

**A PHYSICAL AND ECONOMIC EVALUATION**  
**OF ARGENTINA'S BEEF PRODUCTION SYSTEMS**



**Carlos Manuel Méndez Acosta  
Martín Fraguío**

**UNIVERSIDAD CATÓLICA ARGENTINA  
Facultad de Ciencias Agrarias  
Freire 183  
1426-Buenos Aires-Argentina  
Phone: 54 11 4553-5235  
e-mail address: cmanuelma@ciudad.com.ar**



**M<sup>a</sup> Isabel Alonso Magdaleno**

**UNIVERSIDAD DE OVIEDO  
Facultad de Ciencias Económicas y Empresariales  
Avda. del Cristo, s/n  
33071-Oviedo-España  
Phone: +34 985 10 36 99  
e-mail address: ialonso@econo.uniovi.es**

# ABSTRACT

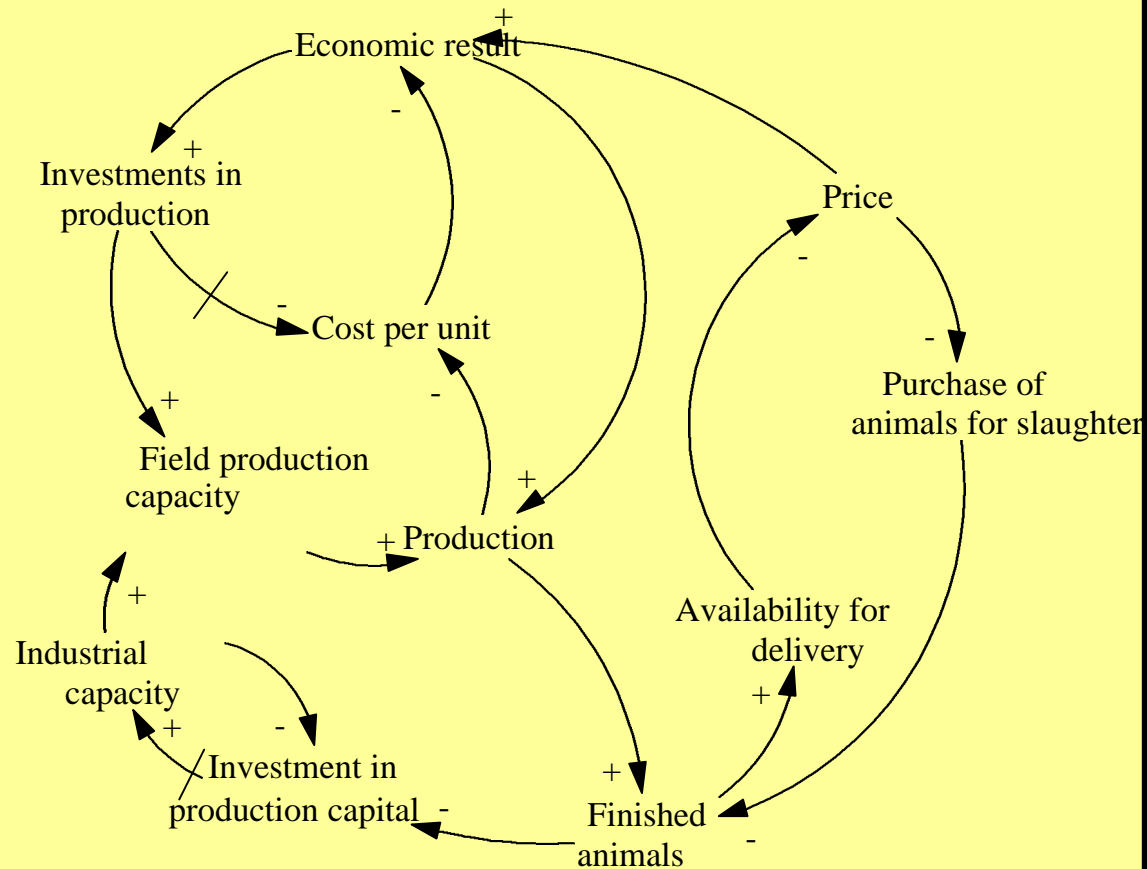
This research studies the physical, economic and financial results obtained by the application of an array of technical methods on the beef production system under grazing conditions generally applied in the “wet argentine pampa”. A simulation model of a ranch was developed to represent the responses to the use of different technological packages. Systems Dynamics is the tool employed in this study.

The Argentine beef production system under grazing conditions is integrated by two subsystems: the first is the cow-calf operation and the second is the fattening of calves after weaning. One of the most important figures of the first subsystem is the variable which reflects the number of animals per unit of surface, or carrying capacity. Carrying capacity, feedstuffs quality and ranch management practices—for example: the employment of compensatory growth—are the most important aspects of the second subsystem. The beef production system was simulated employing these variables (carrying capacity, the quality of diet, compensatory growth) as management tools. It also considered the economic and physical answers reached by modifying them.

The response to changes of the variables above mentioned variables has been observed on the economic result (\$), return on capital (%), gross margin (\$/Ha), beef production (Kg/Ha) and forage requirements (cow equivalent/Ha). These results confirm the figures mentioned in the bibliography of reference to this subject.

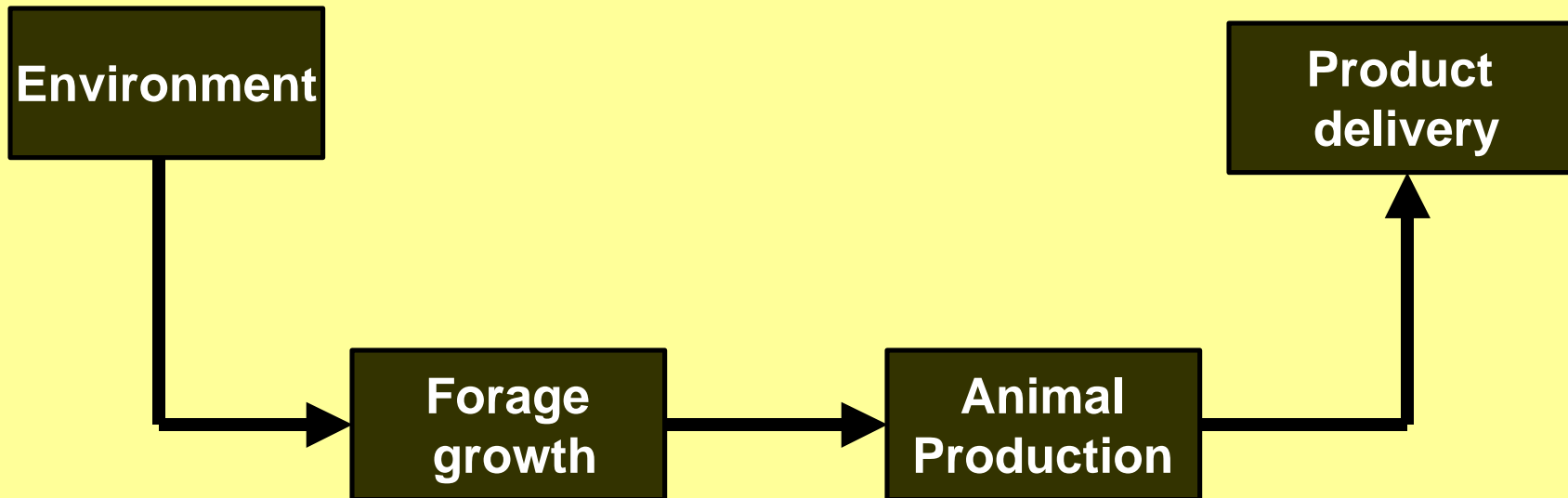
This study has done a sensibility analysis and a risk evaluation to measure the economical support of the thesis. Also, it was useful to analyse different strategies in the beef production system.

