A DECISION SUPPORT SYSTEM FOR BEEF CATTLE FEEDLOT MANAGEMENT[1]

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ABSTRACT - With the objective of increasing the productivity and profitability of beef cattle ranching, many Brazilian cattle ranchers have started using feedlot systems to fatten their cattle. Given the complexity of the decision making process and the power to improve farm management through the application of information technology, this article presents a Decision Support System developed for beef cattle feedlots. We simulated the application of a possible system and observed its potential for use by cattle ranchers and feedlot managers.

Key words: Beef cattle, feedlot, decision support system, farm management.

INTRODUCTION

Historically, the Brazilian bovine meat market is characterized by seasonal supply. Generally, cattle are slaughtered during the first half of the year which drives real meat prices to their lowest yearly level. Meat prices are at their highest in the second half of the year, principally between October and November.

To take advantage of the higher prices, many cattlemen have been stimulated to fatten their beef cattle in feedlots[5] and sell the animals

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5 Fattening systems - the animals are shut in their own pens and receive a ration composed of concentrated and roughage feeds, without access to the pasture.

during the months of October and November. According to FNP Consultoria & Comércio (1996), the number of animals being readied for slaughter in the Brazilian feedlot system jumped from 435,000 in 1986 to approximately 1,275,000 animals in 1995.

To characterize the beef cattle feedlot production system and the myriad of factors affecting the feedlot decision making process, we will enumerate some of the technical and economic requirements that need to be considered during the feedlot planning phase.

a) The intensive use of capital due to the inherent needs of the productive process, such as: furnishing animal dietary requirements, providing vaccines, vermicide and vitamin complements, the installation of minimum infrastructure and equipment installations, among others.

b)The provision of countless techniques[6] and production technologies[7] due the multiplicity of animal types and physical conditions (race, initial weight, sex, final weight, and number of animals), and the difficulties presented by the necessity to manage labor, machinery, dietary requirements, equipment, financial resources, and so on.

c) The feedlot's economic performance is difficult to forecast because this is dependent on variables: thin steer acquisition price, fat steer sale price, interest rates, the short duration of the productive process, and the opportunity cost of capital (Neves et al., 1993).

d) The provision of a balanced diet formulation that fulfills the animals nutritional requirements and achieves the planned daily animal weight gain.

e) The necessity for planning and meeting the daily confined animal weight gain requirements so that the individual steer reaches the "fat steer" classification weight of 450 kgs—failure to reach the "fat steer" weight would cause the feedlot operator large financial damages (Lazzarini Neto, 1993).

f) The potential for non-differentiation of the price paid to the beef

6 Combination of production inputs to produce the same long isoquant (Varian, 1994).
7 Combination of production inputs to produce distincts isoquants or in different output levels (Varian, 1994).

cattle feedlot operator by cold storage facilities and butcher shops—animals fattened in feedlots tend to yield better quality meat and have a higher proportion of eatable meet than cattle fattened using other systems (Lazzarini Neto and Lazzarini, 1995).

Because of the risk and the inherent complexity of the beef cattle feedlot decision process, the development of analytic instruments, models, and applications for "ex-ante" situations would be of great value (Neves *et al.* 1993). These tools would aid the investor to make any decision regarding opening or expanding a cattle fattening feedlot.

According to Noronha and Peres (1992), the cost of making incorrect decisions tends to increase due to intransigent market competition. Therefore, there is an urgent need for the development of managerial information systems, the adaptation or creation of related computer software specific to the rural Brazilian company, and the training of independent professional managerial advisors.

With the tendency toward computer hardware and software price reductions, agriculture is in a favorable position to invest in the modernization of its information controls to improve ranch and farm managerial efficiency. Today, decision support system technology, integrated with an "Expert System," has great potential for application in commercial agricultural activities (Silva Jr., 1993).

The objective of this paper is to present a support system to assist in decision making. This system was developed to aid the professional farm assistant associated with beef cattle feedlot management.

