Sheep Market Model Description

Basic Model Characteristics

This is a model that includes aggregate representations of sheep production, local feed resources (forage) production, and demand for sheep meat. It can be used to stimulate thinking about key effects in Mexico's sheep sector. The model includes four stocks: sheep numbers, forage biomass, sheep meat inventory, and proportion of sheep farmers that will adopt a new technology. It also includes eight "policy-relevant" variables: feed per unit land, net birth rate, delay time between birth and maturity, the rate of growth in demand for sheep meat, rainfall (which affects forage production), a subsidy for sheep producers that reduces their costs of sheep production, the sensitivity of sheep meat sales to sheep meat price, and the proportion of producers who will adopt a new technology (the adoption pattern is assumed to follow S-shaped growth).

Key Relationships

Sheep Numbers:
Sheep numbers are defined for an entire region, and depend on a net birth rate and a sales rate. The net birth rate depends on the availability of feed per sheep (it increases when feed availability increases), on a "health intervention parameter" that allows the user to test the impact of a percentage increase in the net birth rate due to improvements in health management on sheep farms, and the profitability of sheep farming (measured as the ratio of sheep producer revenues to sheep producer costs). The sales rate is a fixed delay of the net birth rate, with a maturity delay of 10 months.

Sheep Meat Inventory:
Inventories of sheep meat are defined for a single region, and are increased by the slaughter of sheep, which is equal to sheep sales times a fixed carcass weight. Sheep meat sales, of course, reduce inventories. The price of sheep meat decreases when inventories are larger than a "reference value" of inventories (an amount that sheep meat processors feel "comfortable" holding) and increases if inventories are smaller than desired. Sheep meat sales depend on the price of sheep meat and a "reference sales" value that can be increased over time to represent growing demand for sheep meat. The responsiveness of sheep meat consumers to sheep meat price is captured by a "sensitivity of sales to price" parameter, which can be varied to assess this (currently not well-known) effect. This parameter has a negative value, which simply means that as price increases, sales decrease. The larger the absolute value of the parameter, the more responsive sales are to price.

Producer Revenues, Costs and Net Margin:
Producer revenues are equal to sheep sales times the price of sheep. The sheep price is calculated from the sheep meat price. The costs of meat marketing (transportation, processing, storage, etc.) in $/kg are subtracted from the sheep meat price received by sheep meat processors (also in $/kg). This price "net of meat marketing costs" is multiplied by the average carcass weight to arrive at the producer price per sheep. Producer costs per sheep are assumed to be a constant value of $/sheep, so total producer costs are equal to sheep numbers times costs per

sheep. A "percent subsidy" variable allows the model to simulate the impact if the government makes a payment to sheep producers equal to a certain percentage of their per sheep costs, that is, reduces sheep producers' costs. (We ignore details about how the government will figure out this cost and make payments to sheep producers). Producer net margin equals producer revenues minus producer costs. The ratio of producer revenues to costs influences future sheep production through an effect on the net birth rate.

<u>Local Feed Resources:</u>
Feed production increases the stock of feed resources and feed consumption by sheep reduces feed consumption. Feed production is equal to feed per unit land times the land area devoted to feed production. Feed per unit land is a base value times a percentage increase due to adoption of a new technology times the proportion of adopters of the new technology. Feed production is also affected by relative rainfall in a linear fashion (that is, a 50% reduction in rainfall is assumed to reduce feed production by 50%). Feed consumption is equal to the number of sheep and the feed consumed per sheep. Feed consumption per sheep depends on feed availability per sheep. If feed availability decreases, feed consumption also decreases (which also then decreases the reproductive performance of the flock, as indicated by the net birth rate).

<u>Proportion of Sheep Producers Adopting New Technology:</u>
The proportion of sheep producers adopting the new technology is assumed to grow over time in an S-shaped growth pattern. The proportion of adopters who ultimately adopt a new technology can be varied to simulate varying perceived attractiveness of the new technology or the effectiveness of technology extension efforts.

