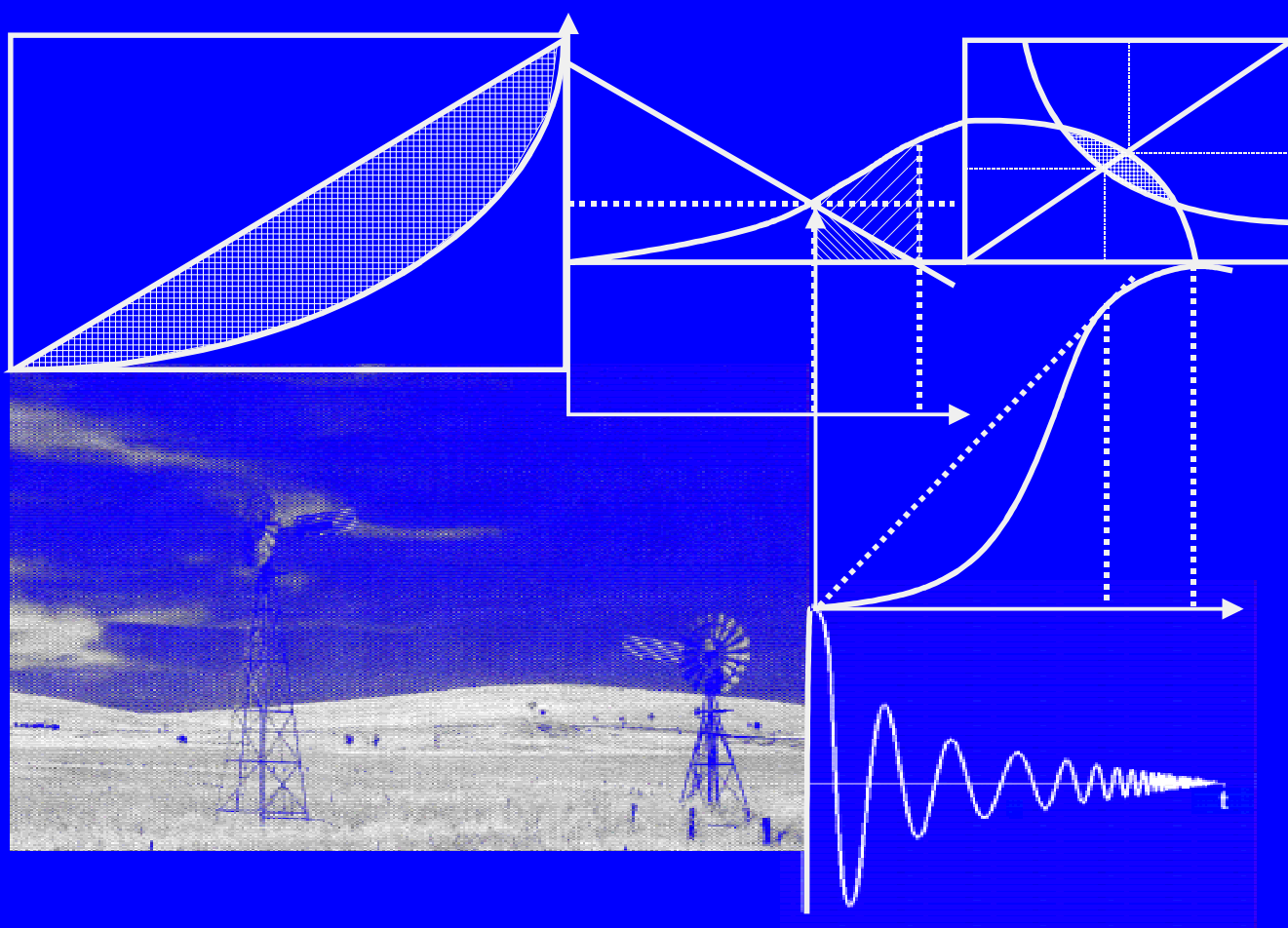


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Beef and Cattle Industry**

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Grain and Oilseed Consumption in China's Beef and Cattle Industry¹

Scott Waldron² and Zhang Jinhang³

In recent years, the question of 'who will feed China' has been debated intensely and widely. While estimates vary considerably, there is a consensus amongst foreign observers that China will be forced to import grain on a substantial scale within 10 years (for an overview see Fan and Agcaoili-Sombilla, 1997). In contrast, most Chinese officials and analysts predict that China will remain basically self-sufficient in the grains sector. China's animal husbandry industry development policy has been strategised to help meet that end.

In their analysis of grain production, consumption and trade, analysts from outside China fail to give adequate attention to two important factors⁴.

One is the role of the animal husbandry industry. Incorporating a sophisticated approach to indirect – as opposed to direct – grain consumption is important for two main reasons: a) approximately 30-34% of China's total grain output was consumed by animals as feed grain in 1995 and this figure is projected to rise to 40% by the year 2000 (Shi, 1997; Ke, 1997)⁵; b) China's animal husbandry sector (along with the literature about it) is developing rapidly and this has important implications for the efficiency with which grain resources are utilised⁶.

The second obvious gap in most projections is the role of policy addressing what is referred to in China as the 'liangshi wenti' (usually translated as the 'the grain issue')⁷. In a proud and socialist country, Chinese policy-makers are highly unlikely to completely transfer to market or to international forces, the responsibility of feeding 22% of the world's population on only 7% of the world's arable land (State Council, 1996(b)). China does and will continue to actively address the 'grain issue' through a range of industry policy mechanisms. Policy initiatives are particularly relevant in the animal husbandry sector which, over the last five years, has been growing at a rate of around 10%, while annual grain production growth rates remain fixed at around 1% (personal communication, Ministry of Agriculture Feed Industry Office)

This paper seeks to contribute to the literature on the subject of grain consumption, utilisation, and policy in China by providing a preliminary analysis of the factors that effect feed consumption in the Chinese beef and cattle industry. According to the Ministry of Agriculture officials (Guo and Yang, 1996), the feeding of treated straw to cattle will save China 42-45 million tons of grain but, at the same time, according to World Bank projections (1993, p.177-8, see Appendix 1), cattle in China will consume 31.4 million tons of grain and oilseeds. These figures are significant given that the average of six projections (listed in Fan and Agcaoili-Sombilla, 1997) on China's grain imports in the year 2000 will be 26.5 million tons.