A Decision Support System (DSS) can be defined as a grouping of computation tools developed to give support in the resolution of specific, structured and non-structured administrative problems. DSS is a product of the interaction between several areas of expertise, incorporating information useful in the various phases of the decision making process, to increase the data base and facilitate the use of facts and analytic models (El-najdawi and Stylianou, 1993; Turban, 1993).

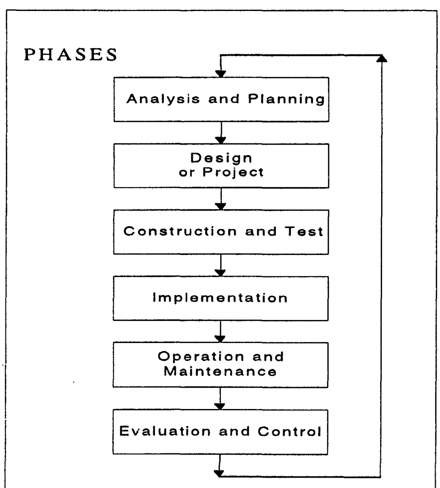
DSS has three connected components: software, hardware, and the user. The software consists of three sub-systems: data, models, and communication. The data sub-system includes the database and the database management system (DBMS). The models sub-system consists of software that contains the management models. The communication sub-system is the interface between the system and the user with which the user commands and communicates with the system (El-najdawi & Stylianou, 1993; Turban, 1993).

According to El-najdawi and Stylianou (1993), an Expert System is software that incorporates the knowledge of one or more human experts in a very specific area and is capable of giving suggestions and advice to solve problems that only experts had once been able to solve. Usually, an Expert System is composed of three main components: the knowledge base, the inference machine, and the interface with the user (Stylianou *et al.*, 1992).

METHODOLOGY

Figure 1 is a flow chart showing the methodology used in the development and construction of the Beef Cattle Feedlot Decision Support System (SADCONF) and the coupled Expert System.

Figure 1
Development Life Cycle of the Decision Support System and the Expert System



Source: Adapted from Turban (1993).

The life cycle of the Decision Support System begins with Analysis and Planning. In this phase a general understanding of the problem is developed; an implantation alternatives study that considers software, hardware, time frame, and costs is made; and a system is designed.

In the next phase in DSS Life Cycle, Construction and Testing, the system is appraised and refinements are made. This leads to a usable, real world system that can be put into operation by the end user.

The DSS Implementation phase, which follows the Construction and Testing phase, prepares the system for actual use: equipment is purchased, personnel is trained, and so on. After implementation, the system enters into routine use: the Operation phase. Routine use leads to system alteration, adapting the system to new unforeseen situations and making the appropriate corrections: the DSS Maintenance phase. The system then goes through continuous Evaluation phase to determine its usefulness and applicability. The knowledge gained during the Evaluation phase is then used to improve Analysis and Planning and ushers in a repeat of the Life Cycle (Turban, 1993).

RESULTS AND DISCUSSION

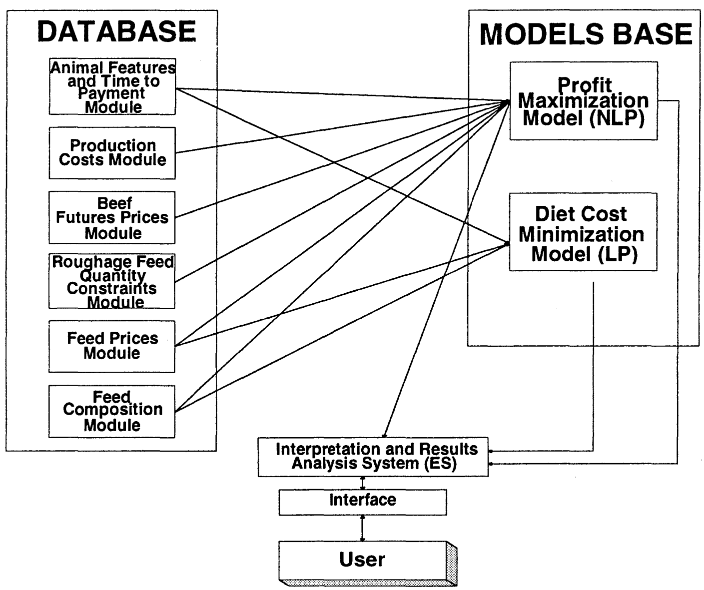
We gave special attention to the user interface when developing DSS and opted to use the Microsoft Windows environment. Due to its graphics potential and the available programming resources, Windows facilitates the development of user friendly tools.

