

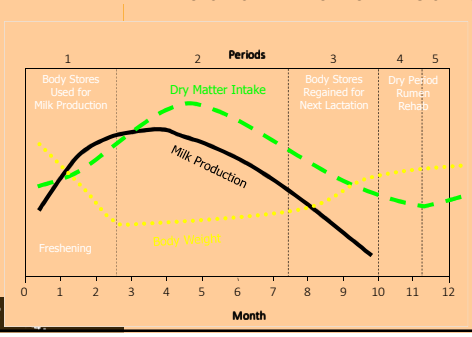




## WHY DO COWS NEED MORE ENERGY NOWADAYS?




## NUTRIENT AND MILK YIELD RELATIONSHIPS IN THE LACTATION AND GESTATION CYCLE






## HOW DO YOU INCREASE THE ENERGY CONSUMPTION ?

INCREASE CONSUMPTION OF DRY MATERIAL

INCREASE THE QUANTITY OF CONCENTRATES IN THE DIET

INCREASE THE ENERGETIC DENSITY OF THE CONCENTRATE OR TOTAL RATIO



## WHY INCREASE THE CONSMPTION OF DRY MATERIAL ?

Animal ingestion capacity is diminished during the first months of lactation

- SPACE OCCUPIED BY THE REPRODUCTIVE SYSTEM
- HORMONAL CHANGES ASSOCIATED WITH GIVING BIRTH
- ADAPTION OF MICROBIAL FLORA

## HOW TO INCREASE THE QUANTITY OF CONCENTRATES IN THE DIET ?


Large amounts of concentrates in the total ration of ruminants should be limited to **maximum 50-60 %** :

CAREFUL SUPPLEMENTATION BECAUSE OF:

- Ruminal Acidosis
- Reduced Acetic : Propionic ratio
- Loss of appetite
- Fall in Milk Production
- Lower Fat Content in Milk



## INCREASE THE ENERGETIC DENSITY OF THE CONCENTRATE OR TOTAL RATIO

- Energy increase cannot be achieved with cereals
- Nutrient with the greatest energetic density be used, i.e. fat
- Carefully evaluate the potential risks

Careful supplementation because of:

**Physical coating of the fiber**
Physical coating of the fiber or the formation of soaps, which especially reduces the production of volatile fatty acids

**Toxic effect on the cellulolytic flora**
Toxicity of unsaturated fatty acids against gram-positive bacteria.

**Physical coating of the microorganism**
Reducing the superficial active enzyme



## TYPES OF FAT USED IN DAILY NUTRITION




## TYPES OF FATS USED IN DAILY NUTRITION

| Category | Form |
|---|---|
| Oilseeds | Whole raw, rolled, ground, roasted or extruded |
| Vegetable oils | Crude, from chemical or mechanical extraction |
| Rendered fats | Tallow and yellow grease |
| Marine oils | Oils from salt water fishes |
| Modified fats | Calcium salts of fatty acids and Prilled fats |



## PLANT SOURCES (COMMODITY FATS) FOR DAILY NUTRITION

| OILSEED | % Fat | $NE_L$ (Kcal/kg) | UNSATURATED FAT (% of Total Fat) |
|---|---|---|---|
| Canola | 40 | 3,000 | 94 |
| Cottonseed | 20 | 1,940 | 71 |
| Linseed (flaxseed) | 36 | 2,780 | 89 |
| Safflower | 35 | 1,930 | 89 |
| Soybean (raw /roasted /extruded) | 20 | 1,930 /2,355/ 2,380 | 85 |
| Sunflower[1] | 28-42 | 2,975-3,225 | 83 |

[1]*Varieties vary with concentration of fat and fatty acid profile as well as whether hulls are present*



## DIFFERENTIATION BETWEEN DIETARY FATS IN DAILY NUTRITION

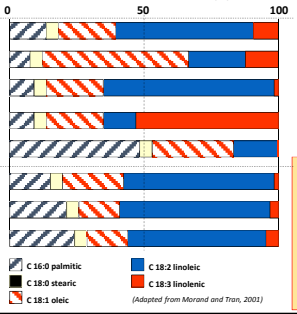
- Their fatty acid composition

- The degree of rumen protection (by pass fats)or rumen activity

## DIFFERENTIATION BETWEEN PLANT FATS

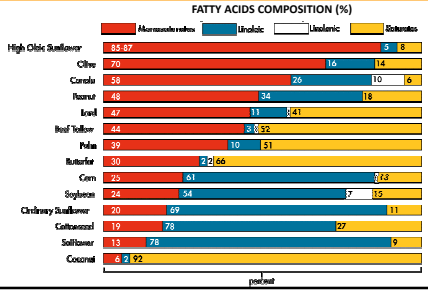
LEVELS OF CRUDE FAT (EE) and FATTY ACIDS (FA) COMPOSITION OF DIFFERENT RAW MATERIALS

| INGREDIENT | EE(%) |
|---|---|
| Soybeans | 22 |
| Rapeseed | 46 |
| Sunflower | 48 |
| Linseed | 38 |
| Palm k. meal | 6 |
| Corn | 4.9 |
| Wheat | 2.4 |
| Barley | 3.1 |