The first section of this paper overviews China's feed resources in an international context and discusses the implications for animal husbandry development policies. The second section outlines the 'Straw for Beef' program, a major central government policy initiative aimed primarily at converting resources not otherwise consumed by humans – mainly straw – into beef and, in the process, to displace growth of the more grain-intensive pig industry. The third part of the paper seeks to assess claims made about the grain-saving potential of the 'Straw for Beef' program by looking at results of feed trials using both straw and feed concentrates. Fourth, different cattle feeding practices employed in different production systems – grazing, household production, contract fattening and feedlot production – are overviewed. The fifth section discusses the relative importance of these different production systems, how this might change into the future and makes some comparisons with the

¹ Paper presented to the 42nd Annual Conference of the Australian Agricultural and Resource Economics Society held at the University of New England, Armidale, 19-21 January 1998. The paper draws upon research from Australian Centre for International Agricultural Research (ACIAR) and Meat Research Corporation (MRC) funded projects on an analysis of socio-economic and agribusiness developments in the Chinese cattle and beef industries. The projects involve collaboration between The University of Queensland, the Institute of Agricultural Economics within the Chinese Academy of Agricultural Sciences, the Rural Development Institute within the Chinese Academy of Social Sciences, and the Department of International Co-operation within the Chinese Ministry of Agriculture. Further details of the research projects can be found at <http://www.uq.edu.au/~aghcail/china.html>. The authors would like to thank the other collaborating scientists on the research projects for their help in preparing this paper and to ACIAR and MRC for their funding support.

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⁴ In addition to these two areas, others are identified in Fan and Agcaoili-Sombilla, 1997

⁵ In personal communication, some Chinese analysts said that these proportions are understated. The World Bank (1993), the livestock sector will consume slightly less than 60% of all grains and oilseeds, compared to 40% consumed by humans. The cattle industry was said to consume 10.6% of all grains and oilseeds.

⁶ Huang, 1995 and Garnaut and Ma, 1992, give considerable attention to the role of animal product and liquor (indirect grain) consumption in projections for the OECD

⁷ This could also be translated as the 'grain problem', the 'food issue' or the 'food problem'

Chinese swine industry. Finally, some observations are made about the efficacy of the ‘Straw for Beef’ program from a grain-saving perspective.

Research notes

As should become evident in throughout the paper, accurately determining and projecting feed consumption in the Chinese beef and cattle industry – and the efficiency in which it is utilised – is a problematic but important exercise. Data on the subject is collected neither by the State Statistical Bureau, or the Ministry of Agriculture⁸. Similarly, information necessary to quantify feed consumption and efficiency of utilisation in the beef and cattle industry – feed conversion ratios, the relative importance of different production systems, scale of production figures, quantity of manufactured feed produced for cattle and average dressing percentages *amongst other factors* – is both scarce and contradictory⁹. The lack of data is due to the relatively recent emergence of the beef and cattle industry and the pace at which it is changing. However, with a bovine herd size of about 140 million head in 1995 – an approximate increase of 9% over 1990 numbers – such data collection will become an increasingly necessary basis on which to frame industry development strategies. This paper may contribute to future research to quantify grain consumption – in terms of absolute quantities and relative efficiency – in the Chinese beef and cattle industry. Because of the lack of available data, this analysis in paper is necessarily more qualitative than quantitative in nature.

While this paper focuses on the impact of the development of the beef and cattle industry on feed usage and grain consumption in China, these issues can be approached in an opposing cause-effect relationship. That is, cattle feed policy and practices also impact heavily on beef industry development; turnoff rates, the quantity and quality of beef produced in China (for exports markets for example) and – by extension – beef consumption in China. One of the findings of a World Bank study on the Chinese Beef Market was that restrictive grain import policies will benefit the beef industry at the expense of reduced pork output (World Bank, 1997).

A methodological note about the use of feed terms used in this paper:

‘Grain’ in China *implies* grain able to be consumed directly by humans. The range of cereals are obviously included, but so too are soybeans, which are classified most other countries as ‘oilseeds’. Corn is classified a ‘grain’ although the used predominantly as a ‘feed grain’¹⁰. These are referred to loosely as ‘energy feeds’ in this paper.

‘By-products’ are a wide-ranging category not consumed by humans directly and generally low-priced. They include straw (the stubble of grain left after harvest), grain husks, brewery or distillers waste, bagasse, a range of fruit and vegetable scraps and residues, animal by-products (feather meal etc.), tofu residue etc. By-products constitute a very important source of cattle feed in China and are referred and some of these – brewery waste and distillers waste in particular – are of good nutritional value and used widely for pig feed.

Strictly speaking, soybean meal (SBM), soybean cake (SBC), rapeseed meal (RSM), rapeseed cake (RSC) and castor oil cake (COC) are also by-products of oil processing, cotton seed and cotton seed cake (CSC) are by-products from the textile industry and fish-meal of the fishery industry. These meal and cake products are referred to as ‘protein or by-pass protein feeds’ in this paper, not ‘by-products’ because: a) they have a high protein content; b) they are relatively high-priced, c) they are in high demanded in the pig and poultry industries.

This paper makes the broad distinction between ‘**concentrates**’ (‘energy feeds’ or ‘grain’ and ‘protein feeds’ or ‘oilseed cakes’ referred to above) and the ‘**by-products**’ referred to above, excluding soybean and oilseed by-products.

With regard to other terms: 15 mu is the size of one hectare; Rmb6.2 (or 6.2 Chinese yuan) was the approximate value of A\$1 when fieldwork was conducted in mid 1997.

‘Short-cycle’ of ‘intensive’ fattening, for the purposes of this paper, takes place over a period of less than 190 days while ‘long-cycle fattening’ takes longer.

⁸ In contrast, equivalent data for the pig and poultry industries is widely available at both national and provincial levels.

⁹ **Feed Conversion Ratios (FCRs) are the most significant factor in accurately determining the efficiency at which feed is utilised. In its’ 180-page Animal Feed Sector Study, the World Bank (1993, p.137) found that a “FCR (for the beef cattle industry) is not possible to assume, given the great variety of cattle and feed regimes”.**

¹⁰ Potatoes and pulses are also included in the grains category

‘Against the Grain’: cattle feed resources in China

The Chinese beef and cattle industry has outpaced all other animal husbandry industries except the poultry industry in terms of growth and China now has the second largest herd in the world. In many ways, this could be expected in a predominantly agricultural country with fast-rising standards of living. From a low base, China now has a beef and cattle industry more in proportion with its’ huge population and land area.