# DESIGN OF THE MODEL



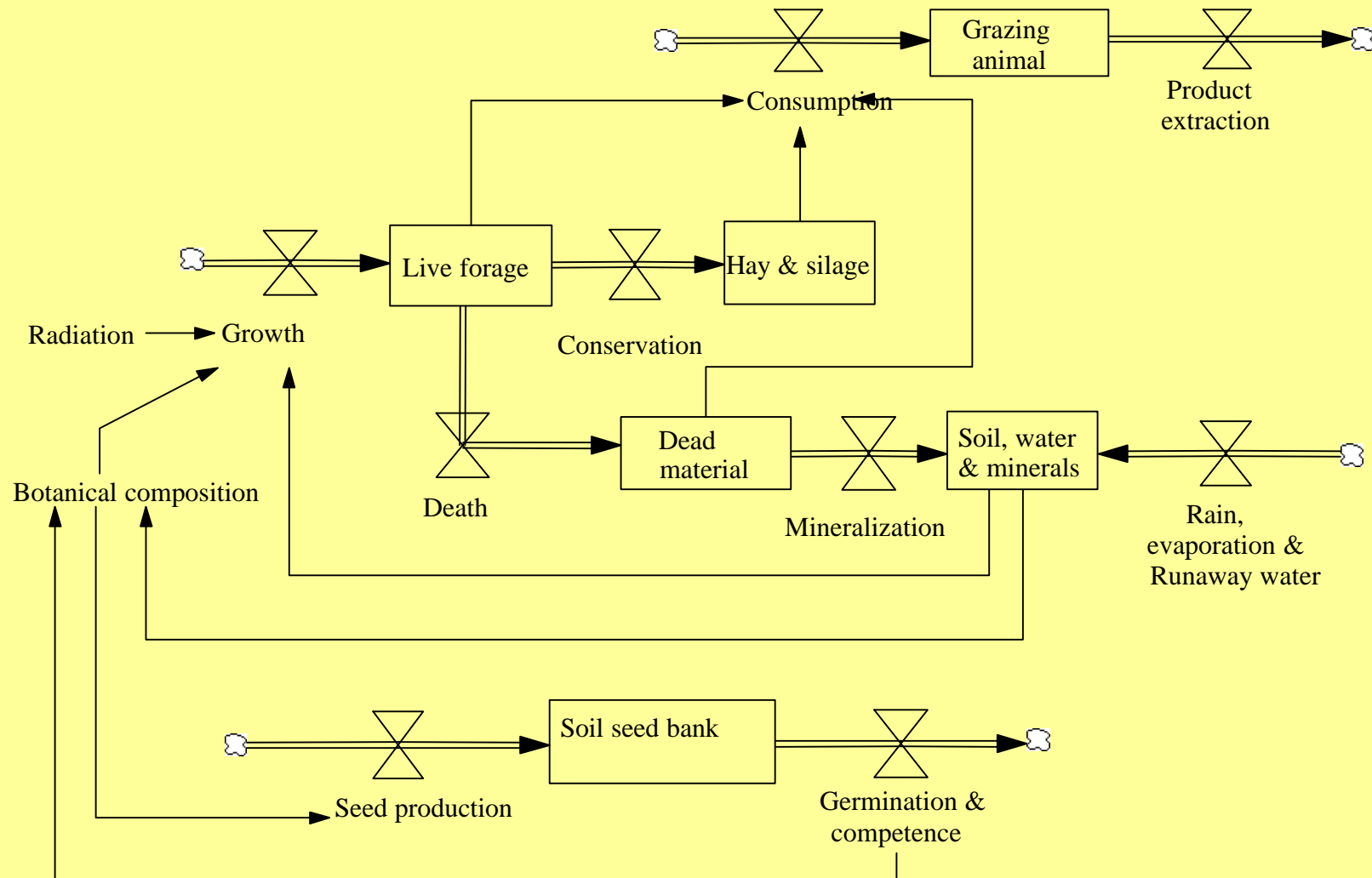
## CAUSAL DIAGRAM

## DESIGN OF THE MODELO



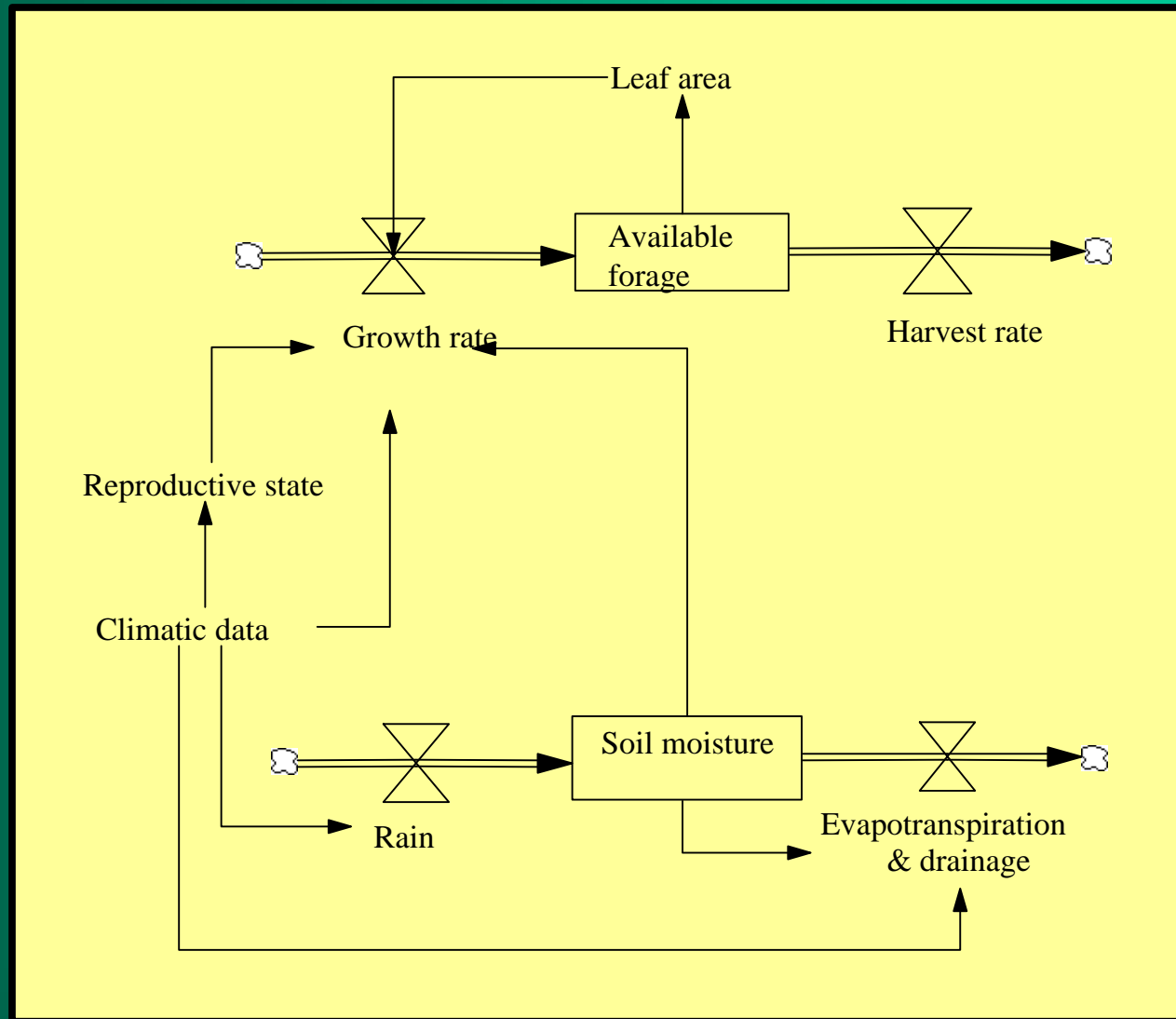
