








# PRECISION FEED FORMULATION FOR ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY

*Dottorato di ricerca in Scienze Veterinarie [XXXIII] CICLO* - Anno di corso: 2°
*Curriculum: Produzioni Animali*


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Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

# Nutritional characterization and variability of different livestock feed used in the national feed industry

| | | Sunglower Meal 36% CP | DEV.ST | Soybean Meal 48% CP | DEV.ST | Soybean | DEV.ST | Rosted Soybean | DEV.ST | Wheat Bran (*Triticum durum*) | DEV.ST | Wheat Bran (Triticum aestivum) | DEV.ST | Wheat flour | DEV.ST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dry matter** | % as fed | 91,16 | 0,65 | 89,01 | 0,37 | 92,56 | 0,46 | 93,59 | 0,43 | 89,98 | 0,66 | 90,49 | 0,31 | 88,59 | 0,41 |
| **Humidity** | % DM | 8,84 | 0,65 | 10,99 | 0,37 | 7,44 | 0,46 | 6,41 | 0,43 | 10,02 | 0,66 | 9,51 | 0,31 | 11,41 | 0,41 |
| **Crude Protein** | % DM | 37,05 | 1,41 | 52,23 | 0,39 | 37,23 | 2,75 | 37,88 | 0,55 | 16,44 | 0,72 | 17,05 | 0,52 | 20,24 | 1,95 |
| **Starch** | % DM | 0,84 | 0,73 | | | | | | | 32,14 | 3,36 | 24,80 | 3,64 | 30,14 | 2,38 |
| **Crude Fat** | % DM | 0,95 | 0,25 | 0,69 | 0,11 | 24,56 | 0,58 | 25,10 | 1,63 | 4,87 | 0,64 | 2,64 | 0,11 | 5,65 | 0,19 |
| **aNDFom** | % DM | 35,53 | 2,32 | 10,01 | 1,56 | 19,21 | 1,16 | 19,87 | 1,79 | 40,66 | 3,84 | 42,29 | 2,71 | 31,37 | 3,88 |
| **ADF** | % DM | 32,27 | 6,01 | 6,88 | 0,71 | 19,05 | 2,15 | 22,03 | 1,45 | 15,11 | 2,51 | 17,17 | 1,54 | 11,30 | 1,69 |
| **ADL** | % DM | 8,48 | 2,88 | 1,22 | 0,34 | 8,32 | 1,83 | 13,85 | 2,27 | 3,87 | 0,23 | 5,53 | 0,66 | 3,34 | 0,32 |
| **Ash** | % DM | 7,11 | 1,13 | 7,32 | 0,21 | 5,26 | 0,15 | 5,27 | 0,09 | 5,34 | 0,71 | 6,16 | 0,57 | 4,81 | 0,33 |
| **dNDFom 12h** | % aNDFom | 23,93 | 6,01 | | | | | | | 34,95 | 1,98 | 39,51 | 7,48 | 45,85 | 5,95 |
| **dNDFom 72h** | % aNDFom | 35,92 | 4,15 | 84,39 | 2,56 | 87,08 | 2,22 | 88,05 | 3,03 | 71,47 | 2,57 | 64,55 | 2,78 | 71,95 | 1,32 |
| **dNDFom 120h** | % aNDFom | 38,89 | 4,26 | 90,46 | 5,16 | 89,74 | 1,69 | 89,92 | 2,46 | 76,29 | 1,44 | 66,68 | 4,06 | 77,68 | 2,47 |
| **uNDF 120h** | % aNDFom | 21,76 | 2,55 | 0,91 | 0,44 | 1,96 | 0,26 | 1,99 | 0,42 | 9,65 | 1,17 | 14,09 | 1,90 | 7,02 | 1,32 |
| **pdNDFom** | % aNDFom | 13,77 | 1,23 | 9,10 | 1,88 | 17,25 | 1,30 | 17,88 | 1,87 | 31,01 | 2,85 | 28,21 | 2,57 | 24,35 | 2,84 |
| **Starch Dig** | % DM | | | | | | | | | 87,97 | 2,60 | 90,15 | 2,51 | 93,53 | 1,50 |
| **Digrum CP/CP** | | 70,04 | 4,96 | 58,98 | 1,86 | 81,81 | 11,12 | 49,50 | 3,51 | 48,69 | 12,17 | 70,09 | 11,92 | 61,60 | 8,59 |
| **DegintCP** | | 24,11 | 6,27 | 37,46 | 2,13 | 13,17 | 11,17 | 42,12 | 4,96 | 36,85 | 13,84 | 23,20 | 14,98 | 32,34 | 6,61 |
| **DegtotCP/CP** | | 94,15 | 4,34 | 96,44 | 0,54 | 94,98 | 0,81 | 91,61 | 1,74 | 85,55 | 6,41 | 93,29 | 4,76 | 93,94 | 3,36 |
| **BypassCP** | | 29,96 | 4,96 | 41,02 | 1,86 | 18,19 | 11,12 | 50,50 | 3,51 | 51,31 | 12,17 | 29,91 | 11,92 | 38,40 | 8,59 |
| **Degint/bypass** | | 80,20 | 13,19 | 91,28 | 1,52 | 65,07 | 16,47 | 83,19 | 4,41 | 70,36 | 16,14 | 68,10 | 31,53 | 84,88 | 6,80 |