What is perhaps most remarkable about the sheer size of the Chinese beef and cattle industry, however, is that it has grown under a set of feed resource conditions almost diametrically opposed to those of other major beef-producing nations. As shown in Table 1, the U.S, Australia, Canada, Argentina, New Zealand and several European countries either have large grassland areas, large grain reserves, or both. To add to the curiosity, the vast majority of China’s population simply do not like to eat beef¹¹.

Table 1. Beef production and cattle feed resources in selected countries, 1994

Country	Per capita grain production (kg)	Per capita grassland (ha)	Per capita beef production (kg)	Per capita meat production (kg)
Australia	822.37	23.50	103.34	190.54
New Zealand *	---	4.27	161.16	347.83
Argentina	628.06	3.79	69.09	95.33
US	1375.20	0.93	42.87	125.99
Denmark	1493.26	0.04	38.15	363.01
Canada	1663.25	1.00	33.94	110.06
France	923.36	0.19	28.91	106.28
England	338.50	0.19	24.09	56.53
Brazil	293.10	1.19	20.17	51.59
West Germany	433.98	0.06	18.59	71.73
Chile	---	0.98	17.31	52.35
Poland	566.04	0.11	11.70	63.16
World	351.14	0.70	9.55	34.49
Pakistan	175.27	0.04	6.29	13.08
Thailand	395.76	0.01	5.38	26.22
Japan	111.95	0.01	4.85	26.74
India	235.92	0.01	2.78	4.59
China	328.87**	0.33	2.04	35.09
Philippines	233.69	0.02	2.00	18.80
Indonesia	276.49	0.06	1.65	8.52

Source: Food and Agriculture Organisation, 1994

* There was contradictory information about New Zealand in Liu (1996).

** While this figure is relatively high, China – unlike the U.S, Canada and Australia – is not a grain surplus nation and, does not have a comparative advantage in producing land-intensive commodities, including grain (Huang, 1995, p.43). Liu (1995) uses an equivalent table showing per capita chicken meat production to argue that China should prioritise the poultry industry because poultry convert China’s scarce grain resources much more efficiently than cattle do.

The Chinese beef and cattle industry is characterised by a predominant production system where cattle are raised on a very small-scale (one to three head per producer) and fed on straw, by-products and grass cut from hill and road sides. As shown in Zhang and Longworth, 1998, the focus of the Chinese beef and cattle industry has shifted from a production system where relatively small numbers of cattle raised extensively in the pastoral region of China to large numbers of cattle raised intensively in the agricultural region, known as the Zhongyuan (Central Plains) Beef Belt¹². It should be noted, however, that the ‘Corn Belt’ region of Northeast China is, from a low base, now recording the highest regional growth rates in cattle numbers in the country¹³. Along with a policy directive to exploit grassland resources in the South of China (Zhang and Huang, 1997; Qi, 1997), this might bring about cattle production and feeding regimes more comparable to international patterns¹⁴.

¹¹ Another difference is that, with the marginal exception of Argentina, beef producing counties are developed rather than developing countries

¹² The proportion of cattle of cattle in China raised in the five pastoral provinces has diminished from 55% in 1980 to 13% in 1995. The proportion of cattle raised in the four Zhongyuan Beef Belt provinces and Liaoning increased from 10% in 1980 to 57% in 1995 (Ke, 1997). The development of the beef and cattle industry in Zhongyuan Beef Belt was orchestrated through a series of bi-annual national symposiums run by the State Council and organised by the Ministry of Agriculture titled, ‘Developing Animal Production in the Agricultural Zones’ (*Nongqu Fazhan Xumuye*). One third of all counties targeted as model ‘Straw for Beef’ counties are located in the Zhongyuan Beef Belt.

¹³ Authorities in Jilin have, since the late 1980’s, sought to use grain surpluses, some of which is not permitted to be ‘exported’ to Southern provinces, to develop the provincial animal husbandry industry. Highly commercialised contract-fattening chicken production systems have been directly transferred to the beef industry. Central government has also given support to beef development in the region. The third State Council symposium on ‘Developing Animal Production in the Agricultural Zones’ determined to “strengthen and further develop the Zhongyuan Beef Belt, develop the Northeast Beef Belt and explore (potential in) the, North Beef Belt”

¹⁴ In order to draw contrasts in production systems, fieldwork in 1997 deliberately targeted representative provinces of the pastoral region (Inner Mongolia Autonomous Region), the Northeast (Jilin) and the Zhongyuan Beef Belt (Anhui)

For the foreseeable future, however, China will continue to base cattle production on unique feeding practices. No other beef producing country raise cattle so intensively or use straw for cattle feed on the scale and degree of intensity seen in China¹⁵.

‘Straw for Beef’: a good trade, what’s the catch?

The Chinese beef and cattle industry emerged suddenly and dramatically in the beginning of the 1990’s mainly because it was prioritised for development under the auspices of the ‘Straw for Beef’ program (jieganr yangniu). The program is actively supported by the highest levels of the political hierarchy within the Ministry of Agriculture and the State Council, which provide very substantial funding and have mobilised research and extension services. Beef producing regions (provinces, prefectures and counties) are enthusiastic participants in the same aspects¹⁶.

The primary aim of the program is to encourage the use of treated straw in particular, but also other by-products, as the dominant source of beef cattle feed in China¹⁷. If successful, the logic goes, cattle will: a) consume low volumes of grains otherwise consumed by humans; b) utilise resources that would not otherwise be used constructively; c) complement rather than compete with other species for concentrate feeds, and; d) produce beef which will displace other meats in the market – particularly pork – and thereby result in concentrates being used more efficiently in the animal husbandry as a whole¹⁸. Officials say that this will result in optimal utilisation and net savings of scarce grain and feed resources.

Analysis in this paper deals mainly with the premise that cattle in China are in fact fed a high percentage of straw and by-products and a low percentage of concentrate feeds. Before turning to that issue, however, the following observations are relevant.