The system was developed with the use of Microsoft Excel 5.0 because of this electronic worksheet's countless potentialities to propagate: (a) linear, integer and nonlinear, programming models; (b) automation routines using macros programming in Visual Basic for applications; and c) a graphic interface (Microsoft, 1994). The Expert System was developed with Exsys version 4.0 software from Exsys Inc., Albuquerque. New Mexico, USA.

The data flow and system structure are presented in Figure 2. This figure outlines the structure of the feedlot Decision Support System we developed and the two mathematical programming models DSS contains: (a) The Feedlot Profit Maximization Model (Nonlinear Programming Problem), which uses information collected in all the DSS data insertion modules; and (b) The Diet Cost Minimization Model (Linear Programming Problem), which only uses the data inserted in the Animal Features, Feed Prices, and the Feed Composition modules.

FIGURE 2

Beef Cattle Feedlot Decision Support System (SADCONF) Architecture



NLP: Nonlinear programming; LP: Linear programming; ES: Expert System.

We used equation proposals made by AFRC (1993) and NRC (1984) to develop the mathematical models inserted into SADCONF. These equations relate metabolizable energy[8] and the daily diet of dry

[8] corresponds to the total energy ingested during animal feeding, less the energy lost through feces, urinates and gases (AFRC, 1993).

matter and minerals required to attain the animal's daily weight gain, taking into account the animal's sex, breed/cross-breed, and live weight.

To animals protein, calcium, phosphorous, magnesium, sodium and potassium requirements, were calculated using equation proposals made by AFRC (1993) and Fontes (1995). These nutrient requirement generate mathematical programming model constraints that affect the resolution of the Profit Maximization and Diet Cost Minimization models.

In addition to the above mentioned model constraints, a series of other constraints are also imposed on the mathematical models: animals minimum finished average weight, feedlot maximum stay in days, maximum number of animals in the feedlot, maximum financial resources, among others. The SADCONF mathematical model formulations were presented by Resende Filho (1997).

It should be observed that in Figure 2, SADCONF allows the use of an Expert System to aid the user in problem solution. This is done because of the complexity of the profit maximization nonlinear model resolution process.

The types of data needed by SADCONF will be presented in the following Use Example.

PRESENTATION OF A SADCONF USE EXAMPLE

To use SADCONF as shown in Figure 2, the user must input data that characterize her/his resources. These resources include number of animals, improvements, equipment, labor, financial assets, and others. In this section, we will present hypothetical beef cattle feedlot resource data derived using feedlot characteristics found in the State of Minas Gerais, Brazil, and catalogued by Campos (1992) and Silvestre et al. (1986).