*The degree of unsaturation influences microbial metabolism in the rumen and thus milk fat*

## DIFFERENTIATION BETWEEN VEGETAL OILS (COMMODITY FATS)




## DIFFERENTIATION BETWEEN PROTECTED FATS USED IN DAIRY NUTRITION

- The degree of rumen protection (by pass fats) or rumen activity


Saponified Fat
*Protected by pH*

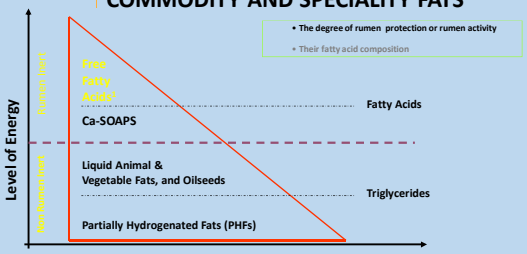

Fractionated Fat
*Protected by Melting Point*


Hydrogenated Fat
*Protected by Melting Point*


Designer Fat
*Protected by Slow Release Carrier*



## RUMINANTS ENERGY VALUE FOR COMMODITY AND SPECIALITY FATS




[1]Fractionated Free Fatty Acids



## QUALITY CHARACTERISTICS OF OILS USED IN DAIRY NUTRITION

| PARAMETER | REMARKS |
|---|---|
| M.I.U. (Moisture, Impurities, and Unsaponifiables) | Less than 1.5% |
| TFA (Total Fatty Acids) | Levels of less than 90% reflect dilution with other ingredients |
| FFA (Free Fatty Acids) | Presence of high levels of free fatty acids may be an indication of improper storage and/or handling of the fat. |
| IV (Iodine Value) | Fats with high iodine values (>60) typically contain vegetable soap stocks |
| IPV (Initial Peroxide Value) | IPV of less than 5 indicates that the sample in not rancid. Properly handled fat should not exceed an IPV of 10. |

*From: R. A. Zinn, U C Davis*



## FAT FEEDING GUIDELINES IN DARIY COWS

## IMPACT OF FATS ON DAIRY COW PERFORMANCE

Fats **increases the energy density** of the diet when starch or fiber is **replaced** with fatty acids.

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## EXPECTED RESPONSES TO FEEDING FAT

To High Production Dairy Cows

**MILK YIELD**
May increase on average by 3 to 8 % (1 to 2.5 kg)

**FAT TESTS**
Can be maintained or increased by 0.2 to 0.3 percentage points.

**REPRODUCTIVE PERFORMANCE**
Can be enhanced because cows return to positive energy balance sooner.

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## WHAT TYPE OF ADDED FAT SHOULD BE FED?

To High Production Dairy Cows

**SUPPLEMENTAL NUTRIENT NEEDS**
If added protein is needed, **whole soybeans** would be a good choice.

**Facility constraint and handling**
Canola seeds are very easy flowing inside of regular conveying systems, favoring spillage

**Palatability of the fat product**
Most fat supplements are very palatable and readily consumed by cows

**Cost of the fat supplement**
Will have a strong influence over its usage

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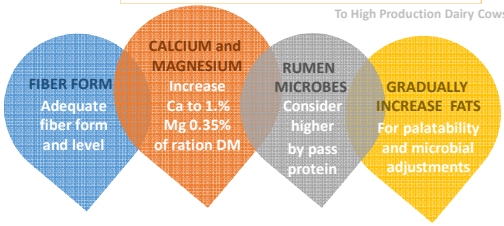
## NUTRITIONAL CONSIDERATIONS WHEN FEEDING FAT (I)

To High Production Dairy Cows

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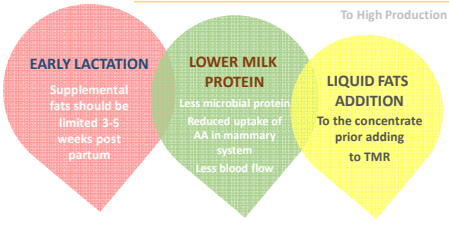
## NUTRITIONAL CONSIDERATIONS WHEN FEEDING FAT (II)

To High Production Dairy Cows

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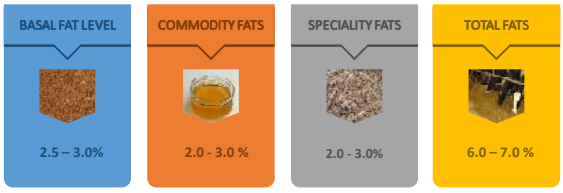
## HOW MUCH FAT CAN BE FED ?