- With regard to b) above, officials of the Department of Animal Husbandry and Veterinary Science say that proportion of straw actually utilised for animal production / cattle rose from 20% in 1992 to 25% in 1995/6. It is expected to rise to 50% by the year 2000. The proportion of straw treated – ammoniated or ensiled – is projected by officials to rise substantially. In 1995, 7.1 million farmers across China were treating straw for

¹⁵ Straw is rarely fed outside of drought periods in Australia, rarely in the U.S, while in Europe, treated straw accounts for just 4% of feed in puts (Liu, 1995)

¹⁶ By the beginning of 1997, 207 model cattle-producing counties had been established in 27 provinces (of a total of 32 provinces) across the nation. Plans are to increase this number to 400 model counties by the year 2000, the majority of which will be in the Zhongyuan Beef Belt. By the end of 1995, 5.3% of all counties in China were designated model beef-producing counties, but these accounted for 25% of China’s beef output and 20% of all cattle turned off. Central government contributes an average of one million yuan to each model county; 40% in grant form and 60% in interest free loans to be paid back within three years. Regional government is expected to match these funds on at least a 1:1 basis. In the case of Anhui, the breakdown was 2 (central government): 1 (provincial government): 1 (county government). The ‘Straw for Beef’ program is part of a broader program termed ‘Straw for Livestock Production’ and, in 1995, was extended to sheep production in agricultural areas (Officials of the Department of Animal Husbandry and Veterinary Science Feed Industry Office, personal communication). In contrast, the pork and poultry industries are not subsidised. Under the Ninth Five Year Plan, however, species with a high Feed Conversion Ratio (broilers and layers) were encouraged to develop. The dairy industry was also encouraged in a bid to improve nutrition levels in China and the aquaculture industry was encouraged as means of better exploiting unused inland waterways (a large proportion of farmed fish are fed on manure). A dedicated ‘Straw for Beef’ Office has been established within the Department of Animal Husbandry and Veterinary Science, Ministry of Agriculture.

¹⁷ Moves to increase the use of locally available by-products for animal production are by no means confined to China.. Straw treatment methods have been used since the beginning of the century and have attracted world-wide attention over the last 20 years (for an overview, Sundstol and Owen (ed.), 1994) and taken up in China only in the last ten. Straw treatment programs were introduced in countries like Bangladesh but met with much less success than is the case in China (see Dolberg and Finlayson, 1995 for an overview of the reasons). Utilisation of brewery wastes, bagasse, cotton trash etc. and a range of other by-products as livestock feed is of course widespread in both developed and developing countries. In recent years, good deal of research has been conducted in this area in Northeast and Southeast Asia (International Seminar on Indigenous Feed Resources for Sustainable Livestock Production, Philippines, 1995). Reducing dependency on feed and grain imports has been a common theme.

¹⁸ Other cited reasons for promoting the ‘Straw for Beef’ program include: a), Straw and manure is used as organic fertiliser on cropland (replacing inorganic fertiliser) and for production of cash crops like mushrooms. Catch phrase of ‘Returning Straw to Farmland via Animal Production’. Livestock systems based on crop residues provides 1 billion tons of organic fertiliser – enough to support 20 million hectares of farmland – which not only reduces crop production costs but also promoted sustainable agriculture (Guo and Yang, 1996), b) Environmental benefits. Less straw is burnt in fields or used for cooking, thus reducing air pollution. Less straw is used by small-scale, inefficient paper-making mills, c) Households are also to benefit from the program in all model beef producing counties, a number of which were targeted as part of poverty alleviation efforts, d) Straw treatment (mainly urea is cheap, techniques are relatively straightforward and therefore easily extendable and practicable at the household level., e) The cattle industry creates a range of agribusiness opportunities, especially in the edible and non-edible by-product sectors, f) Cattle are thought be disease resilient animals. Because cattle are tethered and fed, they are less likely to graze near waterways and become prone to Schistosomiasis. The validity of some of these benefits means that the ‘Straw for Beef’ program should not be assessed solely on the basis of its’ grain-saving characteristics.

livestock production and this is targeted to increase to 20 million by the year 2000. Zhang and Shi, 1993 and Wen (1997) suggest that household cattle producers have strong incentives to treat straw for cattle feed¹⁹.

- With regard to c), straw is not used as feed for animals with a gastric digestive system (pigs and poultry) while China produces enough straw – 600 million tons in 1995 – to eliminate the question of competition for straw resources with sheep and goats. Even in the most intensive cattle-producing regions in China – Fuyang Prefecture in Anhui Province for example – has a straw surplus. Untreated cottonseed and other oilseeds, sometimes used for cattle feed, has to be included in pig and chicken diets within very strict parameters because induces gossypol. There does, however, appear to be some competition between species for SBC, corn and sweet potato chips in particular at both the household and intensive-cattle fattening sectors²⁰. Similarly, brewery and distillers waste is used widely in both the intensive cattle fattening sector and the pig industry²¹.
- Regarding d), beef production, from a low base, grew by 3.29 % between 1990 and 1995 while pork production grew at only 2.01% in the same time period. According to State Statistical Bureau statistics on production trade and population, yearly per capita consumption of beef increased from 1.1kg in 1990 to 3.4kg in 1995 while per capita pork consumption increased from 20kg in 1990 to 30.1kg in 1995 (Ke, 1997)²².

Table 2 is a summary of official estimates of grain saved as a result of straw treatment in China. If accurate, China's grain imports in 1995 would have been 44.2 million tons instead of the actual 20 million tons. Official estimates on grain saved in 2000 are about 1.6 times the higher than the average of six projections (listed in Fan and Agcaoili-Sombilla, 1997) on China's grain imports in that year (26.5 million tons). To support these claims, Guo and Yang, 1996 say that Fuyang Prefecture in Anhui Province and Zhoukou and Shangqiu in Henan Province, all of which are intensive 'Straw for Beef' regions, have turned from grain-deficit into grain-surplus regions.

Table 2. Official estimates of straw fed, treated and grain saved as a result in China, 1993 – 2000 (unit: million tons)

	Straw produced from all crops (1)	Straw fed to cattle (2)	Straw ammoniated	Grain replaced by ammoniated straw (3)	Straw ensiled	Grain replaced by silage (3)	Total grain replaced by treated straw
1993	550	110	11.7	4.7	58.9	8.9	13.6
1995	600	150	21.5	5.4	75.1	18.8	24.2
2000	670 (4)	335	60	15	120	30	42-45

Source: 1993 figures and projections for the year 2000 are derived from Guo (1995). Guo is Director of the Department of Animal Husbandry and Veterinary Science National Feed Office. 1995 figures derive from Chen (1995). Chen is a senior cadre in the State Council

(1) As an average across different crop types, 1 ton of *crops* harvested produces 1.1 tons of straw.