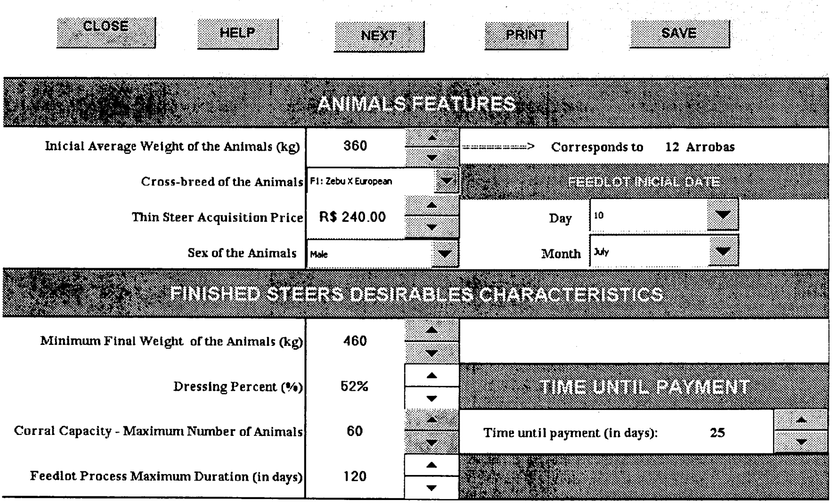
Data Used in the SADCONF Use Simulation

The data inserted into the Animal Features and Time to Payment Module (Figure 3) were defined as follows: animals entry into feedlot

July 10th; animals were male Zebu - European cross-breeds with an initial average weight of 360 kg; average price per steer R$ 240.00 (BM&F, 1996), each steer must reach a minimum weight of 460 kg in 120 days, to take advantage of higher inter-harvest prices; the finished animals would be sold at the 52% dressed meat price grade, the time to payment is 25 days, a common practice in the Brazilian bovine meet market; the maximum number of animals held in the corral was limited to 60, to respect the adopted installation capacity shown in Table 1.

FIGURE 3

SADCONF Animal Features and Time to Payment Module Screen



The values in the SADCONF Production Costs Module, Figure 4, were defined as follows: monthly interest rate of 1.23%, corresponding to the nominal saving account interest rate as of July 10, 1996 (O Dinheiro, 1996); R$ 25,000 in available capital, so that the financial resources aren't limited to the to the profit maximization resolution problem; and costs, including annual depreciation on installations, machines, interest on the capital tied to machinery and installations, payment of labor, social responsibilities, expenses for equipment and machinery fuel, medications, aftosa vaccine and the application of vitamin A (costs obtained from Resende Filho, 1997).

FIGURE 4
SADCONF Production Costs Module Screen

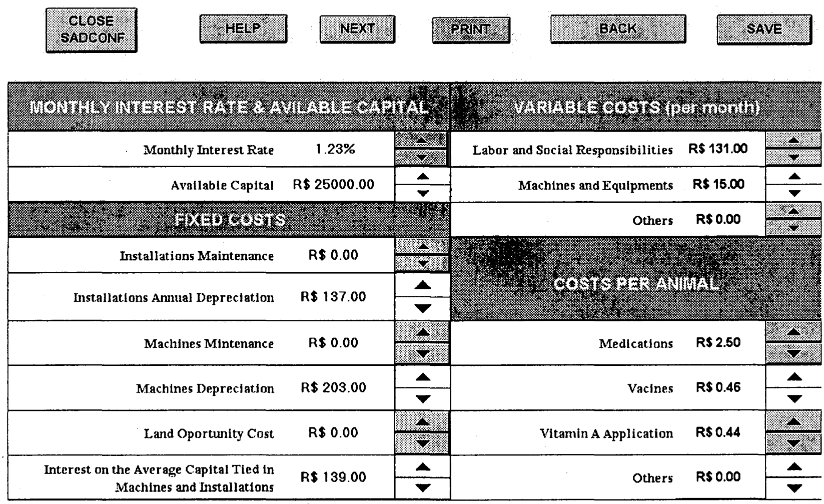


Table 1 presents a synthesis of the characteristics of the actual capital used in the Production Costs Module.

Table 1 - Physical Characteristics of the Feedlot System Used in the Example

Item	**Characteristic**
Capacity of the corral	50 to 60 animals
Area per corral	700 m^2
Capacity	14 to 12 m^2 / confined head.
Corral Characteristics	Corral open to the sky with packed ground base.
Stationary picker	1 (Diesel)
Scale	1 (1500 kg capacity)

Source: Emater-MG, mentioned by Campos (1992); Resende Filho (1997).

The data inserted into the Beef Futures Prices Module are presented in Figure 5. It should be noted that we used the "fattened cattle" closing price as registered on the São Paulo Commodities & Futures Exchange, July 10, 1996 (BM&F, 1996). We used these fattened cattle prices because they are often more reliable than those prices obtained using sophisticated econometric models (Kassouf, 1988).

