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Feasibility analysis for development of Northern China's beef industry and grazing lands

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Abstract

China, with one of the largest grassland and pastoral areas of the world, is placing major effort on sustainable modernization of its rangeland livestock industry. One widely discussed structural change involves development of a cattle feedlot industry with grazing lands oriented to a cow/calf system. However, economic analyses of alternatives have not been carried out. The objective in this article is to evaluate the economic feasibility and benefits to sustainability from shifting from fattening cattle on rangelands in Inner Mongolia to fattening in feedlots in the Beijing area. The method is economic budgeting of costs and returns for both systems combined with comparison of protein and energy requirements for each of them. It is concluded that grazing land producers would obtain more net income from selling weaned calves rather than fattened animals. Furthermore, although 14,230 Mcal of metabolizable energy and 738 kg of crude protein are required per 4-year old male sold at slaughter weight by grazing land fattening, a feedlot fattened male would require only 5,670 Mcal of energy and 371 kg of protein. Additional evaluations of improved cow/calf systems indicate that considerable advances can be made by improving the efficiency of China's cattle industry.

Key Words: China, grazing land, beef, economics, cow/calf, feedlot, rangeland

A major concern of the Chinese government is how meat and other livestock products can be produced more efficiently. This translates to optimizing the amount of feedstuffs required to produce a given product. Alternatively, it means determining how more product can be produced with a given amount of input. Feedstuffs are the focus of this article as they are the major limiting factor preventing transition from subsistence grazing to an integrated livestock production system on China's grasslands. The problem dealt with is evaluation of cattle feedlots as a substitution for grass fattening to slaughter weights.

China has one of the largest grassland and pasture areas in the world, covering nearly 2.9 million km^2. A wide variety of grazing land environments are included, from tiny pastures in the agricultural areas comprising less than one hectare on which a farmer might keep a sow or a goat, to the roadside communal areas where a producer grazes a half dozen dairy cows or milk goats, up to the vast windswept areas of Inner Mongolia. Equally important are the deserts and rangelands of Western China and the mountainous regions, home to minority ethnic groups and yaks. Roughly half of China is designated as pastoral and grassland, as opposed to agricultural area (Simpson et al. 1994). The grasslands per se are immense, accounting for about 30% of the nation's total area. About 2.4 million km^2 or 85% of China's grassland and pastures are in the temperate zone (Zhu et al. 1985).

Livestock production and pastoral systems in China are as varied and complex as the grazing areas are ecologically diverse. For example, a substantial portion of cows in all grassland areas are milked, used for draft and consumed for meat. In the pastoral grazing areas, herdsmen generally own both cattle and sheep. Furthermore, beef in China has traditionally been a by-product of draft animals rather than being a principal output of cattle. In 1990 there were 81 million head of cattle in China (called "yellow cattle" in China to differentiate them from buffalo, but including single purpose dairy cattle). Of the yellow cattle, 93% in Chinese statistics are termed "draft". About 1/4 of all cattle are found in the grassland area. Beef production in all China has grown at an average rate of 20% annually since China opened to the West in 1978 (Simpson et al. 1994). About a quarter of China's beef and 40% of the lamb and mutton come from the grassland area. However, due to mechanization, greater reliance will be placed on rangelands as a source of beef cattle.

A critical factor for analysis of livestock, and grassland area production systems in China in particular, is that they are diverse–and for very good reasons. There is no one solution to the so-called "pastoral problem" of relatively low offtake rates per hectare, but there are a number of viable, logical interventions which could result in considerable improvement in productivity. The objective in this article is to explore economic relationships of China's grassland cow/calf and fattening operations and feedlot fattening as a way to better understand ways in which efficiency and use of national feedstuffs can be improved. Emphasis is placed on an ex-ante economic analysis of the feasibility of fattening cattle in feedlots located in cropping areas in place of rangelands and transition of rangelands toward cow/calf systems.