BIOLOGICAL COMPONENTS IN GRAZING SYSTEMS

# DESIGN OF THE MODEL



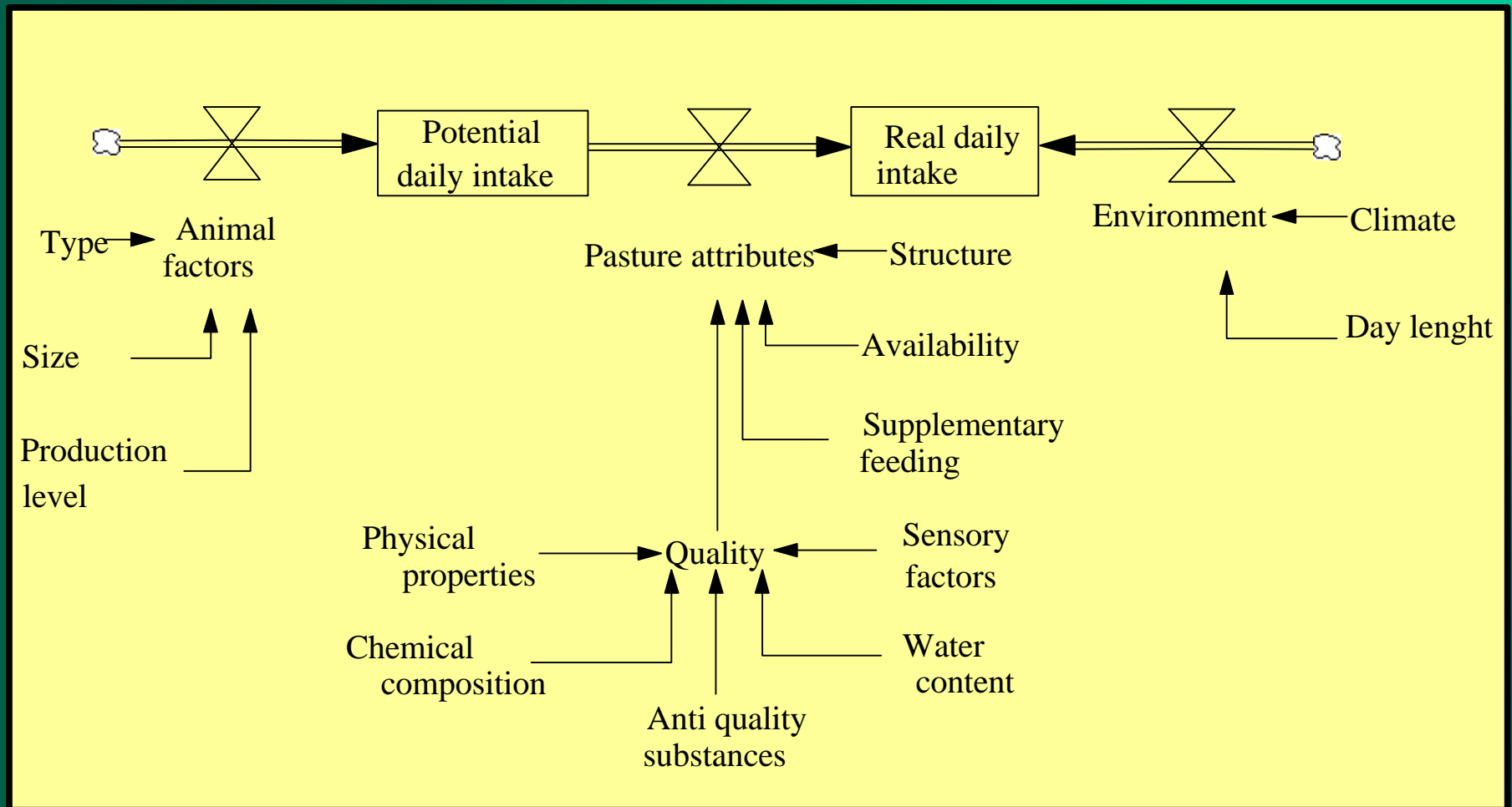
## FLUX DIAGRAMS : BIOLOGICAL COMPONENTS