(2) The amount of straw utilised for animal production / cattle rose from 20% in 1992 to 25% in 1995/6. It is expected to rise to 50% by the year 2000.

(3) 1 kg kilogram treated straw is, on average, equivalent to 0.25 feed grain units (Chen, 1995) Based on the so-called 'oat feed unit', 1kg of dry 'average' straw equals 0.2 units; 1kg of ammoniated straw equals 0.4 units; 1 kg of fresh straw silage equals 0.15 units. Animal scientists at the Anhui AHB Feed Industry Office said that 1kg corn has the equivalent average nutrient value of 3-4kg ammoniated straw and 6.6kg of silage. The grain-saving calculations derived from these ratios support Chen's average ratio.

(4) Based on a conservative estimate of year 2000 crop harvest.

¹⁹ There is an issue of the availability and alternative uses of urea, widely used as fertiliser in China. Urea is subsidised when used for straw ammoniation although some householders said that this subsidy has now been retracted.

²⁰ China has gone from being a net exporter of SBM to a significant importer. The U.S in particular promotes the use of – and exports – SBM to China and a range of other Asian countries. Organisations like the American Soybean Association and the U.S Feed Grains Council lobby officials with the argument that China should concentrate on producing grain for human consumption while deregulating the feed grains trade. Feed trials showing the benefits of using imported feed grains, SBM, SBC and soybean husks are primarily targeted at large-scale pig, poultry and fish producers. To ensure valid trial results Attention must also be given to hygiene, housing, breed and management practices.

²¹ China produces about 40 million tons of distillers waste per year (Qi, 1997). In terms of both Extractable Energy and Crude Protein, brewery and distillers waste is a high value cattle feed. The availability and price of the by-products is the envy of commercial cattle producers in major producing countries (personal communication with an Australian nutrition company contracted to develop a feed regime for a Chinese feedlot). The main problem with these by-products is the high moisture content and associated high transport costs. Many feedlots in China are integrated with 'baijiu' distilleries and are incentivised to do so with tax breaks. This is one way of cutting down on waste from the increasing amounts of grain used for alcohol production. In 1996, central authorities appealed to drinkers to reduce their alcohol volumes on the grounds that it was effecting the national grain balance.

²² While the per consumption of pork is nearly ten times more than it is for beef, the Chinese pig herd has also grown from 352.8 million in 1990 to 414.6 million in 1995 (Ke, 1997). It is somewhat worrying to contrast these figures with those recording by the State Statistical Bureau based on household surveys. According to these figures, yearly per capita consumption for beef apparently actually *decreased* from 3.3kg in 1990 to 2.4kg in 1995 and pork consumption decreased from 18.5kg per person to 17.2kg (Ke, 1997, p.32)

Grain saving claims put to the feed trial test

A good deal of research by animal scientists and economists – both Chinese and foreign – have established that ammoniated and ensiled straw can completely replace other sources of roughage – as well as grains – in feed rations for beef cattle production²³. Tables 3-5 below show that it is technically feasible to produce a 450kg animal before it reaches two years of age, without the use of grass or grains. This production system is termed ‘long-cycle fattening’ and used mainly by householders in China.

Table 3. Relationship between weight gain of steers and feeding regimes of untreated and ammoniated wheat straw at different inclusion rates

Proportion of wheat straw	Untreated wheat straw			Ammoniated wheat straw		
	60%	40%	20%	60%	40%	20%
Intake of wheat straw (kg/d)	2.21	2.12	1.38	3.18	2.42	1.39
Daily gain (kg/d)	0.268	0.48	0.865	0.567	0.644	0.891
Concentrate / gain ratio (kg/d)	5.47	6.73	5.95	3.82	5.96	5.96

Source: Guo, 1995. This feed trial was undertaken by the Beijing Academy of Agricultural and Forestry Science using one to two year old steers. Each of the above rations of straw (20%, 40% and 60%) was fed in 30-day phases.

*Concentrate type not defined (may refer to one oat unit)

This feed trial was designed to show the concentrate-saving benefits of using ammoniated vs untreated wheat straw. The difference in concentrate / weight gain (concentrate conversion) ratios between the two types of straw, amounts to concentrate saved through straw treatment. That is, at a straw inclusion ratio of 60%, 1.65 kg of concentrate is saved for every one kilogram liveweight achieved²⁴. While it is generally acknowledged that treated straw does not constitute more than 80% - but usually less – of the total diet, the principle is that the higher the proportion of ammoniated straw used, the more concentrate is saved.

A number of points, however, detract from the concentrate-saving claims made here.

- Concentrate saved per kilogram liveweight gain is significantly lower at a 40% straw inclusion rate (0.77 kg) while no concentrate is saved at a 20% inclusion rate. The weight gains achieved at these rates (0.64 and 0.889 kg/day, respectively) are close to the minimum required in an intensive-fattening production system, used to turn off quality beef cattle efficiently, when feed concentrate inclusion rates are necessarily high.
- The concentrate conversion ratio – at a best case scenario of 3.82 with an ammoniated straw inclusion rate of 60% – is still much higher (less efficient) than that for pigs (2.53 on average in China) and broilers (1.63 on average) (Shi, 1997). Concentrate conversion ratios for cattle at lower ammoniated straw inclusion rates (around 6:1), compare even less favourably

Another widely accepted factor is that “feeding ammoniated straw alone is inadequate in terms of exploiting the great potential of a basal diet of ammoniated wheat straw for beef production . to fully exploit the potential of an ammonia-treated straw diet, a supplement of by-pass protein is required” (Dolberg and Finlayson, 1995, p.16). While urea used in the ammoniation process helps, by-pass protein feeds are required to stimulate microbial activity in the rumen, necessary to digest the high roughage content of straw.

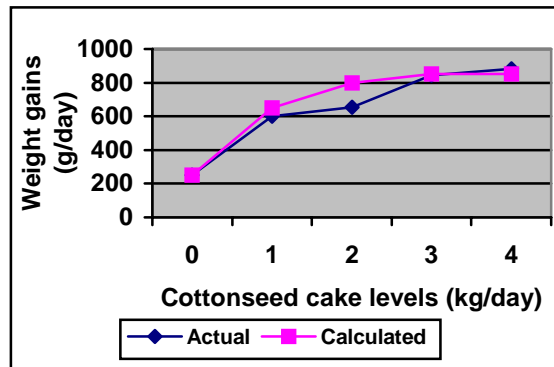
Graph 1 (based on trial results presented in Appendix 2) highlights optimal inclusion rates of cotton seed cake (CSC) when fed with ammoniated straw. CSC is a relatively often-used by-pass protein feed²⁵. SBC and RSC (rapeseed cake), probably used more often in beef cattle diets in China, have a roughly similar composition and effect.