Sheep Market Model Exercise

The purpose of this exercise is to examine strategies (policies) to improve the well-being of sheep producers. You will need to decide what an appropriate definition of "well-being" is; any number of outcomes could be used, including, but not limited to: sheep numbers, sheep sales, sheep price, sheep producer revenues, or producer net margin. (Note that this focus on producers would mean that we give little attention to other groups of interest, such as sheep meat processors or consumers). You have four basic policy tools available to you:

1) <u>Support research to increase the productivity of land</u> for local feed resource production. This research is assumed to result in a "new technology" that will increase the amount of feed produced per unit land, therefore increasing the amount of feed available per sheep (which then also increases the birth rate). We ignore the research process in this model, so an analysis of this policy is achieved by assuming a percentage change in the value of feed per land, through the FP Intervention Parameter (which has units of percentage change in land productivity). Note that this has an interaction with the proportion of adopters of the "new technology" because the increases in yields are assumed to take place only through adoption of the new technology. It is initially assumed that 50% of sheep producers will adopt any new technology.

2) <u>Support research to improve the health status</u> of sheep flocks. This research is assumed to result in a "new technology" that will reduce mortality losses (and perhaps shorten the average maturity delay). This will increase the net birth rate shorten the time required to

bring sheep to market. We again ignore the research process in this model, so an analysis of this policy is achieved by assuming a percentage change in the net birth rate, through the Health Intervention Parameter (which has units of percentage change in net birth rate) and(or) a change in the maturity delay time. Note that this has an interaction with the proportion of adopters of the "new technology" because the increases in net birth rate are assumed to take place only through adoption of the new technology. It is initially assumed that 50% of sheep producers will adopt any new technology.

3) Influence the proportion of adopters: For the new technologies described in 1) and 2), there can be different levels of extension efforts to promote the adoption of the new technologies. As a policy maker, you want to understand the extent to which you should devote resources to promoting these new technologies. One way to assess this is to explore how the impacts of the technologies in 1) and 2) are influenced by the proportion of sheep producers who ultimately adopt them. This effect is evaluated in the model by changing the value of the "final adoption proportion" in combination with percentage changes in land productivity or flock health in 1) and 2). Note that changing this parameter only influences the outcomes when the parameters representing the effects of the technologies in 1) and 2) have non-zero values.

4) Provide subsidies to sheep producers to reduce their costs of production. This policy is analyzed by assuming a percentage subsidy (reduction in per sheep costs) through the "Percent Subsidy" variable (which has units of percentage reduction in costs per unit sheep). Note that a *positive* value of a subsidy *reduces* costs (a negative subsidy would be like a tax on sheep producers, increasing their costs). A subsidy has the effect of reducing total producer costs in the short run, which increases their net margin and increases the revenues to costs ratio (which then has an influence on the net birth rate).

In addition, there are three basic characteristics of the sheep production and marketing system that may influence sheep producer well-being. These are:

1) Rainfall, which affects feed production (and therefore feed availability and net birth rate). The parameter RR Pulse Height can be used to modify the amount of rainfall relative to normal, which has an impact on forage production. The value of the RR Pulse Height parameter has units of percentage change in relative rainfall (so a value of -0.50 would be a 50% reduction in rainfall) over a period of 6 months beginning in model time t=12.

2) Demand for sheep meat, which is typically assumed to be growing over time. The parameter "Ramp Increase" allows for an linear increase in the demand for sheep meat starting in period t=10 and reaching a constant higher value in time t=50. A value for this parameter of 0.005, would indicate a 0.5% increase in sheep meat demand per month, or about a 6% increase per year compared to the initial level.

3) The sensitivity of sheep meat sales to price. This parameter indicates how much sales of sheep meat change in respond to changes in the price of sheep meat. Economists would consider this parameter important for determining the ultimate market outcomes in response to the policies mentioned above. The initial value of the parameter is -0.5 (see discussion of the meaning above), but this value is not really known for the sheep meat market in Mexico. One factor to explore is how a larger absolute value (e.g., -2.5 compared to -0.5) influences the outcomes of the policy options above.