# DESIGN OF THE MODEL



FLUX DIAGRAM: GROWTH RATE AND FORAGE AVAILABILITY

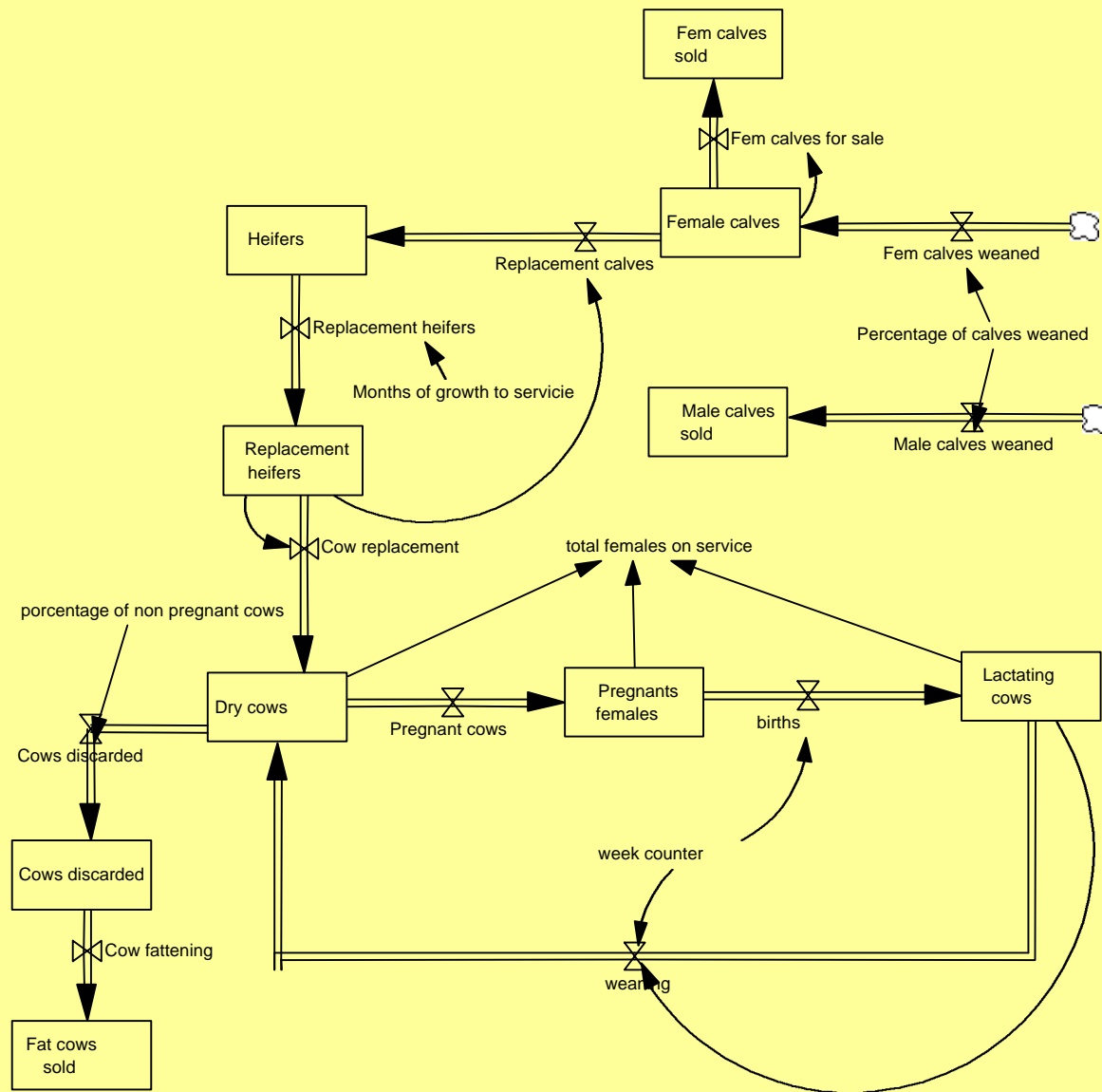
# DESIGN OF THE MODEL



## FLUX DIAGRAM: INTAKE OF THE GRAZING ANIMAL

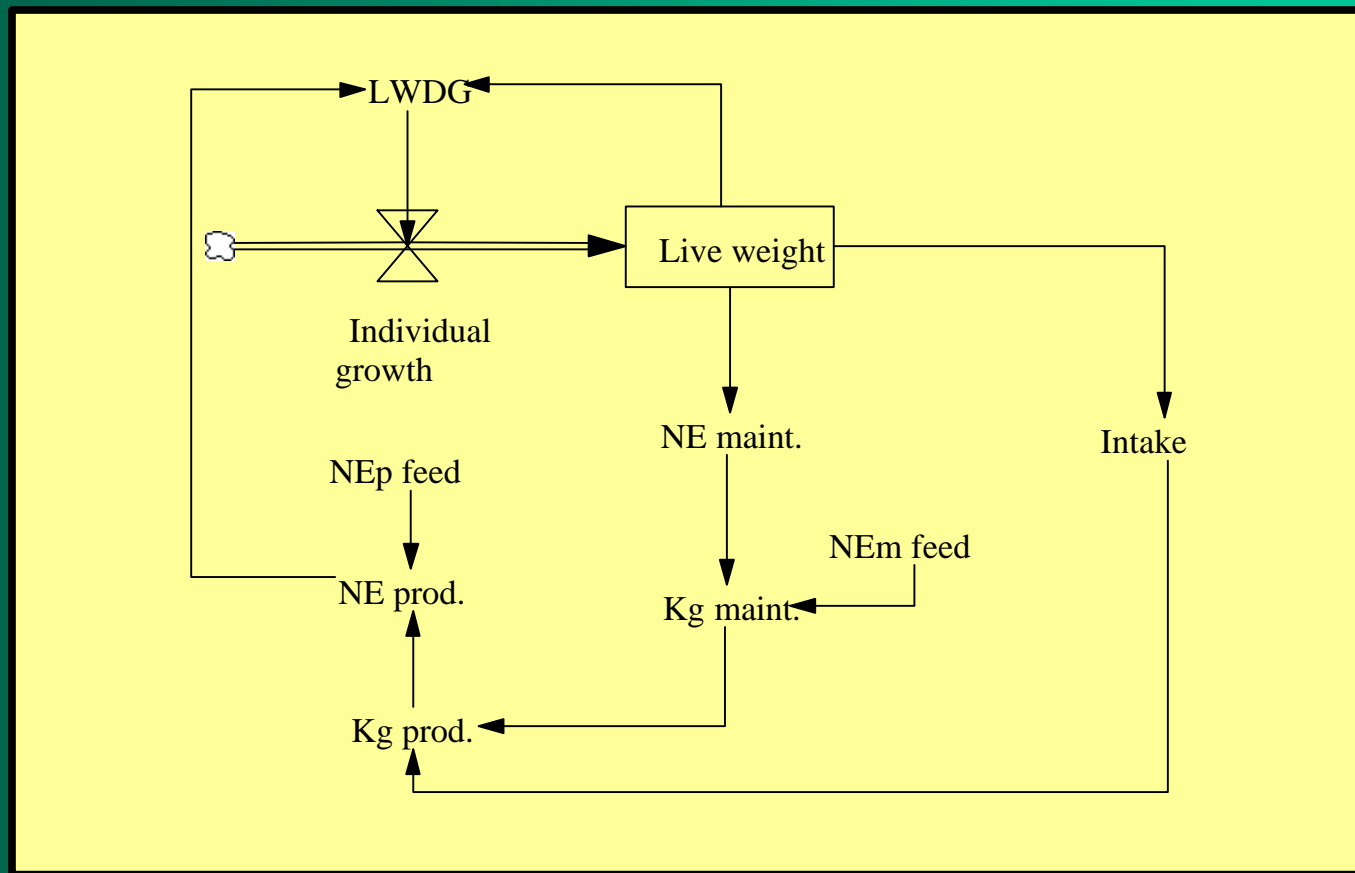


# DESIGN OF THE MODEL






FLUX DIAGRAMS: EVOLUTION OF HEAD COUNT IN A COW CALF OPERATION

# DESIGN OF THE MODEL



## FLUX DIAGRAMS: INDIVIDUAL BEEF PRODUCTION




# RESULTS OBTAINED

11:49 AM Thu, Feb 22, 2001 Table 17: p5 (Untitled Table) ?   

Weeks	1 Intake	2 Intake	3 Intake	4 Intake	5 Intake	6 Intake	7 Intake	8 Intake	9 Intake	10 Intake
.0000	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
4.0000	6.49	6.54	6.58	6.62	6.66	6.70	6.73	6.77	6.80	6.84
8.0000	7.00	7.09	7.17	7.25	7.32	7.40	7.47	7.53	7.60	7.67
12.0000	7.52	7.64	7.76	7.88	7.99	8.09	8.20	8.30	8.39	8.48
16.0000	8.04	8.21	8.36	8.51	8.66	8.79	8.93	9.05	9.18	9.30
20.0000	8.58	8.78	8.97	9.15	9.33	9.50	9.66	9.81	9.96	10.10
24.0000	9.12	9.36	9.58	9.80	10.00	10.20	10.39	10.57	10.74	10.91
28.0000	9.64	9.92	10.18	10.43	10.66	10.89	11.10	11.31	11.51	11.70
32.0000	10.18	10.49	10.79	11.06	11.33	11.58	11.82	12.05	12.27	12.49
36.0000	10.73	11.08	11.40	11.71	12.00	12.28	12.54	12.80	13.04	13.28
40.0000	11.31	11.69	12.04	12.37	12.69	12.99	13.28	13.56	13.82	14.08
44.0000	11.90	12.31	12.69	13.05	13.39	13.72	14.03	14.33	14.61	14.89
48.0000	12.51	12.94	13.35	13.74	14.10	14.45	14.78	15.10	15.40	15.70
Final	13.12	13.59	14.02	14.43	14.82	15.18	15.54	15.87	16.20	16.51

## VARIATION IN GRAZING VOLUNTARY INTAKE

# RESULTS OBTAINED

11:49 AM Thu, Feb 22, 2001 Table 17: p2 (Untitled Table) ?   