²³ In addition to the Chinese officials cite above, animal scientists consulting to the Food and Agriculture Organisation of the United Nations (Dolbeg and Finlayson, 1995) and consultants for the World Bank (1997) have endorsed the program.

²⁴ Treated straw seen on many occasions in China is cut longer than the length advocated by extension agents. This decreases digestibility and produces results less effective than shown in this feed trial.

²⁵ The World Bank (China Animal Feed Sector Study, 1993) projected that in 2000, the nearly two million tons of CSC will be produced, about half of which will be detoxified.

Graph 1. Cattle growth rates at different CSC inclusion levels



Source: Dolberg and Finlayson, 1995 p.20

This table shows that at a 1.5 ± 0.5 kg / day inclusion rate of CSC – where ammoniated straw makes up approximately 75% of the total diet – weight gains of 6-700g / day can be achieved. No grain is used in the system. This type of diet is suited to long-cycle beef production (Dolberg and Finlayson, 1995, p.23)

Again, there is a negative aspect to these feed trial results. Firstly, the weight gains derive mainly from the CSC, not the ammoniated straw (see Appendix 2). Second, marginal weight gain growth rates begin to diminish beyond CSC inclusion rates of 1kg / day and move toward horizontal after 2kg / day. Producers aiming for liveweight gains of 1kg / day (a minimum in Chinese feedlots, most of claim to average 1.5 to 2 kg/day²⁶), will need to feed CSC in this area of diminishing returns. The use of feed grains such as corn helps to improve feed conversion efficiency at higher liveweight growth rates.

In summary, feed trials outlined in Table 3 and Graph 1 highlight two points: Firstly, a treated straw dominated feed mix is a good diet on which to produce cattle on a long-cycle fattening basis. Both concentrate – and grain in particular – are saved. Secondly, and in contrast, intensive or short-cycle fattening regimes aimed at achieving high weight gains will not only use oilseed meals and cakes inefficiently, but also use grain.

Negative implications for China's animal husbandry development policy

Some Chinese observers are concerned that the latter of the above-mentioned production regimes will become increasingly important and, on this basis, argue against China's beef and cattle industry development policy²⁷. In particular, Liu (1996) uses (U.S) data from the National Research Council – as opposed to actual feed trial results – to argue the following.

Cattle convert a corn-based diet at a ratio of 3.830 kg for every 1kg liveweight gain. The feed conversion ratio (FCR) is around 5.33 with a CSC-based feed. If this concentrate feed is used as a supplement for ammoniated straw, 3.82 kg of CSC is required to produce 1kg of liveweight²⁸.

Based on these figures, and on the understated basis that the dressing percentage of Chinese cattle is 40%, Liu (1995) calculates that production of 1 kg of beef requires 9.55 kg of concentrate feed. In contrast, a pig of medium-efficiency (most common in China) requires 4.4-5.1 kg of concentrate feed for every kilogram of pork produced. For higher quality pigs (imported on a large scale over the last few years), the ratio is 3-3.5. Very efficient chickens require 2 kg of concentrate feed to produce 1 kg of poultry. Medium-efficiency chickens require 2.8 kgs.

²⁶ Even with the use artificial growth promotants, used widely for commercial livestock production in China, claims about achieving very high growth rates are almost certainly overstated.

²⁷ Liu says that China should concentrate on producing poultry, in which it has a comparative advantage, cull nearly all of the cattle in China and allow a very limited number of feedlots to produce high quality beef to cater for the five-star hotel, tourist and expatriate market as a means of reducing commodity imports.

²⁸ Chinese breeds – particularly when cross-bred with Charolais, Limousin and Simmental breeds – record fairly high growth rates. Moreover, good nutrition is a far more important factor in cattle growth than is the influence of breed. The high growth breeds China has chosen for its' breed improvement program (Zhang and Longworth, UNE Conference Paper) require good nutrition to reach their potential. In circumstances where feed availability is low, it may be more productive to produce lower growth breeds and cross-breeds. It is conceivable, however, that China's breed program will improve feed conversion ratios by a small degree.

Besides having low feed conversion ratios, cattle are inefficient for other reasons. Compared to chickens and pigs, cattle have a low dressing percentage (although this has improved in recent years). The by-products industry is, however, important in China – perhaps more important than the beef industry. This is one reason why the per kilogram price difference between a high and low quality beast is minimal.

China also feeds a large number of unproductive cattle. The ratio between cattle numbers and turnoff numbers are comparatively low. In 1994, China's herd size was 123,320,000, (of which 24,800,000 were calves). Only 25,130,000 head, or 20% of the herd, were turned off (approximately 20% of which were probably just sold and the remainder actually slaughtered)²⁹. Note however that this is a vast improvement on the 5-8% turned off in the 80's. In comparison, pigs in China are 13 times more productive and 20 times more productive in advanced pig-producing countries (Liu, 1996)

It should be pointed out, however, that beef has a higher nutritional value than other meats [citation].

Types and relative importance of cattle production systems in China

The absolute quantity of concentrate consumed, the efficiency with which these feed resources are converted and – interconnectedly – the appropriateness of targeting the beef and cattle industry for development on grain-saving grounds, depends largely on the relative importance of different cattle production systems employed. This section overviews feed practices in different cattle production systems³⁰. A distinction is made between the following categories:

- Low-level concentrate-inclusion rates – includes non-specialised cattle producing households and households keeping cattle for draught only
- Flexible / medium-level concentrate-inclusion rates – includes specialised households and pastoral producers (on the premise that they produce a significant proportion of feeder cattle for feedlots)
- Intensive / commercialised / high-level concentrate inclusion rates – includes feedlots and households producing under contract

