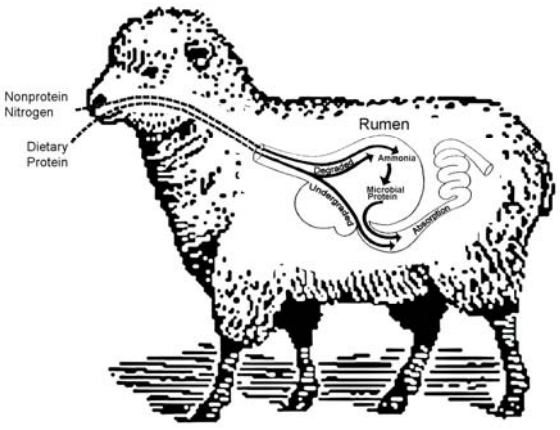
Measures and Weights	
What is ppm?	Parts per million, like percent, is a measure of concentration. Very small concentrations are measured in ppm. Typically, ppm is used for trace minerals (Cu, Fe, Mn, Mo, Se, Zn)
What is mg/kg?	Milligram per kilogram is a measure of concentration typically used for trace minerals (Cu, Fe, Mn, Mo, Se, Zn). Like ppm it represents parts per million.
What is %?	Percent (%) is a measure of concentration normally used for macro minerals (Ca, Mg, P, K, S, Na), crude protein, and total digestible nutrients. Percent (%) represents parts per hundred.
Why are some requirements presented as concentrations (%, ppm, or mg/kg) and others as weights (g, oz, kg, lbs)?	Requirements other than trace minerals are presented in units of weight. Feed nutrient specifications are presented in concentration. In general, sheep have a requirement for an amount of a specific nutrient rather than a concentration of that nutrient. The amount of any nutrient that a sheep consumes is a function of the quantity of feed consumed, the nutrient content of that feed, and the digestibility of that nutrient. Because it is difficult to determine the amount of feed a sheep, particularly a grazing sheep, consumes, many nutrient recommendations are presented on a concentration basis, assuming that the sheep is consuming an adequate amount of feed. This is not always a safe assumption.
Energy and carbohydrates	
Do sheep have a requirement for fiber?	No, but fiber is the primary energy source for sheep and all other ruminants via rumen microbial fermentation.
What is energy?	Energy is a characteristic of feed. Carbohydrates (fiber, sugar, starches) are the primary sources of energy for sheep. However, sheep can use small amounts of fats and oils for energy. Large amounts of fats result in digestive upset. All protein sources except urea can provide energy to sheep.

What is the energy content of protein, carbohydrates, and fats?	Energy content is measured in kilocalories per gram. Carbohydrates have 4.14 kcal/g, proteins have 5.65 kcal/g, and fats have 9.4 kcal/g.
Is there a mathematical relationship between the TDN value of a feed and the DE and ME values?	Yes DE Mcal/kg = TDN% x .01 x 4.4 ME Mcal/kg = DE Mcal/kg x .82
On a lab feed test, how are total digestible nutrients (TDN) determined?	Common equations are: Alfalfa: % TDN = 96.35 - (ADF % x 1.15) Corn Silage: % TDN = 87.84 - (ADF % x 0.70) General: % TDN = 88.9 – (ADF % x 0.779) The actual laboratory calculation of TDN is: digestible crude protein + digestible crude fiber + digestible nitrogen free extract + digestible ether extract x 2.25 Nitrogen free extract includes sugars and starches. Either extract is fats and oils. The either extract value is multiplied by 2.25 because fats and oils general have 2.5 times the caloric density of protein, fiber, sugar and starch.
In a lab feed test how are the net energy (NE) values determined?	Different labs may use different equations commonly used equations are: NE_L: Mcal/lb = (TDN % x 0.01114) – 0.054 NE_M: Mcal/lb = (TDN % x 0.01318) – 0.132 NE_G: Mcal/lb = (TDN % x 0.01318) – 0.459 The NRC calculated NE from ME $NE_m = 1.37\ ME - 0.138\ ME^2 + 0.0105\ ME^3 - 1.12$ $NEg = 1.42\ ME - 0.174\ ME^2 + 0.0122\ ME^3 - 1.65$
What is ADF?	ADF is short for acid detergent fiber. This value refers to the cell wall portions of the forage that are made up of cellulose and lignin. ADF is important because it relates to the ability of an animal to digest the forage. As ADF increases, forage digestibility usually decreases. Many of the calculated values appearing on forage reports are generated using ADF values.

