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Study of milk production and methane emission in the Bolivian Altiplano (highlands). With use of a simulation model.

Introduction

Purpose

- Personal experience of a research project
- Establish links with the International Potato Centre, Lima for future student project opportunities

Objectives

- Analysis of current nutritional management systems to suggest improvements to increase milk production and therefore profits.
- Comparison of milk production with actual measurements and simulated results.
- Determination of emission of methane from enteric fermentation for animals living under the conditions of the Bolivian Altiplano

Methods

- Comparison of nutrient intake with nutrient requirement.
- Determination of the information necessary for simulating the processes of milk production and methane emission.
- Simulation of milk production and methane emission using the Dairy prototype model of CIP-ILRI (Centero International de la Papa – International Livestock Research Institute).
- Determination of lactation curves for a representative sample of cows from the data for the provinces of Aroma, Omasuyos and Ingavi.
- Comparison of the results of the simulation with the real recorded data.

Results and discussion

All animals within the study were undernourished in terms of their nutrient intake and the modelled requirement of nutrients. Cows at the high altitudes of the Bolivian altiplano have adaptations to their environment and do not fit the models. They are not extremely undernourished, as they are still able to produce milk.
Values for the intakes of feed supplements were ascertained from recorded data. Values for the natural pasture were estimated from records made. This data was extracted for a range of sample cows from each study area and applied to the dairy model prototype. Results are shown in table 1.

Site	Cow	Sim. total milk (lt)	Sim. total methane (lt)	Methane to milk ratio	Costs ($/lt)	Real total milk (lt)
Aroma	A3	1929	88	0.046	1.358	2043.661
Aroma	A4	1777	79	0.044	1.441	1398.447
Aroma	A37	2043	78	0.038	1.318	1713.305
Aroma	A49	1726	91	0.053	1.457	1447.921
Aroma	A82	2246	115	0.052	1.529	1679.698
Aroma	A86	2197	111	0.051	1.521	1712.397
Ingavi	I2	1645	70	0.043	1.368	694.927
Ingavi	I3	1763	76	0.043	1.326	1059.692
Ingavi	I43	1647	72	0.044	1.317	600.997
Ingavi	I61	2140	77	0.036	1.289	1284.17
Ingavi	I98	1704	70	0.041	1.244	1058.452
Ingavi	I103	1692	67	0.040	1.216	805.899
Omasoyus	O1	1947	95	0.049	1.501	2481.387
Omasoyus	O19	1803	87	0.048	1.464	1192.913
Omasoyus	O28	1753	92	0.052	1.663	1915.104
Omasoyus	O58	1224	66	0.054	1.634	695.934
Omasoyus	O63	1964	104	0.053	1.620	2410.404
Omasoyus	O117	1820	83	0.046	1.303	750.779

Table 1. Outputs and costs for individual cows

Real milk production plotted against simulated milk production is shown in figure 1. Results show that the relationship between the two is not isometric. The model produces a smaller range of outputs. The real data has a larger range with more lower and higher values.

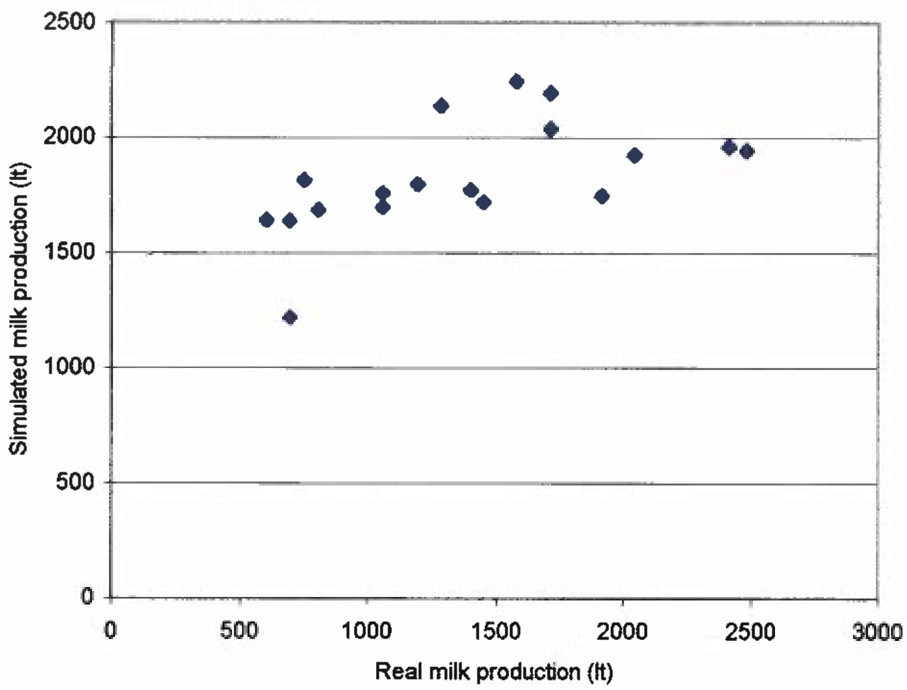

Figure 1. Comparison of real and simulated milk production (lt)

Lactation curves drawn for each of the study areas are shown in figures 2,3 and 4.
Lactation curves for the real data were calculated using the wood equation $Y_t = At^B e^{-Ct}$
where Y_t = production of milk on day t (kg/day)

t = period of lactation
A = positive scalar directly related to total milk production
B = index of the animal's capacity to utilise energy for milk production
C = decay rate

Lactation curves for both the real and the simulated milk production are shown for the average of the sample cows from the area.