Weeks	1 LWDG	2 LWDG	3 LWDG	4 LWDG	5 LWDG	6 LWDG	7 LWDG	8 LWDG	9 LWDG	10 LWDG	
.0000	0.58	0.63	0.69	0.74	0.78	0.83	0.88	0.92	0.96	1.01	
4.0000	0.60	0.65	0.70	0.74	0.79	0.83	0.87	0.91	0.95	0.99	
8.0000	0.61	0.66	0.70	0.75	0.79	0.83	0.87	0.91	0.94	0.98	
12.0000	0.62	0.67	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	
16.0000	0.63	0.68	0.72	0.76	0.80	0.83	0.87	0.90	0.93	0.96	
20.0000	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.90	0.93	0.96	
24.0000	0.62	0.66	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	
28.0000	0.64	0.68	0.72	0.76	0.79	0.82	0.85	0.88	0.91	0.94	
32.0000	0.65	0.69	0.73	0.76	0.80	0.83	0.86	0.89	0.92	0.94	
36.0000	0.68	0.71	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.95	
40.0000	0.70	0.74	0.77	0.80	0.83	0.86	0.89	0.91	0.94	0.96	
44.0000	0.71	0.75	0.78	0.81	0.84	0.87	0.89	0.92	0.94	0.96	
48.0000	0.73	0.76	0.79	0.82	0.85	0.87	0.90	0.92	0.94	0.96	
Final	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.92	0.95	0.97	

LIVE WEIGHT DAILY GAIN (LWDG) VARIATION



# RESULTS OBTAINED

11:49 AM Thu, Feb 22, 2001 Table 17: p1 (Untitled Table) ?

Weeks	1: Live weight	2: Live weight	3: Live weight	4: Live weight	5: Live weight	6: Live weight	7: Live weight	8: Live weight	9: Live weight	10: Live weight
.0000	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
4.0000	216.45	217.92	219.33	220.69	222.00	223.26	224.49	225.68	226.83	227.95
8.0000	233.33	236.20	238.94	241.57	244.10	246.53	248.89	251.17	253.37	255.52
12.0000	250.56	254.77	258.78	262.61	266.29	269.83	273.24	276.53	279.72	282.81
16.0000	268.08	273.58	278.81	283.79	288.56	293.14	297.55	301.80	305.91	309.89
20.0000	285.91	292.65	299.05	305.13	310.95	316.52	321.87	327.03	332.01	336.82
24.0000	303.98	311.93	319.45	326.59	333.40	339.93	346.18	352.20	358.01	363.62
28.0000	321.49	330.68	339.34	347.56	355.38	362.86	370.02	376.91	383.54	389.94
32.0000	339.43	349.79	359.55	368.79	377.58	385.96	393.99	401.70	409.12	416.28
36.0000	357.80	369.30	380.11	390.33	400.03	409.28	418.14	426.63	434.80	442.68
40.0000	376.95	389.51	401.30	412.44	423.00	433.07	442.69	451.92	460.79	469.35
44.0000	396.77	410.33	423.05	435.05	446.42	457.26	467.61	477.53	487.06	496.25
48.0000	416.95	431.46	445.07	457.90	470.05	481.62	492.67	503.26	513.43	523.23
Final	437.41	452.86	467.32	480.95	493.86	506.14	517.86	529.09	539.88	550.27

## LIVE WEIGHT VARIATION

# RESULTS OBTAINED

11:49 AM Thu, Feb 22, 2001 Table 17: p4 (Untitled Table) ?  

Weeks	1: ENm racion	2: ENm racion	3: ENm racion	4: ENm racion	5: ENm racion	6: ENm racion	7: ENm racion	8: ENm racion	9: ENm racion	10: ENm racion
.0000	1.42	1.50	1.59	1.67	1.76	1.84	1.93	2.02	2.10	2.19
4.0000	1.42	1.49	1.57	1.65	1.72	1.80	1.87	1.95	2.02	2.09
8.0000	1.41	1.49	1.56	1.63	1.69	1.76	1.83	1.89	1.96	2.02
12.0000	1.41	1.48	1.54	1.61	1.67	1.73	1.79	1.85	1.90	1.96
16.0000	1.41	1.47	1.53	1.59	1.65	1.70	1.75	1.81	1.86	1.91
20.0000	1.41	1.46	1.52	1.58	1.63	1.68	1.73	1.78	1.82	1.87
24.0000	1.34	1.40	1.45	1.51	1.56	1.61	1.66	1.70	1.75	1.79
28.0000	1.35	1.40	1.45	1.50	1.55	1.60	1.64	1.69	1.73	1.77
32.0000	1.35	1.40	1.45	1.50	1.54	1.59	1.63	1.67	1.71	1.74
36.0000	1.38	1.43	1.48	1.52	1.56	1.60	1.64	1.67	1.71	1.74
40.0000	1.41	1.45	1.50	1.53	1.57	1.61	1.64	1.68	1.71	1.74
44.0000	1.41	1.46	1.49	1.53	1.57	1.60	1.63	1.66	1.69	1.72
48.0000	1.42	1.45	1.49	1.53	1.56	1.59	1.62	1.65	1.68	1.70
Final	1.42	1.45	1.49	1.52	1.55	1.58	1.61	1.64	1.66	1.69

VARIATION OF ENERGETIC CONCENTRATION IN THE DIET (Net energy for maintenance)