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# Nutritional characterization and variability of different livestock feed used in the national feed industry

| | | Soybean Hulls | DEV.ST | Corn (Estero) | DEV.ST | Corn (National) | DEV.ST | Beet Pulp | DEV.ST | Barley | DEV.ST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dry matter** | % as fed | 92,19 | 1,22 | 88,17 | 0,24 | 89,09 | 0,32 | 93,32 | 0,25 | 90,89 | 0,37 |
| **Humidity** | % DM | 7,81 | 1,22 | 11,83 | 0,24 | 10,91 | 0,32 | 6,68 | 0,25 | 9,11 | 0,37 |
| **Crude Protein** | % DM | 13,76 | 3,39 | 7,93 | 0,29 | 8,74 | 0,10 | 9,23 | 0,15 | 12,05 | 0,67 |
| **Starch** | % DM | 3,88 | 0,17 | 54,99 | 1,70 | 50,22 | 4,85 | 6,30 | 0,86 | 48,54 | 6,18 |
| **Crude Fat** | % DM | 5,18 | 1,99 | 3,68 | 0,27 | 3,48 | 0,10 | 0,60 | 0,15 | 1,85 | 0,12 |
| **aNDFom** | % DM | 65,38 | 6,25 | 13,52 | 1,34 | 13,62 | 1,90 | 53,76 | 1,62 | 25,17 | 3,39 |
| **ADF** | % DM | 54,68 | 4,41 | 5,94 | 1,10 | 4,82 | 0,94 | 31,08 | 2,32 | 8,67 | 0,61 |
| **ADL** | % DM | 4,95 | 1,60 | 2,09 | 0,09 | 1,03 | 0,32 | 13,19 | 2,34 | 2,05 | 0,30 |
| **Ash** | % DM | 5,00 | 0,73 | 1,26 | 0,06 | 1,22 | 0,12 | 5,16 | 0,50 | 2,76 | 0,15 |
| **dNDFom 12h** | % aNDFom | 41,99 | 4,08 | | | | | 71,94 | 5,17 | | |
| **dNDFom 72h** | % aNDFom | 94,65 | 0,56 | 83,92 | 6,24 | 81,88 | 7,42 | 84,81 | 1,34 | 69,64 | 3,78 |
| **dNDFom 120h** | % aNDFom | 95,44 | 0,46 | 87,15 | 4,90 | 87,99 | 2,11 | 86,23 | 1,11 | 71,32 | 3,35 |
| **uNDF 120h** | % aNDFom | 2,97 | 0,26 | 1,70 | 0,48 | 1,61 | 0,12 | 7,39 | 0,52 | 7,17 | 0,86 |
| **pdNDFom** | % aNDFom | 62,41 | 6,16 | 11,82 | 1,71 | 12,02 | 1,97 | 46,37 | 1,80 | 18,01 | 3,06 |
| **Starch Deg%** | % DM | | | 65,48 | 2,61 | 53,47 | 4,49 | | | 78,70 | 3,78 |

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# Comparation between use of Conventional and Smart corn silage on milk production

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# Nutritional characteristics of different corn silage

| Corn silage | Conventional | Smart |
|---|---|---|
| Dry matter, % | 35.33 | 35.29 |
| Crude Protein, % DM | 8.45 | 8.48 |
| NDiP, % DM | 1.28 | 1.23 |
| ADiP, % DM | 0.67 | 0.62 |
| Soluble Protein, % DM | 4.72 | 4.91 |
| Fat, % DM | 2.97 | 3.29 |
| Starch, % DM | 36.51 | 37.61 |
| aNDFom, % DM | 36.04 | 34.38 |
| ADF, % DM | 22.05 | 20.66 |
| ADL, % DM | 2.59 | 2.13 |
| pdNDF, % DM | 29.07 | 28.70 |
| uNDF24h %DM | 17.25 | 13.84 |
| uNDF240h %DM | 6.97 | 5.68 |
| kd, $\%^{h-1}$ (calculate) | 4.95 | 6.01 |
| Ash, % DM | 5.81 | 5.96 |