Factors Influencing Livestock Productivity

There are a number of reasons for the low productivity of cattle in China, some of which can be overcome, while there is little

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possibility for changing others. Climate and land are factors over which humankind has little control and thus must adapt systems and management to expand output. One way is to shift from a system in which cattle are raised to slaughter weight on grass (sometimes being sold at 4 to 6 years of age) to a cow/calf system in which calves are shipped to agricultural areas for fattening at weaning time. In this way the vagaries of climate, which lead to weight loss in the winter or during periods of drought, can at least be partially overcome. Other factors are grazing land location in relation to croplands and urban cities. Tradition and social conditions play a large part in management decisions just as cost/selling price ratios affect economic viability. Certainly, the nation's level of economic development affects the level of productivity (Simpson and Farris 1982).

Overstocking of China's grazing lands is a frequent theme in discussion with agricultural officials. Stocking rates can only be reduced if some management mechanism is developed which allows offtake to remain the same or perhaps even expand when animal numbers are reduced. Therefore, there is need to design and implement systems that can accomplish that goal. Recognition of the need to improve rangeland management is not new, for it was recognized by the late 1970's that something had to be done (Simpson et al. 1994). Despite considerable investments in infrastructure, resettlement of herders, commendable management training and legal reform, overgrazing continues.

The household responsibility system initiated in 1985 for the grassland has had a very positive impact on the behavior and attitude by herdsmen on grassland conservation. One major policy has been assignment of animal ownership and land use rights. Part of this has been an initiative which has also led to a more settled lifestyle and transformation from a nomadic to semi-nomadic existence. Finally, the policy has led to desire for improved productivity and further participation in the marketing system. As a result, herdsmen now have great interest in development of inter-regional trade and adoption of the production system described in this article. There has been an increase in cattle and sheep herds in pastoral areas while numbers of other animals, and goats in particular, have remained about the same (Li et al. 1993). The household responsibility system has been thought to be an effective way to make it all work but, without proper control, the situation may be aggravated and not alleviated with this system.

In many areas, particularly in the early 1980's, the household responsibility system assigned herds, but not land, to individuals. In effect, this land remained a public good or a "commons". As a result, there was even more pressure to overgraze in these areas. However, in recent years land use rights have been assigned. There has been a widescale settlement program in which nomadic and semi-nomadic herders live in villages or permanent houses as a means to more effectively control their grassland and herd management practices. In earlier years livestock were given to producers under a contract system which required repayment in kind, i.e., live animals, within a specified period, usually 5 years (Li et al. 1993). Now most animals given to producers are repaid by cash and have a repayment period of 10 or more years. To the extent that producers are under such a contract system and graze their livestock on communal pastures, there will be heavy pressure to overgraze. Some specialists have emphasized that overgrazing can be solved by reallocation of animal species. Still others place their faith in capital investments.

An unfortunate longer term impact of overgrazing and the cropping of inappropriate areas is that despite commendable efforts mentioned above, little scope exists for significant widespread rejuvenation of degraded grasslands due to relatively high cost, although much can be done to prevent further problems. In effect, the problem is of such massive proportions and rangeland productivity so low compared with agricultural areas, that massive investment alone is not the answer to greatly expanded red meat production from China's grasslands.

Another problem related to current grassland systems is that most cattle in sedentary agricultural areas have been selected as a dual purpose animal, albeit with relatively low milk output (less than 3,000 kg per lactation and usually only 1,500 kg or so). One major reason is the short growing season which results in fresh forage being available for only a limited period (120–150 days). Most range grasses cure well and do not suffer great drops in protein content as happens in tropical and semi-tropical areas. Nevertheless, protein is short for much of the year whether livestock graze, are fed hay, or are provided crop residues. In other words, from the technical side, nutrition coupled with limited production, and most important winter feed, is the most serious constraint to expanded production. But, for a nutrition improvement program to be successful, there must be changes in production systems and in management as a whole.

Methods

A computer spreadsheet program based on standard economic enterprise budgeting procedures (Simpson 1988) was developed for this study. The analysis of a large problem like development of China's northern grasslands involves various aspects of production and marketing. Ideally, it would be possible to have physical analyses available of the various systems as well as associated costs and returns studies based on extensive interviews and surveys. Unfortunately, such surveys are not available. Thus, the authors were forced to fall back on logical and theoretical conceptualization of problems and from there on rather straightforward quantitative analyses to support extensive personal interviews and experiences. Investments are involved which, if carried out by private individuals are called capital budgeting analysis. The term project analysis (what was previously called cost/benefit analysis) is used for public investments.