FIGURE 5
SADCONF Beef Futures Prices Module Screen

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BEEF MARKET FUTURE PRICES (FORECAST)

Source: São Paulo Commodities & Futures Exchange

Month	Days Remaining	R$ per Arroba
July	21	23
August	52	24.3
September	82	25.8
October	113	27.4
November	143	26
December	174	25.2
January	205	22.5
February	233	20.8
Mach	264	21.5
April	294	22.2
May	325	22.9
June	355	23.4

As was shown in Figure 2, after insertion of the data into the Beef Futures Price Module, the physical constraints must be added to the Roughage Feeds Quantity module. In this case, we assumed that all feeds were available in the marketplace. In this way, there is no need to consider the respective quantity constraints.

Most of the values inserted into the SADCONF Feed Prices Module (Figure 6) came from the July 1996 feed prices obtained from Preços Agrícolas (1996) and Informações Econômicas (1996). The production cost approach was use to calculate the prices of corn silage, Elephant Grass cv Napier, and ground corn ears (Resende Filho, 1997).

It should be mentioned that the only roughage feeds considered were Elephant Grass cv Napier, silage, and sugarcane because they are the most available roughage feeds used in the State of Minas Gerais' beef cattle feedlots (Silvestre et al., 1986).

FIGURE 6

SADCONF Feed Prices Module Screen

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FEED PRICES MODULE

ROUGHAGE FEEDS

Item	Prices in R$ per ton
Elephant Grass cv Napier, 61 Days	6.40
Elephant Grass cv Napier, Hay	Not Available
Corn Silage	19.80
Elephant Grass cv Napier, Silage	Not Available
Elephant Grass cv Napier, 82 Days	Not Available
Sorghum Silage	Not Available
Sugarcane Bagasse, Hydrated	Not Available
Sugarcane	14.00

CONCENTRATE FEEDS

Item	Prices in R$ per ton
Bone Meal	480.00
Sugarcane Syrup	Not Available
Urea	369.00

CONCENTRATE FEEDS

Item	Prices in R$ per ton
Calcium Carbonate	14.70
Cottonseed Meal (32%)	200.00
Cottonseed Meal (42%)	221.00
Sodium Chlorid (HCl)	130.00
Potassium Chlorid (KCl)	259.00
Ground Corn Ear	64.00
Poutry Litter	Not Available
Weath Bran	223.00
Corn Meal	Not Available
Groun Corn	126.00
Cottonseed Grain	Not Available
Soybean Meal (45%)	293.00
Dicalcium Phosphate	190.00

To complete Figure 2 module requirements, one must input data on the chemical-bromatologic composition of the available feed. Figure 6 lists the 24 feeds already entered into the SADCONF database. The chemical-bromatologic composition of these 24 feeds, as entered in the Diet Dry Composition Module, is presented in Figure 7. This information came from several sources: Valadares Filho (1995), NRC (1984), AFRC (1993), Campos (1995), Jorge (1993).

It is worth noting that the data stored in the Feed Composition Module can be altered by the SADCONF user. This allows for the addition of chemical-bromatologic analyses values of other feeds. This should be especially useful to the feedlot owner as he may produces his own, alternative feeds. For the most part, this data will consist of coefficients associated with Profit Maximization and Diet Cost Minimization decision variables in the constraint matrix.