As concentration of fat increases in the diet, negative effects of fat can be increased

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## EQUATIONS FOR FAT LEVEL CALCULATION

*From: Tom Jenkins, Clemson University*

- **(6 x % dietary ADF) ÷ (% of unsaturated fatty acids as a % of total fatty acids in the fat supplement ÷ % of total fatty acids in fat supplement) x 100%**
- **(4 x % dietary NDF) ÷ (% of unsaturated fatty acids as a % of total fatty acids in the fat supplement ÷ % of total fatty acids in fat supplement) x 100%.**
- **The unsaturated fatty acids considered are generally C18:1, C18:2, and C18:3.**

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## FULL FAT SOYBEAN MEAL AND SOYBEAN OIL AS FAT INGREDIENTS



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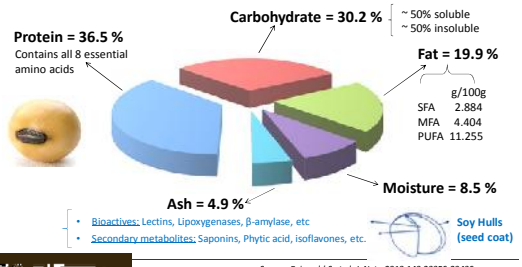
## SOYBEAN COMPOSITIONAL CHARACTERISTICS




*Source: Reinwald S et al. J. Nutr. 2010;140:2355S-2343S*

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## SOYBEANS — HIGH VALUE PLANT PROTEIN AND OIL (SEED)

| Component | Soybean[1] | Canola[2] | Sunflower[3] |
|---|---|---|---|
| Dry Matter (%) | 87,0 – 90,0 | 92,0 – 94,0 | 88,0 – 90,0 |
| Crude Protein (%) | 34,7 – 39,8 | 20,5 – 23,3* | 19,6 – 23,5 |
| Crude Fat (%) | 16,8 – 20,2 | 35,0 – 45,0* | 44,0 – 45,0 |
| Crude Fiber (%) | 4,7 – 5,5 | 12,5 –14,5 | 22,5 – 24,1 |
| Crude Ash (%) | 4,8 – 5,2 | 4,1 –4,3 | 37,0 – 38,0 |

*References: [1]Wang and Johnson, 2001 ; [2]Thakor et.all,1995; [3]Sunflower Technology and Production Agronomy No. 35 1997*
**Canola Oil is generally expressed as a percentage of whole seed at 8.5% moisture , whereas protein is expressed as a percentage in the oil-free meal at 13% moisture.*

**Only half as much canola should be fed as compared to soybeans**


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## FULL FAT SOYBEAN MEAL PROCESSING TECHNOLOGY AVAILABLE

| Technology | Processing Time | Temp ºC | Pressure Bar | Moisture % |
|---|---|---|---|---|
| **Autoclaving** | 30 min | 300 | No | Wet steam |
| **Roasting** | 120 - 180 | 120-170 | No | 10-12 |
| **Toasting** | 20 -30 min | 105 | No | 16-24 |
| **Micronizing** | 20 – 60 sec | 180-220 | No | 10-12 |
| **Extrusion (High Shear)** | 15 – 20 sec | 150-160 | 40-60 | 10-12 |
| **Expander (Low Shear)** | 10-40 sec | 100-140 | >1 | 12-20 |

*From: Chihaia I. 2004*

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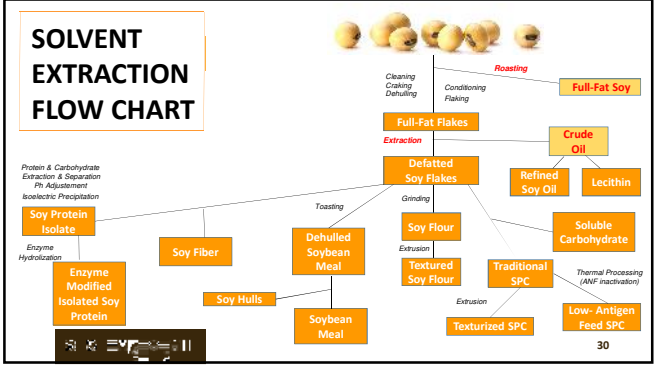
## SOLVENT EXTRACTION FLOW CHART