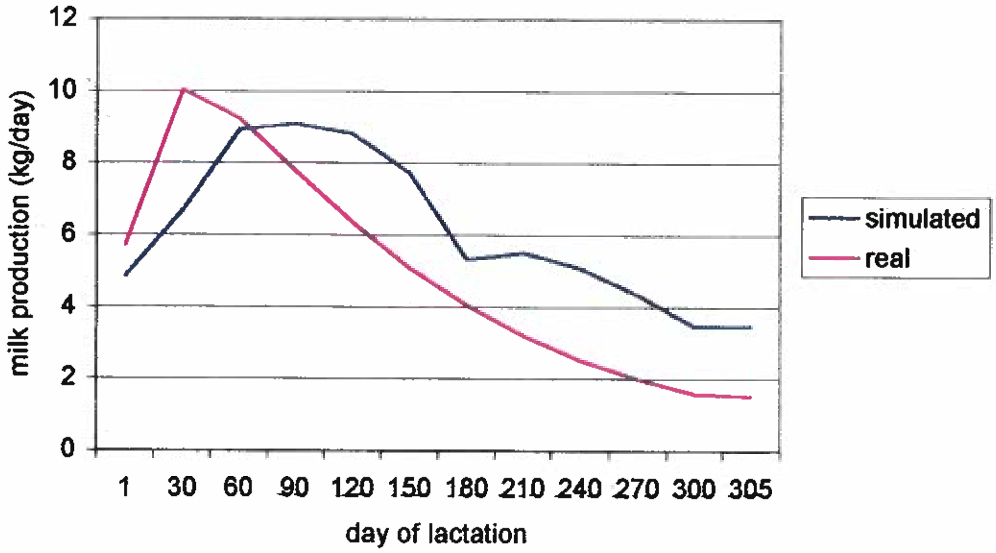

Figure 2.Lactation curve – real and simulated - Aroma

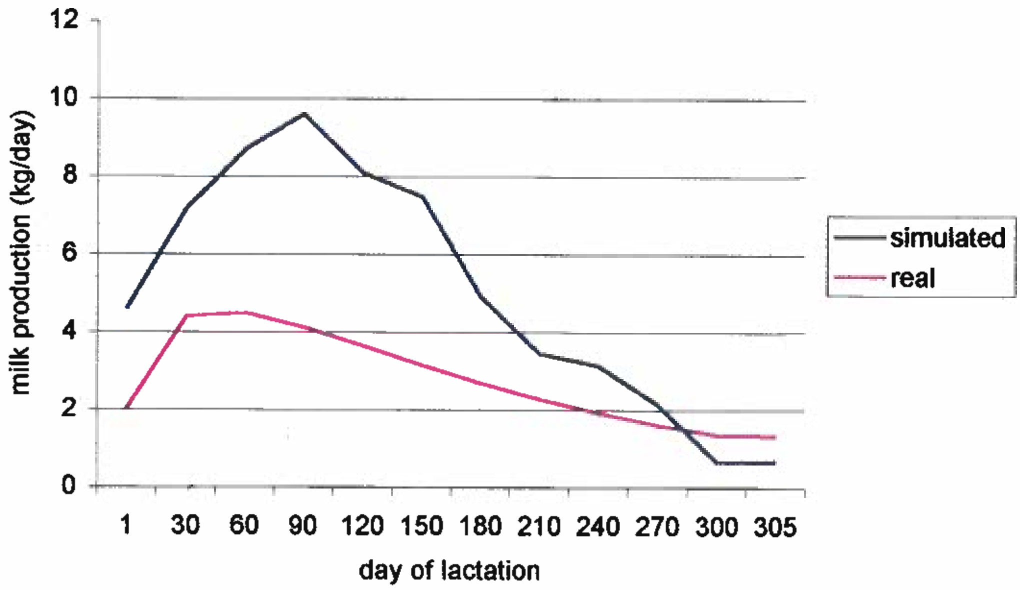

Figure 3. Lactation curve – real and simulated – Ingavi

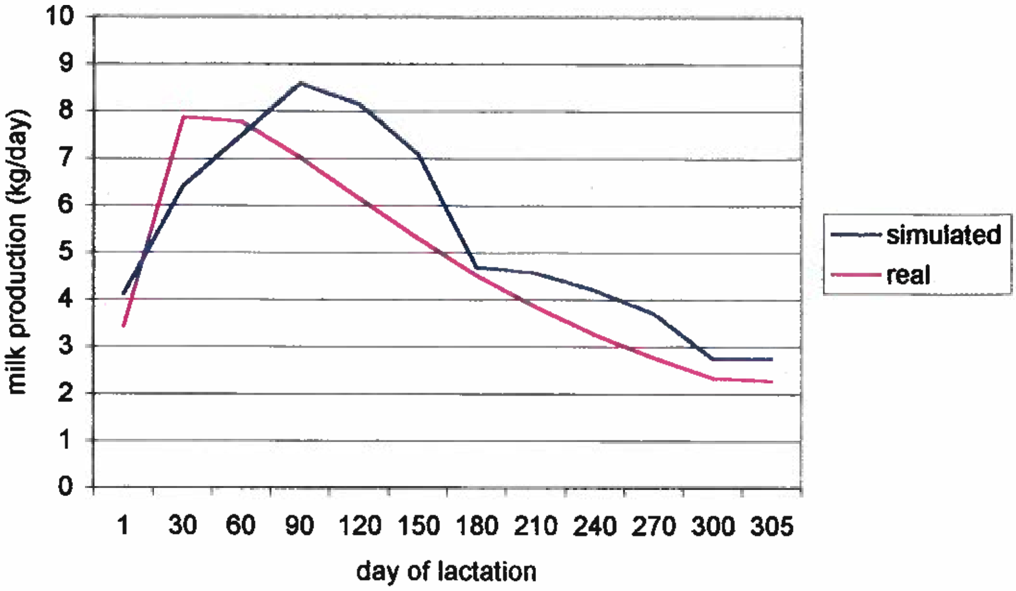

Figure 4. Lactation curve – real and simulated - Omasuyos

Feeds used differ in the study areas chosen. Details of the feeds used throughout the year are given in table 2. Feeds in the table are supplements given in addition to grazing on natural pastures.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cebada verde	A	AI	AIO	AI	AI		I	I	AI	I		
Alfalfa verde		I	AI	AI								
Heno cebada	I	I		A	I	AI	AI	AI	AI	AI	AI	AI
Ichu								A	A	A	A	A
Afrecho	O	IO	O	O		O	IO	AIO	IO	AIO	AIO	IO
Heno avena	AO		O		IO	AIO	AIO	AIO	IO	AIO	AO	AIO
Heno alfalfa				A		I	A		A	A		
Totora	O	O							O	O	AO	O
Avena verde	O	O	IO	O	IO				I			
Balanceado										I		
Residuos	I											
Sal min							I					
P-cat								O				
Rast cult			O	O								
B-haba						O	O	O	O			
Zanahoria			O				O	O				
Borra							O	O		O		

Table 2. Feed supplements given to cows throughout the year. A=Aroma, I=Ingavi, O=Omasoyus

Conclusions

Costs per litre of milk were lowest in the Ingavi region at $1.293. Highest costs were in Omasoyus at $1.531 per litre and Aroma was in between at $1.437 per litre. This data is based upon the simulated milk production. Recommendations would be to use the feeding regime of the Ingavi area. Although milk production in this area was low the costs were measured per litre of milk so would scale up accordingly.
The results of the comparison of real and simulated milk production suggest that more accurate estimates of the nutritional content of the natural pasture need to be made. There was very little variation between the values for the simulated milk

production of the sample cows where there was a greater variation in the real milk production. Inputs to the model were a standard estimate of nutrient content for each area. More accurate estimates using analysis of material from the specific areas would give a more accurate model output. These alterations to the input data to the model may also change the outputs in terms of costs. Recommendations to change feeding regimes would be more reliable from a more accurate use of the model.