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# Composition comparation of two different ration used in the trial

| Period | | Adaptation | Conventional | Smart |
|---|---|---|---|---|
| **Conventional corn silage** | Kg/d | 11,0 | 22,0 | --- |
| **Smart corn silage** | Kg/d | 11,0 | --- | 22,0 |
| **Barley silage** | Kg/d | 7,0 | 7,0 | 7,0 |
| **Hay** | Kg/d | 0,5 | 0,5 | 0,5 |
| **Straw** | Kg/d | 0,5 | 0,5 | 0,5 |
| **Steam flaked corn-sorghum** | Kg/d | 7,0 | 7,0 | 7,0 |
| **Soybean Meal48%** | Kg/d | 4,0 | 4,0 | 4,0 |
| **Rapeseed Meal** | Kg/d | 2,5 | 2,5 | 2,5 |
| **Beet pulp** | Kg/d | 1,5 | 1,5 | 1,5 |
| **Molas** | Kg/d | 2,0 | 2,0 | 2,0 |
| **Megafat ®** | Kg/d | 0,3 | 0,3 | 0,3 |
| **Integrators** | Kg/d | 1,5 | 1,5 | 1,5 |

# Nutritional aspect of the two rations offered during the trial

| Silomais | Convenzionale | Smart |
|---|---|---|
| Dry matter, % | 51,96 | 51,77 |
| Crude Protein, % DM | 15,87 | 15,25 |
| NDiP, % DM | 3,94 | 3,97 |
| ADiP, % DM | 0,56 | 0,53 |
| Soluble Protein, % DM | 6,98 | 7,07 |
| Fat, % DM | 3,79 | 3,96 |
| Starch, % DM | 24,25 | 26,33 |
| Sugar, % DM | 5,71 | 5,67 |
| aNDFom, % DM | 31,94 | 30,73 |
| ADF, % DM | 20,94 | 20,5 |
| ADL, % DM | 4,05 | 4,13 |
| $uNDF_{240,}$ % DM | 9,40 | 9,26 |
| pdNDF, % DM | 22,54 | 21,47 |
| IVNDFD 24h, % aNDFom | 51,74 | 49,57 |
| IVNDFD 240h, % aNDFom | 70,63 | 69,74 |
| Ash, % DM | 7,90 | 7,87 |
| Ca, % DM | 0,86 | 0,61 |
| Mg, % DM | 0,28 | 0,22 |
| P, % DM | 0,41 | 0,45 |
| K, % DM | 1,62 | 1,67 |
| Na, % DM | 0,25 | 0,28 |
| Cl, % DM | 0,86 | 0,73 |

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# Productive performance during trial

| Periodo | | Adaptation | Conventional | Smart |
|---|---|---|---|---|
| **Cows** | n. | 162 | 162 | 162 |
| **Milk** | kg/d | 42,28 C | 43,70 A | 44,22 B |
| **Fat** | % | 3,99 B | 4,19 A | 3,92 B |
| **Protein** | % | 3,65 C | 3,51 A | 3,54 B |
| **Somatic Cells** | n. | 218 | 259 | 233 |
| **Lactose** | % | 4,74 B | 4,70 A | 4,73 B |
| **Urea** | mg/dl | 26,99 | 18,38 A | 23,79 B |
| **Casein** | % | 2,82 A | 2,75 B | 2,75 B |
| **Unsaturated fatty acids** | % | 1,02 B | 1,14 A | 1,02 B |
| **Saturated fatty acids** | % | 3,00 A | 3,02 A | 2,83 B |

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# Observations

- The **silages** preserved using high-density wrapped round bales have proven to be of **excellent quality and easy to use**;

- The analyses revealed some **compositional differences in the smart silage compared to the conventional one**; in particular, it is worth noting the **difference in starch (higher), aNDFom and uNDF240h (decreased)**, and the hourly **degradation rate**, which turned out to be higher;

- Comparing the results of all the cows present in the barn from the beginning to the end of the trial (162 heads), it is important to note a **significant**, albeit quantitatively limited, **increase in milk production during the smart period (+0.52 kg/d)**, which is, however, accompanied by a **decrease in fat** concentration and an **increase in lactose, protein, and urea levels**.

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# Use of Progeo Dairy Manager (PDM) software to asses precision during preparation of TMR mixing wagon

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PROGEO

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# AIMS

- Assess the **deviation between theoretical and actual rations' aspects** of several dairy farms in the area of Parmigiano Reggiano.
- Investigate the **consistency of challenge** in TMR loading.

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# MATERIALS and METHODS

Data were collected in 6 dairy farms located in the area of Parmigiano Reggiano utilizing the Progeo Dairy Manager (PDM) software for herd management during two months.