# RESULTS OBTAINED

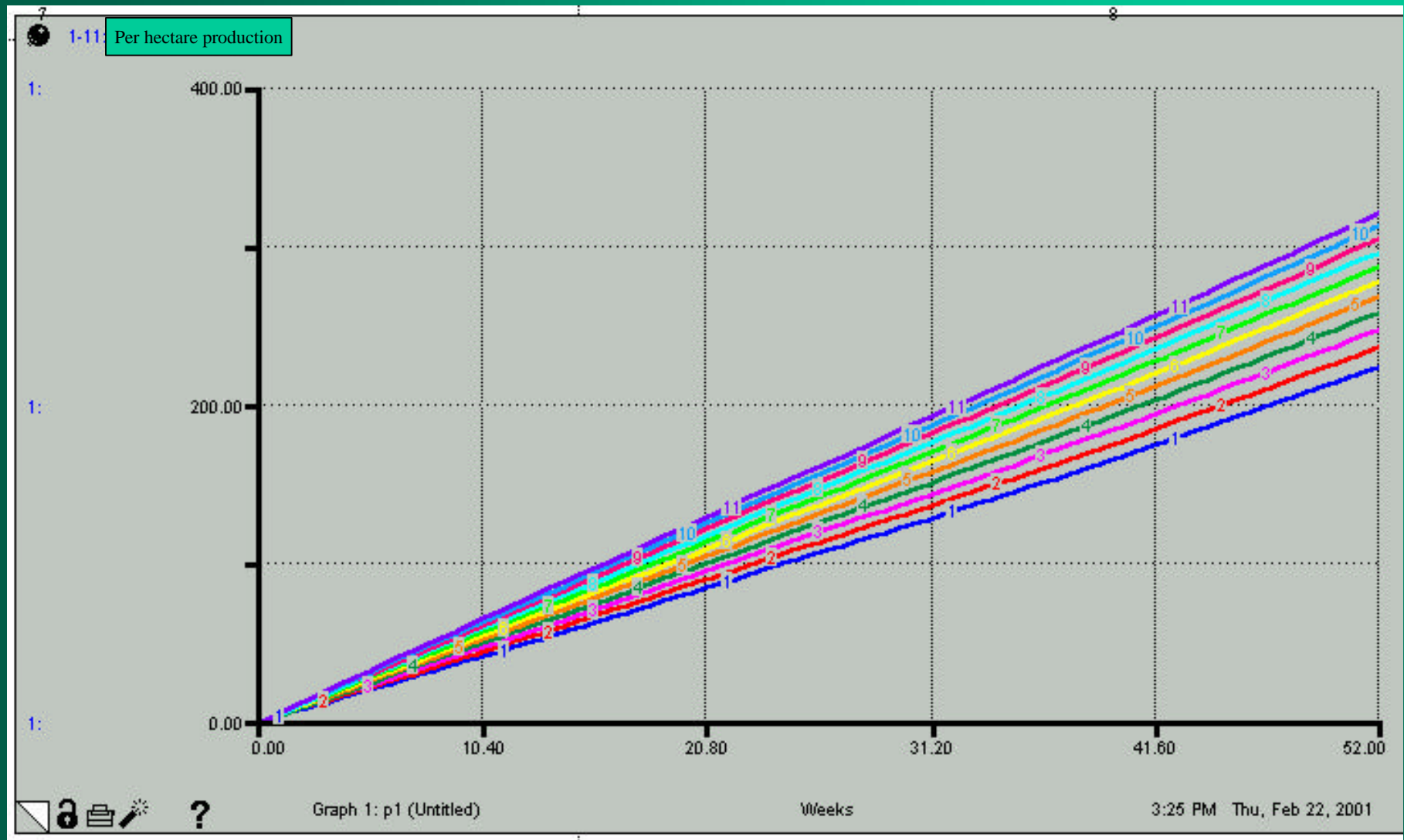
11:49 AM Thu, Feb 22, 2001 Table 17: p3 (Untitled Table) ? [Icons]

Weeks	1: ENp racion	2: ENp racion	3: ENp racion	4: ENp racion	5: ENp racion	6: ENp racion	7: ENp racion	8: ENp racion	9: ENp racion	10: ENp racion
.0000	0.92	0.99	1.06	1.14	1.21	1.28	1.36	1.43	1.50	1.58
4.0000	0.92	0.98	1.05	1.11	1.18	1.24	1.31	1.37	1.43	1.50
8.0000	0.91	0.98	1.04	1.10	1.15	1.21	1.27	1.32	1.38	1.43
12.0000	0.91	0.97	1.02	1.08	1.13	1.18	1.23	1.28	1.33	1.38
16.0000	0.91	0.96	1.01	1.06	1.11	1.16	1.21	1.25	1.29	1.34
20.0000	0.91	0.96	1.01	1.05	1.10	1.14	1.18	1.22	1.26	1.30
24.0000	0.87	0.92	0.97	1.01	1.05	1.10	1.14	1.18	1.21	1.25
28.0000	0.87	0.92	0.96	1.01	1.05	1.08	1.12	1.16	1.19	1.23
32.0000	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21
36.0000	0.89	0.93	0.97	1.01	1.04	1.08	1.11	1.14	1.17	1.20
40.0000	0.91	0.95	0.98	1.02	1.05	1.08	1.11	1.14	1.17	1.19
44.0000	0.91	0.95	0.98	1.01	1.04	1.07	1.10	1.13	1.15	1.18
48.0000	0.92	0.95	0.98	1.01	1.04	1.07	1.09	1.12	1.14	1.16
Final	0.92	0.95	0.98	1.01	1.03	1.06	1.08	1.11	1.13	1.15

VARIATION OF ENERGETIC CONCENTRATION OF THE DIET (Net energy for weight gain)



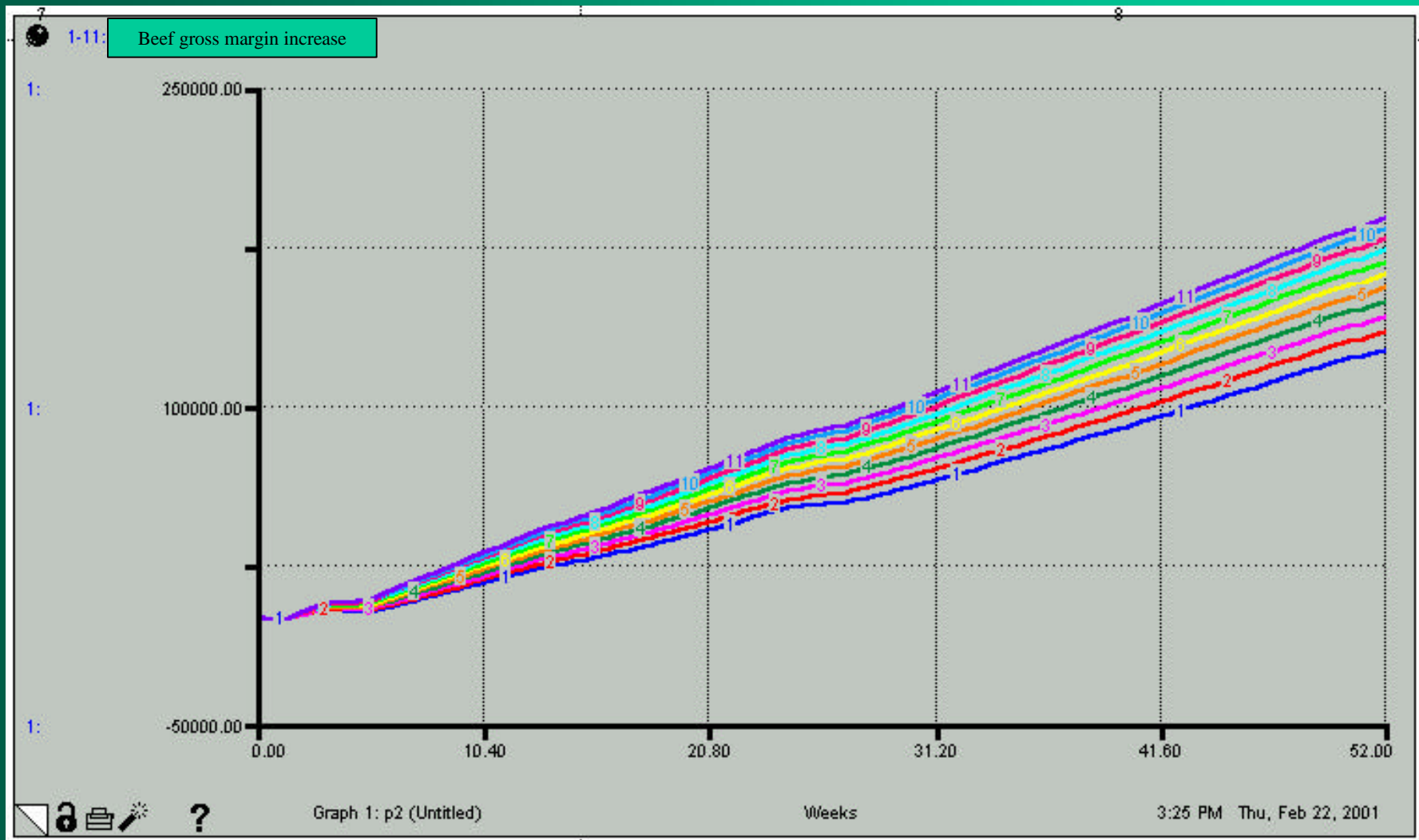
# RESULTS OBTAINED



TOTAL BEEF PRODUCTION VARIATION AS CORN SUPPLEMENTATION INCREASES



# RESULTS OBTAINED



BEEF GROSS MARGIN VARIATION AS CORN SUPPLEMENTATION INCREASE

# RESULTS OBTAINED

12:08 PM Thu, Feb 22, 2001 Table 17: p6 (Untitled Table)