The term systems analysis, as used by economists, is a commonly used research tool which is a goal-oriented process of study through specification of the relevant system, performance of the system and variables (McGrath et al. 1973). Dillon (1976) has written that the research process essentially involves 4 stages; development of a research model, synthesis and information interpretation, development of amended or redesigned models, and evaluation of the system's performance. This view, which is typical of systems methodology, moves scientific research from a reductionistic and mechanistic approach to an expansionistic one based on synthesis. It is an attempt to gain understanding of a system's structure or parts by understanding the way in which the whole system operates (Wright et al. 1976, Johnson and Rausser 1977).

The approach used in this article is to focus on problem identification, evaluation of appropriate technologies, identification of current and potential output mix and development of appropriate means to adopt them. In this sense, improvement of a livestock industry, and China's in particular, is basically a human oriented one (Simpson 1983). In brief, the problem focused on in this article is for Inner Mongolia and involves quantitatively specifying a typical cattle operation and then utilizing judgments by grassland and livestock experts acquainted with the area about an improved system.

There are about 45 variables in the model, as shown in Table 1. These include economic units such as cost of minerals and price per kg for each class of cattle. Multiplication of these economic units times physical units provides totals for cost and income. These data reflect economic conditions in 1992. A second part of

Table 1. Economic and feedstuffs use analysis for grass fattening versus selling calves to a feedlot, China, 1992.

	Grass fattening		Calves to feedlot	
Parameters and results	Current	Improved	Current	Improved
		Cow/calf operation		
Calf crop (weaned) (Pct)	45	65	45	65
Death loss, progeny (Pct)	10	5	10	5
Death loss, Cows (Pct)	5	3	5	3
Land per animal unit				
Improved (Ha)	2.0	2.2	2.0	2.2
Native (Ha)	10.0	10.0	10.0	10.0
Land available				
Improved (Ha)	0	20	0	20
Native (Ha)	2,000	1,980	2,000	1,980
Total animal units				
Potential (AU)	200	207	200	207
Actual (AU)	220	208	208	208
Total breeding cows (Hd)	120	105	168	168
Average land per Au (Ha) (actual)	9.1	9.6	9.6	9.6
Sales weights				
Cull cows (Kg)	250	320	300	360
Heifer calves (Kg)	115	130	145	155
Male calves (Kg)	120	135	150	180
Yearling heifers (Kg)		180	210	
2-year heifers (Kg)	240	300		
Yearling males (Kg)	175	290		
2-year males (Kg)	255	350		
3-year males (Kg)	330	400		
4-year males (Kg)	350	400		
Animals marketed				
Cull cows (Hd)	11	10	16	16
Heifers (Hd)	0	0	17	36
Male calves (Hd)	0	0	35	52
Total calves (Hd)	0	0	52	88
Yearling males (Hd)	1	15		
2-year heifers (Hd)	9	6		
Yearling males (Hd)	0	0		
2-year males (Hd)	0	0		
3-year males (Hd)	0	28		
4-year males (Hd)	17	0		
Total weight marketed (Kg) (Kg)	12,198	20,454	13,829	22,244
Total, basic prod. costs ($)	4,076	7,014	3,886	7,002
Total, all costs ($)	7,547	11,782	7,592	11,785
Sale price				
Grass fattened				
3-year old males ($/Kg)	0.55	0.57		
4-year old males ($/Kg)	0.55	0.57		
Calves to feedlot ($/Kg)	0.46	0.49		
Total income ($)	6,144	10,937	6,009	10,432
Net income above				
Basic prod. cost ($)	2,068	3,923	2,123	3,430
All costs ($)	(1,404)	(846)	(1,583)	(1,352)
Cost per kg produced (a)				
Basic prod. cost ($/kg)	0.30	0.32	0.19	0.26
All costs ($/kg)	0.72	0.62	0.67	0.58
Kilos of cattle produced/ha				
Non reproductive cattle (Kg)	4.1	8.1	3.9	7.5
All animals marketed (Kg)	6.1	10.2	6.9	11.1

Table 1. Continued.