What is NDF?	NDF stands for neutral detergent fiber and is a measure of the total cell wall. The cell wall is comprised of the ADF fraction plus hemicellulose. NDF values are important in ration formulation because they reflect the amount of forage the animal can consume. As NDF percentages increase, dry matter intake will generally decrease.
What is crude fiber and how does it relate to NDF and ADF?	When the crude fiber system was developed it was thought to represent most of the cell wall portion of the forage. However, it was later discovered that it did not account for some of the hemicellulose and lignin components. A modified crude fiber (MCF), which includes the ash or mineral fraction, is used in some states to evaluate alfalfa. Some laboratories calculate a crude fiber value based on the ADF value.
What is ADL or lignin?	ADL stands for acid detergent lignin. Lignin is the prime factor influencing the digestibility of plant cell wall material. As lignin increases, digestibility, intake, and animal performance usually decrease and the percent ADF and NDF both increase.
How is NDF used to calculate dry matter intake (DMI)?	Feeding studies have shown that as the percent NDF increases in forages, sheep consume less of that forage. The formula typically used to calculate DMI is: DMI (as a % of body weight) = 120 ÷ % NDF. For example, DMI=120÷40% NDF=3.0% of body weight.
How is digestibility related to ADF?	Typically, as ADF increases digestibility decreases. Generally, digestible dry matter is calculated as 88.9 – (ADF % x 0.779). Some feed companies also use this equation to calculate TDN.
What is relative feed value (RFV)?	RFV = (% DDM x % DMI) ÷ 1.29 (DDM is calculated from ADF) (DMI is calculated from NDF).
Protein	
What does a test for crude protein tell me?	A test for crude protein is actually based on the amount of nitrogen in the sample and gives no indication of available or heat damaged protein or true plant protein and non-protein nitrogen (urea).

How is crude protein determined and what does it tell you?	Laboratories measure the nitrogen (N) content of the forage and calculate crude protein (CP) using the formula: CP = % N x 6.25. Crude protein includes both true protein and non-protein nitrogen. Sheep can use both types to some degree. Crude protein values give no indication of heat damage, which may alter protein availability.
What is meant by "unavailable protein" in a laboratory feed analysis of feed?	Typically unavailable protein is associated with heat damage. If excessive heating has occurred, the protein content will not be effected but digestibility or availability of the protein will be lowered. All forages have some unavailable protein. This value may also be reported as ADF-N protein, ADF-CP, bound protein, or insoluble protein.
What is meant by "available protein" in a laboratory analysis of feed?	Typically this is the difference between crude protein and unavailable protein.
What is the fate of dietary protein and how is urea used?	Urea and ruminally degradable plant protein have the same fate in the rumen. Both are incorporated into the rumen ammonia pool and are eventually used to make rumen microbes. In most cases, the rumen microbe is the major source of protein reaching the small intestine in sheep. Some dietary protein is not digested in the rumen. This protein may be digested and absorbed in the small intestine, or pass out with the feces as indigestible protein. 
What is "digestible protein" on a feed specification?	On a feed specification, digestible protein is typically a calculated value. Some labs use the following equation

	to calculate digestible protein (Crude protein x 0.908) – 3.77. This calculated digestible protein value gives no indication if any heat damage has occurred. It has little practical value in formulating rations.
Vitamins and Minerals	
What are the functions of vitamins and minerals?	Vitamins and minerals are structural components of organs and tissue. They are a component of body fluids as electrolytes and catalysts in enzyme and hormone systems.
Are vitamin and mineral requirements static or variable?	Mineral and vitamin requirements are variable. Although this program and the sheep NRC (1985) give a single number as a recommended amount, they are actually recommendations for you to use as a starting point in optimizing your sheep nutrition program. Actual requirements can vary with differences in breed, environment, age, physiological stage; interaction with other nutrients; animal adaptation to level of nutrient; level of intake; chemical form; and level of production (i.e., milk, wool, meat).
What are trace minerals?	Trace minerals occur in living tissue at low concentrations and are the reaction catalyst of biological systems. Included in the category of trace minerals are: copper, iron, zinc, selenium, fluorine, manganese, cobalt, molybdenum, and iodine.
What nutrients are important in an active immune system?	As a whole, good nutrition is critical in developing and maintaining an active immune system. Specifically, copper, zinc, iron and selenium in addition to certain vitamins (A, D, E, and B^6) and other nutrients are strongly related and act together and/or separately to form an active immune response.
What is a macro mineral?	Macro minerals occur in relatively high concentrations and are widely distributed throughout the body. They serve a variety of functions. Included in the category of macro minerals are calcium, phosphorus, magnesium, potassium, sodium, sulfur, and chlorine.