Weeks	1: Cow Eq Carry capacity	2: Cow Eq Carry capacity	3: Cow Eq Carry capacity	4: Cow Eq Carry capacity	5: Cow Eq Carry capacity	
.0000	584.94	389.94	197.94	132.94	132.94	
4.0000	584.94	389.94	197.94	132.94	132.94	
8.0000	682.44	438.69	246.69	165.44	165.44	
12.0000	1,039.94	617.44	425.44	284.61	284.61	
16.0000	1,089.44	618.19	474.19	317.11	317.11	
20.0000	967.94	545.44	425.44	284.61	284.61	
24.0000	930.44	605.44	605.44	497.11	219.61	
28.0000	1,060.44	670.44	670.44	540.44	262.94	
32.0000	1,157.94	719.19	719.19	572.94	295.44	
36.0000	987.94	532.94	532.94	381.27	306.27	
40.0000	893.69	544.32	352.32	235.86	235.86	
44.0000	682.44	438.69	246.69	165.44	165.44	
48.0000	617.44	406.19	214.19	143.77	143.77	
Final	584.94	389.94	197.94	132.94	132.94	

VARIATION OF HERD REQUIREMENTS AS SEASONS GROW UNFAVORABLE

# RESULTS OBTAINED

12:08 PM Thu, Feb 22, 2001 Table 17: p7 (Untitled Table)

Weeks	1: Cow Eq Requirements	2: Cow Eq Requirements	3: Cow Eq Requirements	4: Cow Eq Requirements	5: Cow Eq Requirements	
.0000	676.62	677.06	577.74	577.74	577.74	
4.0000	713.18	713.80	592.39	592.32	592.32	
8.0000	750.03	750.80	606.99	606.88	606.88	
12.0000	787.02	787.84	665.63	621.52	621.52	
16.0000	824.40	825.15	687.66	636.02	636.02	
20.0000	862.35	863.13	709.65	650.41	650.41	
24.0000	892.60	888.83	810.79	791.34	664.63	
28.0000	930.81	926.43	847.44	827.30	679.06	
32.0000	969.22	964.20	884.33	863.51	693.44	
36.0000	1,012.29	1,008.71	927.02	906.12	707.77	
40.0000	1,056.83	1,056.75	857.24	772.69	721.84	
44.0000	1,098.12	1,098.41	803.18	786.34	735.61	
48.0000	1,139.60	1,140.16	817.25	800.20	749.51	
Final	1,181.40	1,182.23	831.40	814.15	763.47	

VARIATION OF HERD REQUIREMENTS AS SEASONS GROW UNFAVORABLE

# CONCLUSIONS

**Non linear relations**

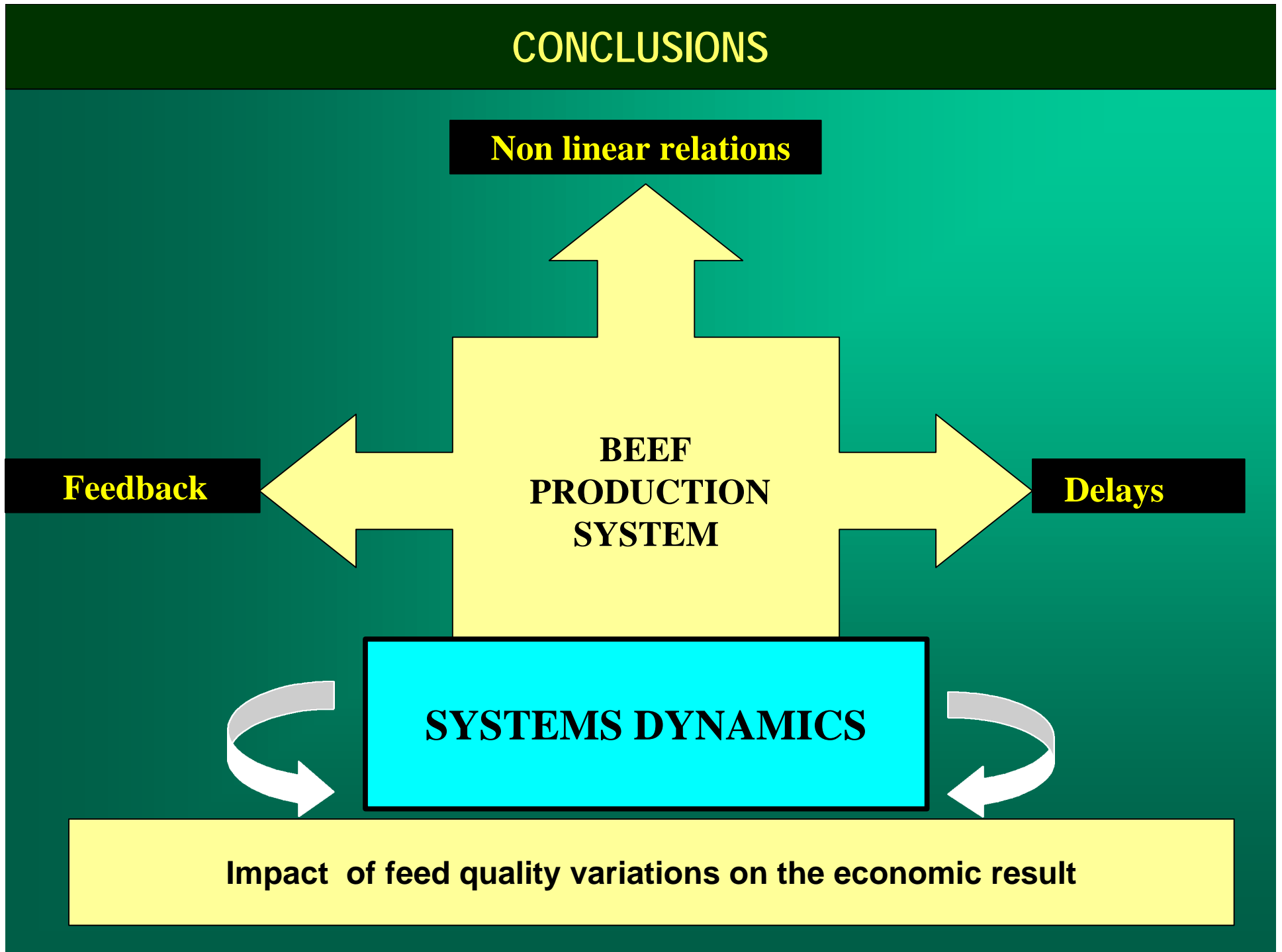
**BEEF  
PRODUCTION  
SYSTEM**

**Feedback**

**Delays**

**SYSTEMS DYNAMICS**

**Impact of feed quality variations on the economic result**



# CONCLUSIONS

Systems dynamics is a methodology that simplifies the analysis of complex systems in which a large number of interrelations between variables is found, and in which intuition is not sufficient or trustworthy in the decision taking process.

