**Exercise 5**

**Ration Formulation I – Balance for Energy and Protein   
15 Points**

To begin ration formulation we will balance for two main nutrients (energy and protein) using three ingredients. The logical scenario for this basic formulation is for ruminant (or horse) rations where a combination of forage and grain is used to balance for energy, and a protein ingredient, such as soybean meal, is used to bring the ration to the correct protein level. For example, growing cattle rations may be formulated to achieve a desired rate of gain. Because the level of energy in the ration is a major factor influencing gain, by using various ratios of forage and concentrate, the producer can create rations that will provide the correct amount of energy for the desired rate of gain. The appropriate amounts of required protein, phosphorus and calcium may then be provided in a supplement.

In the example provided we will use a commercially prepared protein/mineral supplement to provide the protein, Ca and P needs of the calves. Also, we will assume that this supplement is equal to the grain in energy content.

**Steps for Formulating Ruminant/Horse Rations**

1. Look up requirements for energy, protein, P and Ca.
2. Look up the nutrient composition of available feeds in the book.
3. Balance for energy always use roughage and the energy feed. It is important to remember to always ***balance for energy first!***
4. Balance for crude protein -- use the amount of forage estimated in step 3 as a fixed ingredient and let the amount of protein supplement replace the energy feed. Never replace the roughage feed with the protein supplement.
5. Determine the amount of calcium contained in the ration.
6. Determine the amount of phosphorus contained in the ration.

**EXAMPLE:**

Balance a growing ration for feedlot steers and heifers (1100 @ finishing) 660 lbs BW, 80 % TDN of DM. Use corn silage, corn and a 44% crude protein supplement.

**Step 1. Determine the requirements:**

**Hint:** Please convert Mcal/lbs to Mcal/kg  
1Kg = 2.2 lbs

|  |  |  |  |
| --- | --- | --- | --- |
| NEm, Mcal/kg | CP, % | Ca, % | P, % |
| 1.98 | 14.7 | 0.56 | 0.27 |

**Step 2. Feedstuff composition**:

**Hint**: Except DM, please use dry-matter basis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredient  (Appendix II) | DM, % | NEm,Catl  Mcal/kg | CP, % | Ca, % | P, % |
| Corn grain | 87.3 | 2.24 | 10.1 | 0.02 | 0.33 |
| Corn Silage | 34.1 | 1.63 | 8.1 | 0.27 | 0.20 |
| Commercial Supplement | 90 | 3.16 | 44 | 4.0 | 1.0 |

**Step 3. Balance for energy** (let x = amount of corn grain, therefore 100 - x = amount of corn silage).

Convert ME requirement from Mcal/lb to Mcal/kg:

0.9 Mcal/lb \* 2.2 lb/kg = 1.98 Mcal/kg

If need 1.98 Mcal/kg, then need 198 Mcal/100 kg

corn corn silage

198 = 2.24 (x) + 1.63 (100 - x)

x = corn =57.38 corn silage = 42.62

**Step 4. Balance crude protein** (let x - amount of supplement)

corn silage corn suppl.

14.7 = 0.081(42.62) + 0.101 (57.38 - x) + 0.44 x

***\*NOTE: Supplement replaces corn because of their similar energy content.***

x = 16.08 = % protein supplement

57.38 - x = 41.3 = % corn

**Step 5. Determine the amount of calcium contained in the ration**

**Amount of Ca** = 0.0027(42.62) +0.0002 (41.3) + 0.04 (16.08)

= .0.77% Ca (This meets the requirement for Ca of 0.56)

**Step 6. Determine the amount of phosphorus contained in the ration**

**Amount of P** = 0.002(42.62) +0.0033(41.3) + 0.01(16.08)

= .38% P (This meets the requirement for P of 0.27)

Final Ration

|  |  |
| --- | --- |
| Ingredient | % Dry Matter Basis |
| Corn | 41.3% |
| Corn Silage | 42.62% |
| 44% Supplement | 16.08% |

The first two homework problems that follow involve balancing rations for energy and protein for the same beef heifer with the same ingredients with the exception that three different forages are used are used for Problems I to II. This give you practice at balancing diets and will give you a chance to observe how forages of different quality require different amounts of concentrate ingredients in order to balance a diet.

Problem three is different in that you will balance a ration for horse using her daily requirements rather than balancing on a concentration of the diet basis.

Problem I

Balance a ration for ME and protein for feedlot steers and heifers 660 lbs (1200 @ finishing) and 70 % TDN of DM (Table 8-2c). Feed ingredients available are: Timothy hay, early bloom (listed below); barley grain (Appendix II, P621); and soybean meal, solvent extracted (Appendix II, P621).

1. Requirements of the animal:

**Hint:** Don’t forget to adjust NEm Mcal/lb to Mcal/kg

1kg=2.2lbs

|  |  |  |  |
| --- | --- | --- | --- |
| NEm, Mcal/kg | CP, % | Ca, % | P, % |
|  |  |  |  |

1. Feedstuffs:

**Hint:** Except DM, please use dry-matter basis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredient  (Appendix II) | DM, % | NEm, Mcal/kg | CP, % | Ca, % | P, % |
| Timothy hay, early-bim |  |  |  |  |  |
| Barley, grain |  |  |  |  |  |
| SBM |  |  |  |  |  |

1. Balance for ME (use Timothy hay and barley).

**Hint:** Don’t forget to adjust Mcal/kg to Mcal/100kg

1. Balance for crude protein (use SBM).
2. Does the ration satisfy the Ca and P requirements?
3. What is the ration on an as-fed basis?

Problem II.

Balance a ration for ME and protein for the same heifers using forage of a lower quality than the Timothy hay that was used in Problem 1. Feed ingredients available are: Timothy hay, early bloom (listed below); barley grain (Appendix II, P621); and soybean meal, solvent extracted (Appendix II, P621).

1. Requirements of the animal:

**Hint:** Don’t forget to adjust NEm Mcal/lb to Mcal/kg

1kg=2.2lbs

|  |  |  |  |
| --- | --- | --- | --- |
| NEm, Mcal/kg | CP, % | Ca, % | P, % |
|  |  |  |  |

1. Feedstuffs:

**Hint:** Except DM, please use dry-matter basis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredient | DM, % | NEm, Mcal/kg | CP, % | Ca, % | P, % |
| Timothy hay, early-bim | 84 | 1.10 | 6.3 | 1.54 | 0.2 |
| Barley |  |  |  |  |  |
| SBM |  |  |  |  |  |

1. Balance for ME (use Timothy hay and barley).

**Hint:** Don’t forget to adjust Mcal/kg to Mcal/100kg

1. Balance for crude protein (use SBM).
2. Does the ration satisfy the Ca and P requirements?
3. What is the ration on an as-fed basis?

Problem III

Rations can be formulated on a daily amount of nutrient needed basis as well as a nutrient concentration basis as in the Problems 1-2. Balance a ration for an 1100 lb mare in lactation. The mare’s DMI is 22 lbs (therefore X + Y = 22), and her requirements are for 28 Mcal of DE/day and 1.5 kg of protein/day. Use Timothy hay, early -bim (Appendix II, P621); barley grain (Appendix II, P621); and a 40% commercial protein supplement to meet her requirements. The supplement is 40% crude protein (DMB), has equal energy as the barley, and is 92% DM. Use table values for the brome hay and the barley. First balance the ration on a DMB (determine the amounts of DM of each ingredient to feed daily) and then provide the as-fed amounts of each ingredient that you will feed the mare daily.

**Hint: Convert DMI from pound to kg**