How much of a problem are sub-clinical mineral and vitamin deficiencies?	Sub-clinical mineral deficiencies are ones in which specific clinical symptoms are not evident. They may be a larger problem than acute deficiency. Sheep with sub-clinical status continue to produce, but have reduced rates of production, decreased feed efficiency, and depressed immune function.
What impacts sheep vitamin and mineral requirements?	Different breeds, environments, sheep age, and physiological stage all impact vitamin and mineral requirements. Requirements are also impacted by interaction with other nutrients. Sheep can adapt to some extent to different level of nutrient. The level of intake and chemical form along with the level of production (i.e., milk, wool, meat) also impact requirements.
Are mineral requirements dynamic or static?	Mineral requirements vary with the criteria used to determine the recommendation. A good example is if wool quality is used as the criterion, then the copper requirement is higher than if growth rate is used as the criterion. Or – the level of vitamin E necessary to prevent white muscle disease is much lower than that needed for peak immune function during periods of physiological stress.
How important is the base forage diet in meeting mineral requirements?	The adequacy or deficiency of a particular vitamin or mineral is based upon the entire diet, not just the mineral supplement. Factors that reduce forage intake (low protein and high ligninification) reduce the amount of minerals and vitamins consumed by the grazing animal. Thereby increasing the amount needed in a mineral supplement.
Is good quality alfalfa hay all a lactating ewe needs as a source of phosphorus?	Lactating ewes fed alfalfa hay typically need supplemental phosphorous.
Do internal parasites impact mineral nutrition?	Internal parasitic infections have a serious impact on calcium and phosphorus status.
Why are calcium and phosphorus important?	These two minerals are important in the development and maintenance of bones and cell growth, maintaining proper acid base balance, and other metabolic functions. These minerals are also important in fertility.
What happens when phosphorus	Sheep can adapt to some degree by increasing their

and/or calcium is lacking?	efficiency of absorption of these minerals. However, under severe or extended periods of deficiency, subnormal growth in young animals and poor weight gain in older sheep can occur. Poor feed efficiency and loss of appetite along with pica may also occur with deficiencies.
What other factors impact calcium and phosphorus nutrition?	Adequate Ca and P nutrition depends not only on total dietary consumption, but also chemical form and vitamin D status of the animal.
What are signs of zinc deficiency?	Decreased appetite, reduced rate of growth, impaired reproduction, and impaired immune function, particularly in stressed animals are all signs of zinc deficiency.
What are organic minerals?	General classes of organic minerals are: 1) Chelates which are minerals associated with amino acids forming a closed ring structure, 2) Proteinates which are minerals associated with amino acids or peptides forming an open ring structure, and 3) Complexed minerals which are bonded to an organic compound.
Why is salt important?	Salt is important for maintaining cellular osmotic pressure, regulating acid-base balance, and controlling water metabolism in tissue. When salt is lacking, sheep may consume non-foods or toxic foods. They may also lack appetite, their growth rate may be retarded and they may become inefficient at using feed
Can I consider just one mineral at a time?	Ration formulation and ration programs typically focus on one specific nutrient at a time. However, minerals are interrelated and balanced against each other and most often cannot be considered as single elements with independent roles. A deficiency or excess of one will interfere with the proper use of the other.