The use of this methodology permits a clear visualization of the cause: effect relationships that are hard to explain and weren't previously noted.

The results obtained in the simulation do not differ with other methods in the calculi employed. The advantages found by the use of Systems Dynamics are two: on one side the transparency of the formulas and equations employed, wich facilitates enormously the communication. On the other side the comprehension achieved thru the flux diagrams. Both factors add significant value to team work.

It is possible to extend this methodology to other environments, finding that it is an extraordinary tool in production strategy analysis, simplifying the comprehension of the system. As an example the model proves that a modification of the quality of the diet modifies the economic result.

# BIBLIOGRAPHY

- AROSTEGUY, J.C., BRAVO, B.F., FUJITA, H.O. Y LÓPEZ SAUBIDET, C., (1981). *Simulación del crecimiento de una pastura permanente*. Asociación Argentina de Producción Animal, 1981.
- BIERMAN, H., BONINI, CH. & HAUSMAN, W. (1994). *Análisis cuantitativo para la toma de decisiones*. Ed. Addison – Wesley Iberoamericana. Wilmington, Delaware, E.U.A.
- BLAXTER, K. L., (1956). *The nutritive value of feed as sources of energy; a review*.
- DIJK, VAN AND HOOGERVORTS, N., (1983). *The demand for grasslands in Europe towards 2000. Some implications of a possible scenario*. In Efficient Grassland Farming, ed. A.J. Corral, pp. 21-31. Hurley, UK: British Grassland Society.
- DOYLE, C.J. AND ELLIOT, J. G. (1983). *Putting an economic value on increases in grass production*. Grass and Forage Science, 38:169-77.
- FORRESTER, J. (1961). *Industrial Dynamics*. Cambridge, MA: The MIT Press.
- FORRESTER, J.W. (1994). *Policies, decisions and information sources for modeling*. En John D. W. Morecroft and John D. Sterman (eds): Modeling for learning organizations. Copyright © 1994 by Productivity Press. Portland.
- HART, R.H., (1972). *Forage yield, stocking rate and beef gains on pasture*. Herbage abstracts, 42:345-53.
- HODGSON, J. AND WILKINSON, J. M., (1967). *The influence of quantity of herbage and its digestibility on the amount eaten by grazing cattle*. J. Br. Grassland. Sc. 23:75-80.
- HODGSON, J. AND WILKINSON, J. M., (1976). *The influence of grazing pressure and stocking rate of herbage intake and animal performance. Pasture utilization by grazing animal*. London. British Grassland Society. Occasional Symposium Nro 8. Pp. 39-103.
- JOLLANS, J.L., (1981). *Grasslands in the British Economy*. CAS paper 10. 589 pp. Reading, UK: Centre for Agricultural Strategy.
- JONES, R.J. AND SANDLANDS, R.L., (1974). *The relation between animal gain and stocking rate*. Journal of Agricultural Science. 83:335-42.
- KIM, D.H. (1994). *Systems archetypes I*. Toolbox reprint series. Pegasus Communications, Inc.
- KIM, D.H. (1994). *Systems archetypes II: using systems archetypes to take effective action*. Toolbox reprint series. Pegasus Communications, Inc.
- KIM, D.H. (1995). *Systems thinking tools: a user's reference guide*. Toolbox reprint series. Pegasus Communications, Inc.
- KIM, D.H. (1993). *The link between individual and organizational learning*. Sloan Management Review, otoño 1993.
- KIM, D.H. Y SENGE P. (1994). *Putting systems thinking into practice*. System Dynamics Review, Vol. 10, No 2–3, verano–otoño, 1994.



# BIBLIOGRAPHY

- KLEINMUNTZ, D.N.(1993). *Information processing and misperceptions of the implications of feedback in dynamic decision making*, System Dynamics Review, 9(3).
- MÉNDEZ ACOSTA, C. M. (1998). *Hacia los mercados no afitósicos: el rol de la tecnología en el aumento de la rentabilidad ganadera*. Universidad Católica Argentina. Fac. de Ciencias Agrarias.
- MÉNDEZ ACOSTA, C. M. Y ALONSO MAGDALENO, M. I. (1999). *Análisis de la producción de carne vacuna en la pampa húmeda argentina, desde las aportaciones de la dinámica de sistemas*. Revista de Ciencias Agrarias y Tecnología de los Alimentos, vol. 16-17, pp. 24-39.
- MILSON, D. J. AND MILFORD, R., (1967). *In vitro and fecal nitrogen techniques for predicting the voluntary intake of Chlorisgayana*. J. Br. Grssland. 50:22-170.
- NATIONAL RESEARCH COUNCIL, (1996). *Nutrient Requirements of Domestic Animal*. Seventh Revised Edition.
- PEARSON, C. J. AND ISON, R. L., (1987). *Agronomy of Grasslands Systems*. Cambridge, University Press.
- PERKINS, J., TETHERMAN, J. RACHMAN, R. AND SEMALI, A., (1986). *Prospects for the introduction and management of forages in livestock production systems of South .East Asian and South Pacific*. In Forages in Souht-East Asian and South Pacific Agriculture, ed. G.J. Blair, D. A. Ivory & T.R. Evans, pp.15-23. Canberra: Australian Centre for International Agricultural Research.
- RICHARDSON, G. (1991). *Feedback Thought in Social Science and Systems Theory*. Philadelphia: University of Pennsylvania Press.
- RICHARDSON, G. AND PUGH, A. (1981). *Introduction to System Dynamics Modeling with DYNAMO*. Cambridge: MIT Press.
- SCHROEDER, W.W. (1977). *Dinámica de sistemas: un instrumento único para el análisis de sistemas sociales para los que existe escasez de información*. Lecturas sobre dinámica de sistemas. Subsecretaría de planificación - Madrid.
- SENGE, P.M. Y STERMAN, J. D.(1992). *Systems thinking and orgnizational learning: Acting locally and thinking globally in the organiazation if the future*. European Journal of Operational Research, 59.
- SENGE, P.M.; ROSS, R.; SMITH, B.; ROBERTS, CH. Y KLEINER, A. (1995). *La quinta disciplina en la práctica*. Granica, Barcelona.
- STATA, R. (1989). *Organizational Learning: The Key to Management Innovation*. Sloan Management Review, 30(3), Spring.
- STERMAN, J. (1989 a). *Misperceptions of Feedback in Dynamic Decision Making*. Organizational Behavior and Human Decision Processes 43(3).
- STERMAN, J. (1989 b). *Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment*. Management Secience 35(3).
- STERMAN, J. (1994). *Learning in and about Complex Systems*. System Dynamics Review, 10(2).
- STOCKDALE, C.R., AND KING, K.R.,(1983). *Effect of stocking rate of the grazing behaviour and faecal output of lactating dairy cows*. Grass and Forage Sc. 38:215-218
- TOLEDO, J.M., (1986). *The role of forage research networking in tropical humid and sub-humid environments*. In Forages in South-East Assian and South Pacific Agriculture, ed. G. Blair, D.A. Ivory & T.A. Evans, pp 69-75. Camberra: Australian Centre For International Agricultural Research.
- VERDE, LUIS, (1973). *Crecimiento compensatorio*. Serie Materiales Didácticos, INTA Balcarce.