The assignment is to explore various changes in the policy parameters and marketing system characteristics to propose a policy to improve sheep producer welfare.

Some suggested initial scenarios to examine:

Increase feed production per unit land 20%, with final adoption proportions of 0.50 and 1.00 and sensitivity of sheep meat sales to sheep meat price values of -0.5 and -2.5;

Set the value of the health intervention parameter equal to 0.20, which would imply a 20% increase in the net birth rate for adopters, for final adoption proportions of 0.50 and 1.00;

Set the value of the subsidy equal to 25% for sensitivity of sheep meat sales to sheep meat price values of -0.5 and -2.5;

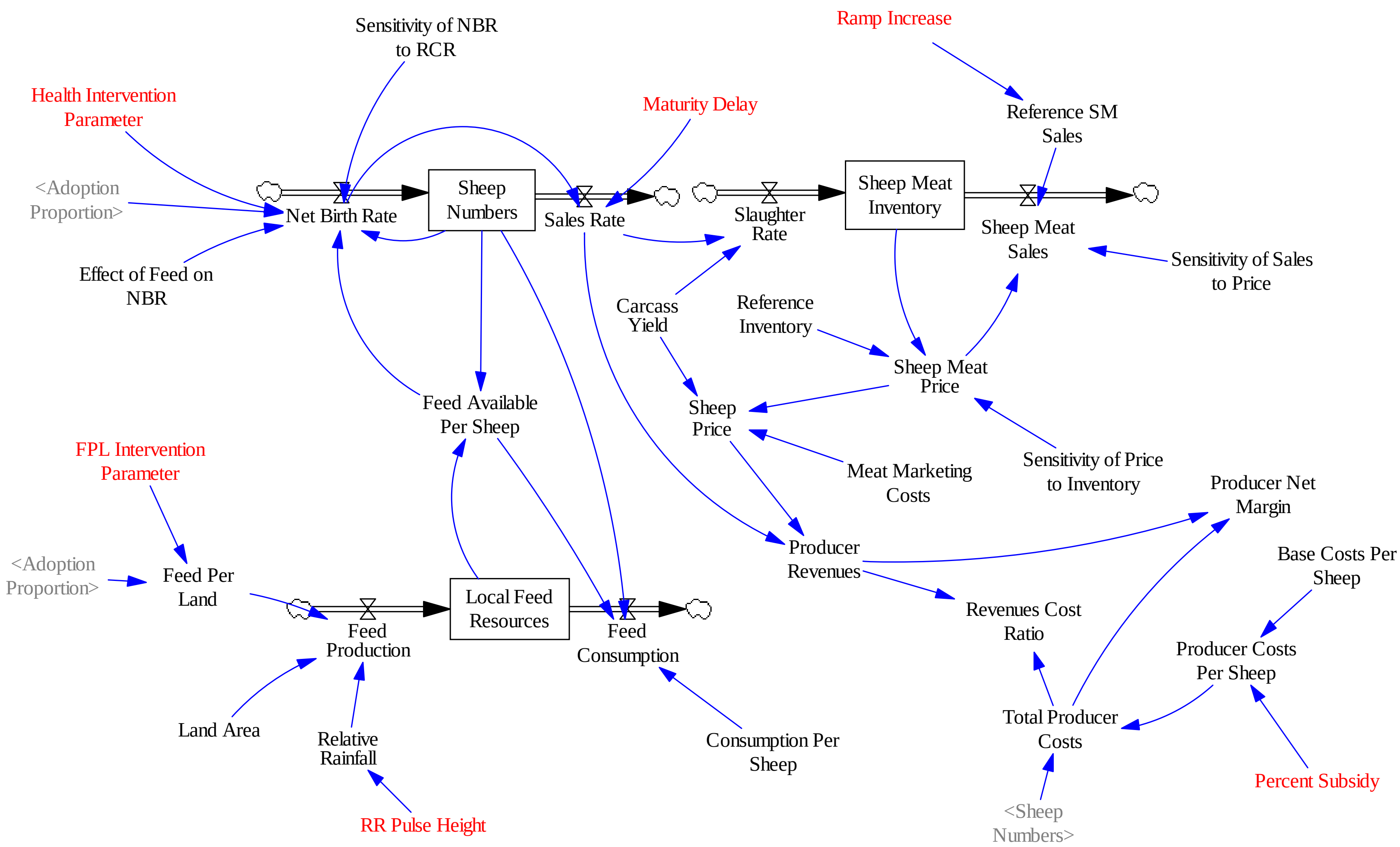
Set the value of the "ramp increase" parameter to 0.005 and 0.001;