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## MECHANICALLY EXTRACTED SOY PRODUCTS

**EXTRUDED FULL FAT SOYBEAN MEAL PRODUCTS**

- Soybeans
  - Extruded Full fat Soybean Meal
- Soybeans
  - Low Fiber Extruded Full Fat Soybean Meal
  - Soy Hulls

**EXTRUDED & EXPELLED SOY PRODUCTS**

- Soybeans
  - Undehulled Ex-Press SBM
  - Crude Soy Oil
- Soybeans
  - Dehulled Low Fiber Meal Ex-Press SBM
  - Crude Soy Oil
  - Soy Hulls

From: Riaz M 2004

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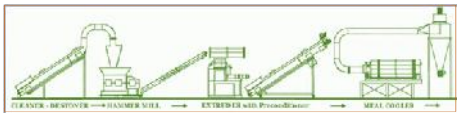
## FULLL FAT SOYBEAN MEAL DRY EXTRUSION PROCESS FLOW



**Whole soybeans are subject to:**

- Cleaning
- Particle size reduction
- Cooked by dry friction heat
- Cooling

| Dry Extrusion Process Parameters | Unit | Value |
|---|---|---|
| Soybeans initial moisture | % | 11,0 |
| Extrusion processing time | sec | 15-21 |
| Temperature at the nose cone point | °C | 154-156 |
| Extruder barrel pressure | bar | 40-60 |

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## DRY EXTRUDED FULL FAT SOYBEAN MEAL


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## MECHANICALLY PROCESSED SOYBEAN PRODUCTS



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## NUTRIENT COMPOSITION OF CONVENTIONAL SOY PRODUCTS

MANUFACTURED BY

- HEAT TREATMENT
- DEHULLING
- SOLVENT EXTRACTION
- EXTRUSION

| Specs | FFS | NDH SBM | DH SBM | EX-EX SBM |
|---|---|---|---|---|
| DM % | 92.36 | 89.98 | 88.79 | 93.85 |
| CP % | **37.56** | **43.9** | **47.73** | **44.56** |
| CFat % | **20.18** | 1.24 | 1.52 | **5.69** |
| Ash % | 4.89 | 6.38 | 6.27 | 5.7 |

Source : NRC 2012

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## IMPACT OF FULL FAT SOYBEAN MEAL AND SOY OIL IN DAIRY NUTRITION


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## WHOLE SOYBEANS, FULL FAT SOYBEAN MEALS AND SOY OIL IN DAIRY NUTRITION

RAW SOYBEANS | ROASTED SOYBEANS | EXTRUDED SOYBEANS | PRESSED OIL

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## NUTRITIONAL VALUE OF RAW SOYBEANS, EXTRUDED SOYBEANS, ROASTED SOYBEANS AND TALLOW AS FAT SOURCES IN EARLY LACTATING DAIRY COWS

- Eight-week experimental period
- Thirty multiparous high-producing Holstein cows
- Tie-stall system
- Five treatments / Five diets

H. Amanlou *et. al.* , 2012 *Open Veterinary Journal*, (2012), Vol. 2: 88-94 38

## INGREDIENT AND CHEMICAL COMPOSITION OF THE EXPERIMENTAL DIETS

| Item, % of DM | Control | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Alfalfa hay | 27.38 | 27.38 | 27.37 | 27.42 | 27.45 |
| Corn silage | 22.56 | 22.56 | 22.55 | 22.01 | 22.04 |
| Corn, ground | 24.29 | 22.36 | 22.36 | 23.56 | 23.58 |
| Tallow | - | 1.93 | - | - | - |
| Corn gluten feed | 6.94 | 6.94 | 6.94 | 8.11 | 8.12 |
| Soybean meal | 8.1 | 8.1 | - | - | - |
| Raw soybean | - | - | 10.02 | - | - |
| Roasted soybean | - | - | - | - | 10.05 |
| Extruded soybean | - | - | - | 10.04 | - |
| Fishmeal | 4.78 | 4.78 | 4.96 | 1.86 | 1.74 |
| Meat meal | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| Calcium PhosDi | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 |
| Molasses | 3.86 | 3.86 | 3.86 | 3.86 | 2.7 |
| Fish oil | - | - | - | 0.39 | 0.39 |
| Urea | 0.15 | 0.15 | | 0.62 | 0.64 |
| Premix VitMin | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| Wheat straw | - | - | - | 1.35 | 1.35 |