FIGURE 7
SADCONF Feed Composition Module Screen

Item	Feed Composition (in feed dry matter)										
	MS %	EM MJ/Kg	EM Mcal/Kg	FME MJ/Kg	Ca g/Kg	P g/Kg	Mg g/Kg	Na g/Kg	K g/Kg	CP g/Kg	ADIN g/Kg
Roughage Feeds											
Elephant Grass cv Napier, 61 Days	20.00%	8.76	2.09	8.13	6.00	4.10	2.60	0.10	11.31	160.00	0.70
Elephant Grass cv Napier, Hay	88.00%	7.53	1.80	7.00	3.00	1.70	2.40	0.85	9.20	106.40	1.20
Corn Silage	31.00%	10.10	2.41	8.00	2.80	1.90	2.00	0.10	10.00	70.00	0.00
Elephant Grass cv Napier, Silage	20.00%	8.33	1.99	7.73	8.00	2.00	2.60	0.10	11.31	56.00	1.18
Elephant Grass cv Napier, 82 Days	25.90%	8.03	1.92	7.46	6.00	4.10	2.60	0.10	11.31	133.00	0.70
Sorghum Silage	31.00%	8.76	2.09	8.13	3.50	2.10	2.90	0.20	13.70	60.00	0.70
Sugarcane Bagasse, Hydrated	40.00%	8.01	1.91	7.43	0.40	0.30	2.90	0.20	13.70	16.00	0.70
Sugarcane	28.00%	9.10	2.08	8.46	2.27	0.73	0.25	0.50	1.26	25.00	0.70
Concentrate Feeds											
Calcium Carbonate	100.00%				385.00						
Cottonseed Meal (32%)	92.00%	9.36	2.24	7.42	1.80	12.10	5.90	0.50	15.20	323.00	3.05
Cottonseed Meal (42%)	92.00%	11.17	2.67	8.86	1.90	10.00	5.50	0.40	13.90	440.00	3.56
Sodium Chlorid (HCl)	100.00%							370.00			
Potassium Chlorid (KCl)	100.00%								505.40		
Ground Corn Ear	88.70%	11.30	2.70	10.17	0.20	2.20	1.00	0.10	4.10	81.00	1.71
Poutry Litter	86.00%	9.62	2.30	7.63	31.60	17.20	5.00	5.10	16.80	139.00	5.15
Weath Bran	89.00%	9.51	2.27	7.54	1.30	13.80	6.00	0.40	15.60	178.00	1.57
Corn Meal	86.00%	13.80	3.30	12.40	1.20	0.40	0.70	0.80	8.90	102.00	0.00
Groun Corn	88.00%	13.60	3.25	12.20	0.30	0.32	1.20	0.10	4.40	98.00	0.00
Cottonseed Grain	92.00%	14.52	3.47	11.90	1.60	7.50	3.50	3.10	12.10	239.00	2.20
Soybean Meal (45%)	88.00%	12.97	3.10	12.13	2.20	6.40	3.10	0.70	20.2	460.70	2.20
Dicalcium Phosphate	100.00%				230.30	180.00					
Bone Meal	100.00%				301	145					
Sugarcane Syrup	75.00%	10.89	2.60	8.92	10.00	1.10				40.00	0.70
Urea	100.00%									2700.00	

MS: feed dry matter in percentage; EM: metabolizable energy in megajoules per kg and megacalories per kg of dry feed; FME: fermentable metabolizable energy in megajoules per kg of dry feed; Ca: calcium in g. per kg of dry feed; P: phosphorus in g per kg of dry feed; Mg: magnesium in g. per kg of dry feed; Na: sodium in g. per kg of dry feed; K: potassium in g. per kg of dry feed; CP: gross protein in g. per kg of dry feed; ADIN: acid detergent insoluble nitrogen in g. per kg of dry feed; a, b, c: are the coefficients defined by AFRC (1993) to quantify protein degradability at the rumen level, for each feed.

Feedlot Profit Maximization Resolution

The results calculated using the previously defined data are shown in FIGURE 8. Using the planned feedlot strategy, the animals final weight is shown be 475 kg, greater than 460 kg minimum final weight established for this example. 475-kg corresponds to 16.47 arrobas,.