## Farms characteristics

| Item | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Number of lactating cows (n)** | 102 | 390 | 860 | 969 | 490 | 180 |
| **Pens for lactating cows (n)** | 2 | 6 | 7 | 7 | 4 | 3 |
| **Milk Production (kg/d)** | 38.50 | 37.00 | 32.17 | 29.40 | 29.60 | 34.20 |
| **DIM (d)** | 155 | 156 | 186 | 175 | 169 | 158 |
| **DM offered (kg/cow/d)** | 30.50 | 29.10 | 26.05 | 28.10 | 25.50 | 28.20 |
| **Ration (%)** | 103 | 98 | 108 | 105 | 100 | 110 |
| **Number of ingredients (n)** | 9 | 10 | 8-11 | 7-9 | 8-10 | 9 |


**Legend.** A, B, C, D, E, F: farms; DIM: Days in Milk; DM: Dry Matter.

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# RESULTS

| | FORAGES | | | CONCENTRATES | | |
|---|---|---|---|---|---|---|
| | % | T-test | Effect Size | % | T-test | Effect Size |
| **FARM** | **Mean Deviation (±SD)** | **P- value** | **Cohen's d** | **Mean Deviation (±SD)** | **P- value** | **Cohen's d** |
| **A** | 104.40 (6.64) | **<.001** | 0.66 | 110.45 (14.09) | **<.001** | 0.74 |
| **B** | 108.26 (11.34) | **<.001** | 0.73 | 100.25 (3.77) | .089 | 0.07 |
| **C** | 102.62 (4.45) | **<.001** | 0.59 | 98.96 (4.97) | **<.001** | 0.21 |
| **D** | 102.35 (4.29) | **<.001** | 0.55 | 100.70 (3.24) | **<.001** | 0.22 |
| **E** | 105.49 (8.87) | **<.001** | 0.62 | 100.83 (4.04) | **<.001** | 0.20 |
| **F** | 101.14 (7.71) | **<.001** | 0.15 | 100.73 (2.16) | **<.001** | 0.34 |

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# RESULTS

| | TMR | | | UNLOAD | | |
|---|---|---|---|---|---|---|
| | % | T-test | Effect Size | % | T-test | Effect Size |
| **FARM** | **Mean Deviation (±SD)** | **P- value** | **Cohen's d** | **Mean Deviation (±SD)** | **P- value** | **Cohen's d** |
| **A** | 103.33 (1.67) | **<.001** | 2.00 | 101.39 (3.04) | **<.001** | 0.46 |
| **B** | 102.27 (2.11) | **<.001** | 1.07 | 100.89 (4.72) | **<.001** | 0.19 |
| **C** | 100.91 (1.03) | **<.001** | 0.88 | 98.76 (4.35) | **<.001** | 0.28 |
| **D** | 101.18 (0.88) | **<.001** | 1.33 | 99.83 (2.57) | .071 | 0.07 |
| **E** | 101.61 (2.34) | **<.001** | 0.69 | 101.60 (7.66) | **<.001** | 0.21 |
| **F** | 100.53 (0.91) | **<.001** | 0.58 | 102.19 (8.81) | **<.001** | 0.25 |

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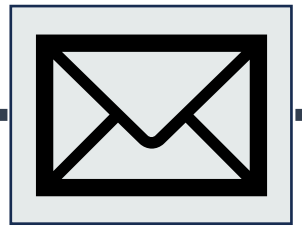
# CONCLUSION

Almost all the farms **overweight** the **ingredients**, except for farm B that weighted with good precision concentrates.

**TMR** and **unload** to pens were **also significantly different from target**. This could lead to **overfeeding** and excess of nutrients for animals.



**Operators** must be well trained and **conscious of their role** in the farm during operation of preparing the TMR.

There are **opportunities to improve precision feeding** in dairy farms setting **higher standard** for loading TMR wagon and unloading **accuracy and precision**.

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# Future & work in progress research

- Validation of Algomilk Photofiber for automatic determination of fiber lenght fraction in TMR;
- Substitution rate between feed given in Automatic Milking System and TMR;
- Influence of errors during TMR preparation on milk production in Parmigiano Reggiano dairy cows;
- Nutritional characterization and variability of different livestock feed.

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# Published works

*Communication*

## Reaching a Wider Audience: Instagram's Role in Dairy Cow Nutrition Education and Engagement

Edlira Muca [1,*], Giovanni Buonaiuto [2], Martina Lamanna [2], Simone Silvestrelli [2], Francesca Ghiaccio [2], Alessia Federiconi [2], Julio De Matos Vettori [3], Riccardo Colleluori [2], Isa Fusaro [3], Federica Raspa [1], Emanuela Valle [1], Andrea Formigoni [2] and Damiano Cavallini [2,*]

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# Use of Progeo Dairy Manager (PDM) software to asses precision during preparation of TMR mixing wagon

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Bongiovanni J.[b]; Toni F.[b]; Formigoni A.[a]

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Thank you for
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