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## NUTRIENT COMPOSITION OF THE EXPERIMENTAL DIETS

| Item, % of DM | Control | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| DM, % | 55.4 | 56.33 | 56.27 | 57.04 | 57 |
| CP, % of DM | 18.6 | 18.5 | 18.5 | 18.5 | 18.5 |
| RDP*, % of CP | 58.9 | 59.0 | 58.7 | 58.4 | 58.4 |
| RUP*, % of CP | 41.1 | 41.0 | 41.3 | 41.6 | 41.6 |
| NDF, % of DM | 28.9 | 28.8 | 28.9 | 29.6 | 29.6 |
| NFC1, % of DM | 44.3 | 42.8 | 42.8 | 43.2 | 43.3 |
| Ether extract, % of DM | 3.5 | 5.4 | 5.1 | 5.3 | 5.3 |
| Calcium, % of DM | 0.9 | 0.96 | 0.9 | 0.73 | 0.72 |
| Phosphorus.% of DM | 0.61 | 0.55 | 0.63 | 0.54 | 0.52 |
| NEL*, Mcal/kg DM | 1.69 | 1.75 | 1.74 | 1.72 | 0.52 |

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## EFFECTS OF DIFFERENT FAT SOURCES ON LACTATION PERFORMANCE AND EFFICIENCY OF DAIRY COWS

| Item | Control | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| DMI, kg/d | 24.27 | 23.91 | 24.29 | 24.41 | 24.91 |
| Milk yield, Kg/d | 43.66 | 45.55 | 45.55 | 45.77 | 46.11 |
| 3.5% FCM1 | 41.46b | 43.57a | 43.87a | 43.28a | 44.25a |
| FCM/DMI | 1.70b | 1.82a | 1.79a | 1.77 a | 1.78a |
| Milk fat, % | 3.1 | 3.23 | 3.3 | 3.17 | 3.31 |
| Milk fat, Kg/d | 1.35b | 1.46a | 1.49a | 1.45a | 1.51a |
| Milk protein, % | 3.04 | 3.03 | 3.06 | 2.86 | 2.83 |
| Milk protein, Kg/d | 1.32 | 1.38 | 1.39 | 1.31 | 1.3 |
| Milk lactose, % | 5.07 | 4.73 | 5.05 | 4.88 | 4.7 |
| Milk lactose, Kg/d | 2.2 | 2.14 | 2.3 | 2.23 | 2.17 |
| Body weight, kg | 657.62 | 652.54 | 656.7 | 655.86 | 661.21 |
| BW change, kg2 | -4.09 | -4.2 | -4.24 | -4.76 | -4.54 |
| Energybalance3,Mcal/day | 2.27 | 1.74 | 1.84 | 1.96 | 1.99 |
| NEL intake, Mcal/day | 41.06 | 41.9 | 42.28 | 41.98 | 42.82 |
| Energy efficiency4 | 0.96 | 0.97 | 0.96 | 0.95 | 0.9 |
| BCS | 2.52 | 2.51 | 2.48 | 2.5 | 2.46 |
| BHBA | 0.484 | 0.43 | 0.378 | 0.383 | 0.368 |
| NEFA | 0.254 | 0.245 | 0.239 | 0.241 | 0.228 |

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## STUDY CONCLUSIONS

- The addition of 1.93% oil from extruded or roasted soybeans added to the diet of early lactating dairy cows, beside supporting equal or higher milk and milk composition, help to minimizing the dietary level of imported bypass protein sources such as fish meal, without any adverse effect on circulating NEFA or BHBA concentrations, when compared to raw soybean or tallow.
- There were no significant differences between extruded or roasted soybean oil in lactation performance and energy balance of dairy cows.

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## CONCLUDING REMARKS: WHY FEED FAT TO DAIRY COWS?

| For increased milk production | To maintain body condition | To enhance reproductive efficiency | Maintain fiber, reduce risk of acidosis |
|---|---|---|---|
| Increases in peak milk production, but also to an increase in persistency of the lactation curve | Consider feeding supplemental fats for at least the first 150 days of lactation | Increase the number of follicles that will be formed on the ovary | Consider supplemental fat when high quality forages are not readily available |
| HIGH PRODUCTION | BREEDING | EFFICENCY | HEALTHY ANIMALS |

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