The nominal price calculated at the end of feedlot fattening is R$ 27.35 per arroba, the inter-harvest beef cattle price in October, 1996 (see: Figure 5). The reduction in moneys received due to the delay of cattle's sale for slaughter until October, applying Figure 4's postulated 1.23% per month savings account interest rate (opportunity cost), reduces the relative price received to R$ 26.18 per arroba and takes into consideration the 52% dressed meat requirement

FIGURE 8

SADCONF Calculated Profit Maximization

NATURAL MATTER RATION COMPOSITION	CALCULATED SOLUTION		DRY MATTER RATION COMPOSITION
Animals Finish Weight	16.47 Arroba	===========>	475 Kg of Live weigt
Nominal Price	R$ 27.35 per Arroba		
Price Corrected to the Initial Month	R$ 26.18 per Arroba	SOLUTION SENSIBILITY	
Animals to Feedlot	60 Animals	Minimum Price to Profit = 0 (per Arroba)	
Finish Date to the Feedlot	October 1	R$ 21.50	
Duration to the Feedlot in Days	83 days	% Price Variation to Profit = 0	
Live Weight Gain in Arroba	4.5 Arroba	21.39%	
Cost with Thin Animals per Arroba	R$ 20.00 / Arroba		
Ration Cost	R$ 9.89 / 100 Kg of Dry Matter	========>	R$ 1.00 /animal per day
Daily Dry Matter Intake (Average)	9.74 Kg per Animal	Daily Ration Intake	1243.7 ration per day (kg)
Daily Live Weight Gain	1.39 Kg /dia	Cost per Arroba	R$ 22.13 /Weighted arroba
Metabolisable Energy in Ration	2.52 Mcal/Kg of dry matter	==============>	10.5 MJ/Kg of dry matter
ECONOMIC BUDGET (Up-to-date Values)		% Upon the Costs	
REVENUE	R$ 25863.78	127%	
TOTAL COSTS	-R$ 20331.59	100%	
Total Cost with Thin Animals	-R$ 14400.00	71%	
Total Feeding Cost	-R$ 4898.17	24%	
Costs with Other Itens	-R$ 1033.42	5%	
PROFIT	R$ 5532.19	27%	
Profit due Price Differential	R$ 4447.48	22%	
Profit with Feedlot	R$ 1084.71	5%	

Some of the calculated results given in the SADCONF Calculated Profit Maximization , Figure 8, can be summarized as follows: animal fattening should be finished in 83 days, October 1, which corresponds to the date forecast for highest market price in the inter-harvest period (Figure 5); average daily animal weight gain of 1.39 kg, a gain of 4.5 arrobas in the period; each animal in the feedlot consumes on average 9.74 kg of dry feed per day; total period feed intake is 1243.7 kg for the 60 animals in the feedlot.

Figure 8 contains figures showing that the implemented SADCONF production plan should result in a feedlot profit of R$ 5,532.19; a 27% profit in relation to total production cost. The delay of sale until the inter-harvest period, when beef prices are at their highest, generates 22% of the 27% profit; and 5% of the profit is due to the animal's weight gain in the feedlot.

The preponderance of profit attributable to seasonal price differentials was expected; these price differentials are a typical Brazilian beef cattle market characteristic. The implementation of beef cattle feedlots in Brazil would be economically impractical if prices did not go through a seasonal price change (Thiago and Costa, 1994). Therefore, the result calculated through use of the SADCONF Profit Maximization Model is compatible with reality.

The Sensibility Solution found in the SADCONF Calculated Solution screen refers to a possible nominal fall in beef prices relative to the price forecast at the end of the feedlot fattening process. This lower price is the minimum beef price the feedlot operator needs to break even; the price that guarantees at least zero profit (including capital opportunity costs). In this feedlot strategy proposal, zero profit would come if the nominal cattle price per arroba was reduced from R$ 27.35 to R$ 21.50, a fall of 21.39%.

Acting on the result generated by SADCONF on July 10, 1996 (the date the animals enter the feedlot), the beef cattle feedlot operator could have used the São Paulo Commodities & Futures Exchange to hedge against a price fall from the anticipated October 1, 1996, price of R$ 27.35 per arruba. This hedging procedure would be reasonable for the beef cattle feedlot operator; during the 1996 inter-harvest period, there was a constant decrease in beef cattle futures prices at the São Paulo Commodities & Futures Exchange.