	Grass fattening		Calves to feedlot	
Parameters and results	Current	Improved	Current	Improved
		Feedlot operation		
Number purchased (Hd)	35	52		
Weight in (shrunk) (Kg/hd)	134	156		
Weight out (Kg\hd)	450	450		
Days on feed (Days)	290	255		
Average daily grain (Kg/daily)			1.09	1.15
Feed conversion (as fed) (Kg)			9.1	8.5
Feed consumption/head/day (Kg)		6.0	5.3	
Shrunk cost + death @ lot ($/kg)		0.58	0.59	
Sale price ($/kg)			0.62	0.62
Net income per head sold ($/kg)			1.41	15.59
Cost per kg sold ($/kg)			0.65	0.61
Cost per kg sold ($/kg)			0.92	0.94
Cost per head sold ($)			292	276
Breakeven price on				
Purchase, feeder cattle ($/kg)			0.47	0.58
Sale of finished cattle ($/kg)			0.62	0.59

Source: Author's field work. Results are summary from computer program.
(a) Heifers and male calves or fattened males only.

the model for a feedlot located near Beijing is based on data developed by researchers at Beijing Agricultural University as shown in Simpson et al. (1994).

Four analyses of the model grassland cattle operation are developed. There are 2 systems, each with a current typical operation quantitatively evaluated and an improved operation. One of the systems is based on the current practice of fattening cattle to slaughter weight on grass while the other one is a simulation in which weaned calves are shipped to feedlots. The objective is to determine if the improved system is economically viable and if it would be superior to the traditional system in terms of feedstuffs utilized.

Results

Cow/calf Operation

The model breeding cow enterprise is based on 2,000 hectares (Table 1). The scale may seem rather large, but does reflect a situation of a larger producer, or in which several smaller producers operate together. It is recognized that most producers in Inner Mongolia raise sheep as well as cattle. However, even though the 2 species are often grazed together, conceptually the cattle can be considered a separate enterprise and the costs which pertain to them partitioned out and allocated to the cattle enterprise. In any event, there are relatively small economies of scale in cattle grazing so that the unit costs would not vary significantly regardless of the size.

Two systems, and 2 alternatives in each one, are provided in the results section in Table 1. One alternative, titled "current", is typical of the low efficiency found in China's grasslands. The other, titled "improved", in which cattle are still grass fattened, is based on considerably improved management. The parameters for the improved operations were determined by discussion with animal husbandry and range management specialists at Beijing Agricultural University and local specialists in Inner Mongolia as well as evaluation of existing operations by the authors. For example, in the current operation there is a 45% weaned calf crop and a 10% death loss of calves while the improved system embodies a 65% calf crop and a 5% progeny death loss. In the current operation fattened progeny are sold as 4-year olds while in the improved system they reach market as 3-year olds.

The current system assumes overstocking, with 220 animal units (AU) compared to an "ideal" or recommended carrying capacity of 200 AU. The improved system has 20 ha of improved land used to provide winter feed. The actual carrying capacity of 208 AU in the improved model is nearly equal to the optimal carrying capacity of 207 AU. The current alternative has 120 cows while the improved one only has 105 breeding cows. The difference in breeding cow numbers in the grass fattening alternative is due to a greater number of progeny carried to slaughter weight in the improved operation.

Results in Table 1 show that 28 3-year old males and 21 yearling and 2-year old heifers are sold in the improved cow/calf-grass fattening operation compared with seventeen 4-year old males and 10 heifers in the current operation. Basic production costs (i.e., mainly cash costs) are greater in the improved system ($7,014 versus $4,076) due to added supplementation, labor cost, improved pasture, fuel, etc. But, much greater income leads to nearly double net income; $3,923 in the improved system compared with $2,068 in the current system when only basic production costs are considered. If all costs are taken into account including opportunity cost on capital invested, but with no charge to labor, there is negative net income of $846 in the improved operation which, while still a loss, is less than in the current operation ($1,404). Evaluation of worldwide beef operations indicates that very seldom are all costs covered (Simpson and Farris 1982).