General Ration formulation	
Should I balance my ration on an “as fed” or dry matter basis?	Do all calculations on a dry matter basis. Then - convert the amount of DM to the actual or “as fed” amount (divide the DM amount by the DM coefficient) to determine how much to feed. Do not forget to include some amount of feed as wasted such as blown away or not consumed by the sheep for a variety of reasons
What is a concentrate?	Any feed with a high concentration of a particular nutrient or nutrients is a concentrate. Although typically applied to energy feeds, a feed with (example) high protein can also be considered a concentrate.
Do sheep have a requirement for specific feeds?	No. Sheep have energy and nutrient requirements, feeds are simply the way that sheep consume the nutrients they need.
What is the difference between feeds and nutrients?	Nutrients are the components of feeds. Feeds contain nutrients along with other chemicals that may have positive, negative, or no impact on the availability of the nutrients within a specific feed.
What is the difference between dry matter and as fed?	Dry matter is as fed minus the moisture component of the feed. Expressing intake and nutrient content on a dry matter or percent of dry matter basis allows fair comparison among feeds with different water concentrations. DM = as fed - moisture For example: a sheep consumes 5.5 lbs of feed (as fed) per day that is 91% DM. This means the sheep is consuming 5 lbs of dry matter (5.5 x .91). Another sheep is fed 10 lbs of silage that is 50% DM. The sheep also is consuming 5 lbs of dry matter (10 x .5)
Why does this program use DM when sheep producers deal on an “as fed basis”?	Rations are compared on a dry matter basis to provide a fair comparison of nutrient content and price among feeds with different moisture content.

What is an essential nutrient?	All nutrients are necessary for the sheep to maintain life process and production. However, some of these nutrients can be synthesized within the body. Essential nutrients are those that must be in the diet because the sheep can not synthesize the nutrient or can not synthesize an adequate amount. For example, at the cellular level sheep have basically the same amino acid requirement as pigs or humans. But, because the sheep's rumen microbes are capable of synthesizing these amino acids from nitrogen (urea and plant protein) amino acids are typically not required in the diet. The exceptions are young and high producing sheep that may have a need for more amino acids than the rumen can synthesize. Then, bypass or rumen undegradable protein may be beneficial.
With all the textbook feed values available, why should I test my hay and other feeds?	Nutrient content of feeds can vary drastically. Using a textbook value may lead a producer to think a ration is properly balanced, when in fact a significant deficiency is occurring because a lower than textbook nutrient concentration actually exists. On the other hand, a producer may find that a forage previously thought to be deficient may actual meet the sheep's requirement.
How are the terms toxic, deficient, and required related to nutrition?	NRC gives recommendations not requirements. At some level all nutrients including water in rare instances can be toxic and result in death or lower levels of production. Required levels depend upon a host of animal, genetic, and environmental factors and the criteria for determining the requirement. Deficiency can be either acute or sub-acute. An acute deficiency will result in classic symptoms while sub-acute deficiencies will typically result in lower production.

How do I make sense of all the numbers on a feed tag?	First you have to have some knowledge or make some assumptions about the base feed or forage. Let's step through the following example to better understand the process. The balance program will perform this type of calculation for you. 1. What is the animal's requirement? In our example, a ewe requires 3 g of phosphorus (P) per day. 2. How much of the base feed will she consume and how much P is in the base feed? This is the tough question. Based on NRC or your experience, let's assume she will eat 1500 g (1.5 kg or 3.3 lbs) of dry matter/day. The feed is grain stubble and we'll use a textbook value of .09% P. 3. How much P is in the base forage? The amount of P in the base feed = 1500 g x .09%. We convert .09% to its decimal equivalent and multiple. 1500 g x .0009 = 1.35 g. The ewe requires 3 g P/day. We are deficient. 4. What is the supplement? The supplement may contain more than just P. It may also contain protein, energy, and other macro and trace minerals. Let's assume the tag read .75% P and the manufacturer recommends feeding .5 lb/ewe/day. If you have 200 ewes, you would feed 100 lbs/day and hope each ewe eats approximately .5 lb/day. Because P requirements are expressed in g, we need to convert lbs of intake to g of intake. Use the conversion calculator convert as follows: .5 lbs/2.2 = .227 kg = 227 g/day of supplement consumed. 5. Determine the amount of P consumed from the supplement. P intake from supplement = 227 g x .75% = 227 x .0075 = 1.70 g of P from the supplement assuming each ewe gets her fair share. 6. Add the amount of P from the grain stubble (1.35 g of P) to the amount of P from the supplement (1.7 g of P) = 3.05 g of P in the whole ration (supplement and base forage). 7. Compare the dietary P (3.05 g of P) to the NRC recommendation (3.0 g of P). The diet contains approximately the amount of P required by the ewe.