Figure 9 presents the SADCONF calculated minimum cost diet that insures the planned animal weight gain in the feedlot.

Figure 9
SADCONF Calculated Cost Minimized Diet Composition

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COMPOSITION OF DIET IN NATURAL MATTER BASE			
ROUGHAGE	Natural Matter Base (%)	CONCENTRATE	Natural Matter Base (%)
Elephant Grass cv Napier, 61 Days		Wheat Bran	
Elephant Grass cv Napier, Hay		Corn Meal	
Corn Silage	72.96	Ground Corn	
'Elephant Grass cv Napier, Silage		Cottonseed Grain	
Elephant Grass cv Napier, 82 Days		Soybean Meal (45%)	
Sorghum Silage		Dicalcium Phosphate	
Sugarcane Bagasse, Hydrated		Bone Meal	
Sugarcane		Sugarcane Syrup	
CONCENTRATE	Natural Matter Base (%)	Urea	0.47
Calcium Carbonate	0.20	MINERAL PREMIX	(Kg/100Kg of PREMIX)
Cottonseed Meal (32%)		Calcium Carbonate	80.28
Cottonseed Meal (42%)	9.12	Sodium Chlorid (NaCl)	19.02
Sodium Chorid (NaCl)	0.05	Potassium Chlorid (KCl)	
Potasssium Chlorid (KCl)		Dicalcium Phosphate	0.41
Ground Corn Ear	17.20	Bone Meal	
Poutry Litter		g de premix/ 100 Kg de Concentrate	0.94
ROUGHAGE (% in Natural Matter Base)			**72.96**
CONCENTRATE (% in Natural Matter Base)			**26.79**
PREMIX (% in Natural Matter Base)			**0.25**

The daily dietary requirement for the 60 animals in the feedlot (1243.7 kg per day) could be pre-prepared by the feedlot owner if he/she takes advantage the SADCONF Calculated Cost Minimized Diet Composition schedule shown in Figure 9.

If the beef cattle feedlot owner had previously defined the number of animal to be fed, their planned daily weight gain, and their planned final weight, the owner would only need to use the Diet Cost Minimization model to maximize profit at the planned level of production.

As it was mentioned previously, having obtained a SADCONF solution for profit maximization, it is possible to use the Expert System to interpret and to analyze the calculated results. In the case that the SADCONF profit maximization solution is negative or gives an unfeasible result, the Expert System could aid the user in finding possible causes for this result, such as incompatible constraints or erroneous data.

CONCLUSIONS

The Beef Cattle Feedlot Decision Support System (SADCONF) regards the problem of diet cost minimization and feedlot profit maximization in a deterministic way. SADCONF views the variable's values as perfectly known. It must be realized that such variables as animals daily weight gain, feed intake, future beef prices, production input prices, among others are uncertain. Biological and market variables normally present deviations in real situations.

In spite of these limitations, the Beef Cattle Feedlot Decision Support System described in this article generates results compatible with reality. In this way it can potentially aid the beef cattle feedlot owner in his/her decision making process. It was also found that SADCONF is an improvement relative to other, previously developed software (Ferreira, 1993): (a) it facilitates calculation of minimum diet costs; (b) it has potential to reduce losses due to a decrease in the future price of beef; (c) it allows for the establishment of minimum and maximum roughage feed constraints to adjust for the quantity of roughage available at the farm; (d) it provides for an Expert System to guide the user in evaluation of the solution calculated through use of the feedlot profit maximization model; (e) it facilitates the use of software to obtain the local maximum for the nonlinear profit function, increasing the chance of meeting the global requirement for maximization of profit; and (f) it facilitates the user's interaction with the system due to its user friendly interface.

A Decision Support System (DSS) interrelates several areas of scientific knowledge. The present study applied a combination of various fields of expertise: animal science, agricultural economics, mathematical programming, and computer science. As DSS develops, we improve our ability to unite the complex and dynamic reality of the decision making process with scientific knowledge, aiding the agricultural manager to answer the classic inquiries of what, how, when, and how much to produce.

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