The cost per kg produced is $0.30 for the current operation when only basic production costs are considered and $0.32 in the current system. These costs are not much higher than in similar areas of Canada and the United States; however, the cost in the drier cow/calf areas of Australia would be lower.

The second grassland system, results of which are provided in the third and fourth columns of Table 1, represents a situation in which calves are shippped after weaning to a feedlot in the agriculture area. Two alternatives, also called current and improved, are analyzed. The current system rests on the basic production parameters in the grass fattening systems except that progeny are sold as weaned calves rather than fattened animals. There are 168 total breeding cows in each alternative, susbstantially more than in the grass fattening alternative, because the only progeny held to the second year are replacement heifers. There are 88 calves sold in the improved alternative compared with 52 if the current production methods were continued. Net income to producers above basic production costs is $3,430 in the improved alternative compared to $2,123 in the low efficiency or current one. Production costs per kg produced are less than in the grass fattening system.

The net income of the improved operation in which calves are sold at weaning is 13% less than the improved grass fattening alternative. The reason is that China does not have a beef grading system, feedlot fattening is still in its nascent stages and transportation costs of calves are high. Consequently, as in all countries where cattle are grass fattened, heavier animals sell for a higher price per kg than calves. Although the grass fattening is the higher income alternative in the improved model, the feedlot alternative produces more net income if current production methods were to be continued ($2,123 versus $2,068).

Feedlot

The feedlot operation is modeled as a continuation of the weaned calf sales from the cow/calf operation. Thus, the numbers purchased include 35 head from the current level of management and 52 head from the improved one (Table 1). There are 2 alternatives in the feedlot, calves from current and improved alternatives. Management, type feedstuffs, etc., is the same in both of them. However, because the calves from the current cow/calf operation are of a lower quality than in the improved cow/calf alternative, the average daily gain is lower (1.09 kg versus 1.15 kg). The weight into the lot (shrunk weight) is also less (134 kg versus 156 kg) although the weight at sale of 450 kg is the same. The result is that 290 days are required for cattle from the current management cow/calf operation compared with 255 days with the higher grade cattle. Transportation cost is reflected in the difference between selling price of calves and purchase price. For example, in the improved system, transportation costs would be $0.13, the difference between $0.46/kg calf sale price in Inner Mongolia and $0.59/kg purchase price at the feedlot in the Beijing area.

The cost per kg sold is $0.61 for the higher grade cattle versus $0.65 for the calves from the current cow/calf operation. There is $16 net income from each head of the higher grade cattle sold compared with $1 from the lower grade cattle.

Feedstuffs Utilization

One of the most dramatic parts of the analysis, and of particular interest for macro level planning, relates to a comparison of feedstuffs use as measured on an energy and protein basis. Results in Table 2 show that while 14,230 Mcal of metabolizable energy (ME) and 738 kg of crude protein are required per 4-year old male sold at slaughter weight in the current alternative, a feedlot fattened animal from the current alternative cow/calf operation needs only 5,670 Mcal of ME and 371 kg of crude protein (CP). In the improved operation, only 5,410 Mcal of ME and 351 kg of CP are required. In effect, less than half as much ME and CP are required when the feedlot system is introduced. The ME and CP in the grass fattened operation are an accumulation of utilization by the calf as well as the amount attributable to each year of life. Grass fattened cattle in China gain during the summer months but then lose during the winter. The ME and CP are calculated dry

Table 2. Metabolizable energy and crude protein per head sold.

Parameters and results	Grass fattening		Calves to feedlot	
	Current	Improved	Current	Improved
	Cow/calf operation			
ME/Hd finished to slaughter weight				
Grass finished				
3-year old males (Mcal)		13,320		
4-year old males (Mcal)	14,230			
Feedlot finished (Mcal)			5,670	5,410
CP/Hd finished to slaughter weight				
Grass finished				
3-year old males (Kg)		730		
4-year old males	738			
Feedlot finished (Kg)			371	351

Source: Author's field work. Results are summary from computer program.

matter based requirements for minimal growth. The feedlot ME and CP are based on dry matter based equivalents of feedstuffs consumed (Simpson et al. 1994).