Lactation curves for the sample cows also showed discrepancies between the real and simulated data. These differences are also likely to be due to the input data of the model. Curves for Aroma and Omasoyus were the most closely matched. The lactation curve for simulated milk production was much higher than that for real milk production. These differences can also be explained by the accuracy of the input data.
The model calculated enteric methane production. There was no calculation of real methane production so no comparison could be undertaken. Indications of accuracy of the milk outputs of the model could be applied to the methane outputs.
The processes of the dairy model are reliable but the inputs must be accurate to make any assumptions or recommendations from the results.

Acknowledgements

Financial assistance: Weir fund for field studies - £500
James Rennie Bequest - £300

Personal assistance:
Dr. Neil Jessop and Dr. Mario Herrero for organising the project opportunity.
Abel Rojas – for use of his database, collected towards his PhD work.
Erik Murillo – for use of the dairy model prototype.
Dr. Roberto Quiroz, Dr. Carlos Leon-Verlade and the natural resource management and modelling department of the International Potato Centre for their help and support in the duration of my time in Peru. Thanks also for their provision of accommodation and their extensive efforts to speak in English to me.

Appendix

Time spent:
Weeks 1, 2 and 3 – Familiarisation with the milk production database, analysis of nutrient intake and requirements.
Weeks 4 and 5 – Sweet potato project statistical analysis. Selection of dual purpose clones for feeding of livestock and production of commercial roots.
Weeks 6 and 7 – Application of the Wofost crop simulation model to an excel spreadsheet for use by the department.
Week 8 – Familiarisation with the dairy model. Help with the translation from Spanish for the English version of the model.
Weeks 9 and 10 – Determination of data necessary for running of the model for a range of sample cows from the study areas. Application of data to the model and analysis of results. Initial feedback with Erik on the dairy model.