Set the value of the RR Pulse Height to -0.75 for sensitivity of sheep meat sales to sheep meat price values of -0.5 and -2.5;

You are encouraged to try as many other scenarios as appropriate to develop policy recommendations.

When you have finished exploring the impacts of the various policy options and system characteristics, prepare a short (5 minute) presentation that summarizes:

1) Your proposed policy and the reasons for it (this should include which variables you looked at to arrive at your policy recommendation)
2) Consideration of important elements that may have been omitted from the model and that may influence the policy recommendations that you have arrived at.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Sheep Meat Sales
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Sensitivity of Sales to Price
Carcass Yield
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Feed Available Per Sheep
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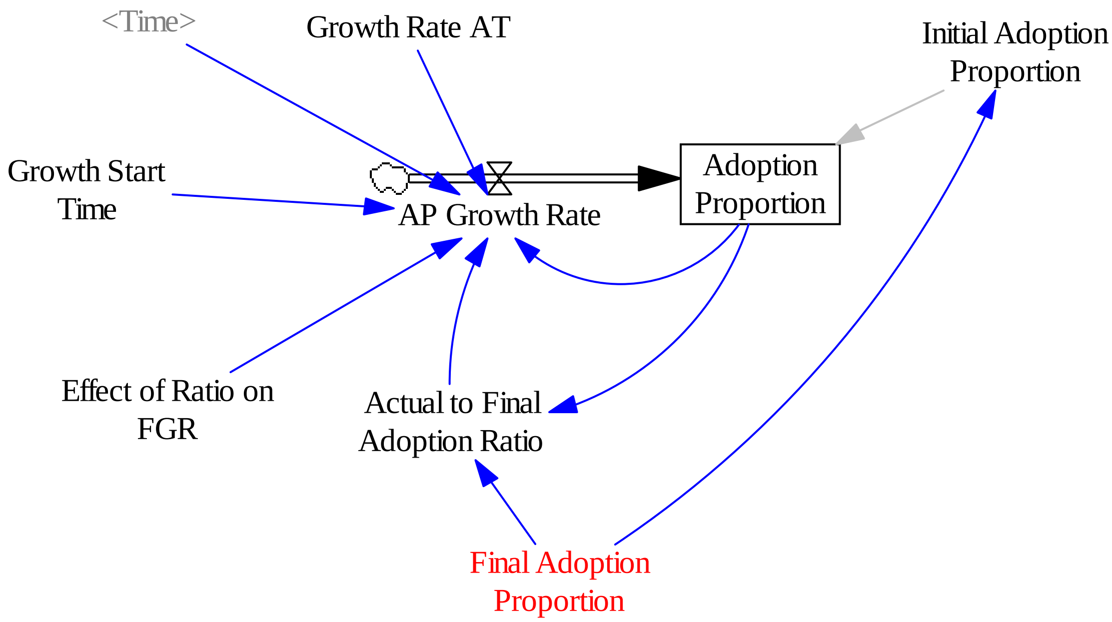
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