Pastoral production

In the pastoral regions of the Inner Mongolia Autonomous Region (IMAR), cattle numbers are limited less by grazing rate regulations or fees, than they are by the amount of feed available for cattle feed in winter when grass covers the grasslands. Producers have a limited amount of land, labour, water and, in some cases, willingness to farm crops that produce enough corn and straw for winter months³¹. It is obvious that very little concentrate is fed to cattle in a grazing production system. When calculating the number of cattle raised under this system, however, provincial and autonomous region statistics on cattle numbers are not an accurate guide. IMAR is an important cow/calf production base and source of feeder cattle for feedlots in agricultural regions³². At the same

²⁹ There are several reasons for the low turnoff percentages. Two cited below relate feed issues. One of the most important is that cows do not have the right nutrition conditions to induce them to [bull / oestrogenise]. Calving cycles in Liaoning, for example, are about 23 months. Another reason is that with low quality feed regimes, most cattle in China take a comparatively long period of time to reach slaughter weight. A large proportion of cattle cited on fieldwork – both in live cattle markets and abattoirs – were around four years of age. The average slaughter age of cattle in the U.S is 30 months and 31 months in European countries (Liu, 1996). With regard to the implications for grain consumption, however, it could be expected that the majority of these unproductive cattle (both cows and slaughter cattle) are fed on a diet of marginal quality – and grain quantity.

³⁰ Discussion of production systems in this section is based on observations and interviews undertaken on fieldwork in major, and varied, beef-producing regions of China. From existing data, a more detailed economic analysis of relative production costs, profitability and future viability will be integrated in forthcoming papers. With regard to the representativeness of findings presenting below, it is apparent that there is a high degree of uniformity in household production practices in the agricultural region, mainly because practices have been disseminated to model beef-producing regions through central government policy mechanisms and a common extension system. Less intensive beef-producing regions may, however, employ different production practices at the household level. In particular, the ratio of specialised to non-specialised beef producing households is likely to be lower in these areas.

³¹ There are regulations in Zhelimu Banner stipulating that pastoral households can cultivate only five mu per household member (an average of 30 mu per household). Corns yields on this land are relatively low – 350kgs per mu – but substantially higher if land is irrigated. Very few households have a well, however, because of the Rmb10,000 investment required. One interviewed pastoralist said that he feeds 30 cattle over five winter months at a rate of less than 1kg of corn per day. 40 to 45% of the corn harvest is fed to cattle (the rest is fed to other livestock or consumed by household members). This land also yields approximately 450 kg of straw per mu. One fully-grown animal requires about 12 kgs of straw per day over about five winter months – enough for only 7 animals. Straw is then necessarily bought in at a cost of around Rmb 0.2 / kg

³² Simpson et.al, 1994 have developed a model for the pastoral region in which grass-fed and feedlot-finished production systems are analysed. Metabolisable Energy and Crude Protein demands are provided for each system and a contrast is made between requirements in 'current' and 'improved' systems. The model also examines relative profitability.

time, the number of feedlots in both IMAR and Xinjiang Uygur Autonomous Region, are increasing significantly. Because many cattle raised in the pastoral region are raised in a grazing system but turned off for intensive fattening, these can be classified as a production system requiring 'medium-level concentrate inclusion rates'.

Both the 7th and the 9th Five Year Plans directed that the 'grasslands' in Southern China be targeted for exploitation and development³³. In Anhui Province, for example, has 4.17 million hectares of grassland resources. Officials of the Anhui Animal Husbandry Bureau Feed Office said that one head could reasonably be raised on 1.73 hectares of this grassland — a total of 2.4 million head. With the exception of Zhubei Prefecture in the north of Anhui, this grassland lies south of the Yangzi River and most of it is mountainous. This means that much of the grass will need to be cut and fed rather than grazed. Concentrate supplements will also be required³⁴.

Household cattle production systems in the agricultural region

Households in the agricultural region raise the overwhelming majority of cattle in China. The household production category is differentiated into specialised and non-specialised cattle producers. In terms of both absolute numbers of cattle-producing households and cattle numbers, non-specialised household producers are by far the dominant group.

Unlike the pig and poultry industry³⁵, there does not appear to be a recognised nation-wide definition to distinguish between specialised and non-specialised cattle producing households. For the purposes of this paper, households raising six cattle or more at any one time and turning off ten or more per year is classified a 'specialised household producer (*zhuan ye yangniu hu*)'³⁶.

In terms of production practices, specialised households are more likely to buy in cattle for fattening and more likely to have straw ammoniation pits than are non-specialised households. Both are very reluctant to buy in feed not produced on-farm and both are adamant in remaining self-sufficient in terms of labour³⁷. Both specialised and non-specialised cattle-producing households also farm (see Appendix 4) and raise pigs or chickens. There is competition amongst livestock types for concentrate feeds produced on-farm. In this competition, cattle in specialised cattle-producing households fare much better than they do in non-specialised cattle-producing households.

Non-specialised households allocate very little concentrate feed for cattle production. Reasons, as understood with interviews with households, include: a) many cattle held are used either primarily for draught or are dual-purpose draught / beef cattle; b) a 'traditional' mindset prevails that cattle can be fed on almost anything; c) in contrast, pigs and chickens are more grain-dependent; and d) most importantly, scarce feed resources are more profitably fed to other livestock types – particularly in current price conditions³⁸. In other words, non-specialised households – more dedicated to pig or chicken production – can not justify feed concentrate expenditures on cattle, but keep a few head either for draught or for sale anyway, for the very reason that they require little outlay in terms of concentrate feed or labour.

Specialised cattle-producing households take cattle production somewhat more seriously. Although some of the rationale seen in non-specialised is also true of specialised households, they are far more likely to feed cattle a higher quality and quantity feed mix. A common response to questions of cattle feed was that, under normal conditions, cattle were fed untreated straw and grass in summer months, treated straw in winter, together with a

³³ Zhang and Huang, 1997 cite State Statistical Bureau statistics that there 66.7 million hectares of hilly grassland resources in Southern China and that the area of utilisable grassland is 1.9 times larger area than the area of existing arable land. For a regional breakdown of China's grasslands, see Zhu et. al., 1985.

³⁴ While these plans are an important development for ruminant production in China, it is not analysed here: the policy is futuristic; the carrying capacity of these grasslands would appear to be overstated; and – given the distance of these grasslands from beef markets – there may be questions about the potential of these regions for commercial beef cattle production.

³⁵ Households which turn off more than 10 pigs or 100 chickens are classified 'specialised households'

³⁶ The Anhui Province Animal Husbandry Bureau decided that any producer holding more than 10 head of cattle is a 'scale (*guimou*) producer'. In one region of Fuyang Prefecture, Anhui Province, the average number of cattle kept by households was 3.2 head.