Discussion and Conclusions

The economic and feedstuffs use models presented clearly indicate that considerable advances can be made in improving the efficiency of China's cattle industry. A shift to a cow/calf orientation would also free up some rangeland for renovation. Furthermore, although the analysis was done for cattle, the principles hold for sheep production as well. One conclusion is that feedlots are a viable alternative. However, use of them will take time due to the need for improved transportation and communication systems and knowledge about management. Fed cattle prices are not particularly favorable for feedlot finishing but, as the economy develops and demand grows, prices will improve. Meantime, for wide adoption of feedlots, a number of market and institutional changes will be necessary. For example, sale price of slaughter cattle may be bid up to reflect higher quality, or cow/calf operators and feedlot operators might form joint ventures. In this type of business venture cow/calf operators would gain by selling calves rather than grass fattened animals. Another possibility is that advances might be made in feeding efficiency or in reducing feedstuffs cost in the feedlot.

Development of China's beef industry has to be evaluated from a micro as well as macro viewpoint. The micro, or producer oriented analysis, indicates that a substantial increase in profitability could be obtained from an improved system, even when fattening on grass. Additionally, shipment of calves to feedlots is more profitable than the present grass fattening oriented system. Naturally, there are considerable differences among producers, part of which is based on management and part on location. Some producers are so isolated that calf production will not be a viable alternative for many years. In other cases, where producers are located near rail lines or major roads, many of them could shift over to a cow/calf system if a viable marketing system were developed. To date, the rail, road, and communication infrastructure has been inadequate to support the proposed feedlot system. But, rapid development of infrastructure is taking place and, by the end of the 1990's, is expected to be sufficiently adequate that some grassland producers could participate.

On the macro or national level, the analysis indicates that a substantial savings is possible in feedstuffs per kg of meat produced (on a protein and energy basis). China has a surplus of animal feedstuffs and is one of the world's largest exporters of feedstuffs. This surplus situation is expected to continue well into the next century (Simpson et al. 1994). Furthermore, there is an abundance of low quality roughage in farming areas such as rice and other straws as well as stovers such as maize residues which can, and do, serve as a basis for feeding cattle. China has a very large program in farming areas for treatment of low quality roughages with ammonia and urea. This will expand with demand for higher quality feeds. Research has been carried out on feedlots, especially by Beijing Agricultural University and through the Food and Agriculture Organization of the United Nations (FAO) programs. The government has a self sufficiency food policy that is oriented to importation of technology rather than feedstuffs or food. This policy, articulated through both tariff and non-tariff means, will stimulate development of the feedlot industry. Beef imports and exports about offset each other.

One impediment to development of a large scale feedlot industry is knowledge, i.e., a technical problem. In general, capital is not a constraint, especially to villages and cities, which are already major owners of hog and chicken operations. However, lack of grading systems for live cattle and carcasses are major barriers, especially when considering tourist trade outlets. As incomes increase, quality aspects of carcasses via a grading system, especially those related to grain feeding, will have to be instituted for feedlots to really flourish.

Continual land tenure changes will be required which draw people from grassland areas to urban settings. The grasslands are overpopulated in the sense that expansion of holdings--and thus greater incomes--through size, scale economics and more sophisticated management requires human depopulation. An example of measures being taken is experimentation of land use rights sales in Anhui province (in central eastern China). The last impediment is need for a marketing program that will facilitate sales from grassland areas to crop areas. One innovation being experimented with at Beijing Agricultural University is a contract system in which cow/calf producers retain ownership of calves through the fattening process and/or a contract system.

Sustainable production of China's grazing lands--and continued improvement of them--means that in addition to programs related to livestock owners, infrastructure development such as roads, marketing channels and transportation mechanisms are critical. Massive programs are being carried out. If China continues the high rates of economic growth recorded over the past decade (8–12% annually), there will be potential for a profound impact on China's grazing lands.

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