³⁷ A desire to remain self-sufficient within the household may be a result of insecurity learnt from rural China's turbulent history. In the case of the cattle and beef industry, this factor not only cuts down on feed grain on the market, but also reduces the number of cattle each household is willing to raise. It might also help explain absence of beef-producing, finance and marketing co-operatives in China.

³⁸ In Fuyang Prefecture, most households fed pigs 3–4 jin grain per day for 150 days (sold at 200 kgs). Current pig prices Rmb 6.8 per kg.

small amount of concentrate (see Appendix 3). Concentrate inclusion rates are increased when younger cattle are finished for sale in local markets. Ex-draught cattle or old cows are fed very little concentrate, even when due to estruses or before slaughter.

After harvesting crops and cutting the stubble, households take their straw to the village specialised straw cutting household and have it cut for a modest fee (Rmb2-4 to cut one ton of straw in Fuyang Prefecture). Modest quantities of corn – and sometimes SBC – is usually included with straw during treatment and urea is added at a rate of 4% for ammoniated straw. Ammoniation pits and open-sided cattle sheds are constructed outside each household in the streets of model beef-producing townships and villages. In Fuyang, the construction of these pits costs approximately Rmb150 while sheds cost about Rmb 800-1000 (both are subsidised)

In Fuyang Prefecture, soybeans are either sold to market or crushed locally. When crushed locally, householders pay a small processing fee and retrieve the oil (12 to 13% of crushed product) and cake. In Fuyang, householders soak the SBC in water for a few hours, mix the liquid in with cattle feed and feed the solid mash to pigs.

Above the state procurement quota (30% of harvest in Jilin Province), households usually sell the majority of the remainder of their grain harvest on local markets. In Fuyang Prefecture, households visited stored around 2.5 tons of wheat and corn and around 0.3 tons of SBC on-farm for household consumption and animal feed. A decree was passed by Anhui provincial authorities stating that households are not permitted to use more than 1 part grain to 3 parts straw in animal feed mixes. This was not of concern to these households because the ratio is more like 1:7 at the very most. (and 1:10 if green grass and weeds is included). Households visited in Liaoyuan Prefecture, Jilin Province in July 1997 stored nearly all their corn on-farm because of the low open market corn price at the time (lower, in fact, than the state procurement price). These households planned to store this corn until the market price improved rather than feed more of it to cattle. The household continued to feed corn only by including small amounts to ensiled and ammoniated straw during the treatment process.

Anecdotal evidence such as this suggests that, even in grain-surplus provinces where there is a high proportion of specialised to non-specialised cattle producers, household producers do in fact feed low proportions of concentrate feeds to cattle. For these reasons, even the analysis of Dolberg and Finlayson on optimal inclusion rates of protein feeds (CSC), which seem most suited to specialised household production, might have to be adjusted down (see Appendix 3 for a summary of cattle feed regimes used by specialised households in Fuyang Prefecture, Anhui Province).

This might change under better market conditions for cattle. One of the advantages of household production is that it is very flexible. If cattle and beef prices are low – as they have been over the last two years or so – the amount of grain fed is adjusted accordingly. In a worst case scenario, cattle can be fed on a very low-cost treated straw-only diet. If prices rise, there obviously is an incentive to turn off cattle at a greater liveweight and this involves good animal nutrition³⁹. The flexibility and low input costs – labour, disease control and particularly feed – that cattle bring to household farm systems under different market conditions, acts as a major incentive for households to raise cattle⁴⁰.

Contracted household producers

Another policy directive currently receiving attention in the Ministry of Agriculture and throughout China is the so-called ‘farmer plus companies’ (*nonghu+qiye*) model. This is designed to involve and benefit the masses of households (*wanhu*) in China’s agro-industrialisation (*nogyeqiyehua*) drive. In the beef industry, regional officials are advocating a system where specialised households raise cattle to strict specifications, including diet, for abattoirs.

³⁹ Three and a half year old cattle seen, or said, to be to be turned off from households in Lixin County (see Appendix 2) averaged roughly 350kgs and sold at local markets for an average net profit of around Rmb 600. Two interviewees in Mengcheng County said that they turned off calves at around 8 months of age for a gross profit of Rmb 1500. While households do not usually produce cattle to stipulated specifications and young or well-muscled cattle do not necessarily command a price premium at *local markets*(see the section below about producing on contract for abattoirs), cattle are usually sold at local markets on the basis of estimated (ie. without the aid of scales) liveweight and sometimes estimated dressing percentage. One abattoir in Hebei Province paid a higher price for local Yellow cattle than it did for cross-bred cattle because they have softer, better coloured hides and because they have a lower dressing percentage (ie. more intestines). In this sort of market, householders have a low incentive to produce quality beef through high-nutrition feeds.

⁴⁰ Feed input costs make up a much higher – and more fixed – percentage of total costs of swine production. As a result, pig/pork prices follow the grain (especially corn) market with a lag of about five to six months. Alternatively, swine producers get squeezed out of existence with high feed prices because – unlike cattle – there is a limit to the amount of non-grain resources pigs can be fed.

In Lixin County in Anhui Province, 10% of cattle were said to be raised on contract and officials estimated that this would increase to 80% “in the future”. A newly constructed abattoir in Changchun City, Jilin Province – a so-called ‘dragon head enterprise’ (*longtouiye*) called Dexin – has contracted more than 20,000 households to produce cattle and plans to increase this number to 100,000 “in the future”⁴¹. In Jilin, there are three other abattoirs that use the same contract arrangements. Dexin will not sign with households that hold less than ten head on feed. In the households visited, cattle are fattened for 180 days, turned off before they reach two years of age at weight of around 500kgs. The high-grade cattle are purchased by the abattoir for Rmb9.6 / kg and ‘second-grade’ cattle for Rmb9.2 / kg – a price significantly higher than those in local live cattle markets. These contracted households effectively act as small-scale feedlots.

The following feed regime – which is very grain and oilseed intensive – was developed and disseminated by Dexin abattoir⁴².

Cattle are to be fed for a total of 180 days at an average daily liveweight gain of 1.17kgs.

The average daily concentrate inclusion rate was 4.66 kg / head / day (total of 840 kg over 180 day period)

- The average corn millet ration was 3.83 kg / head / day (incremental increase of 2 to 4.05 kg / day) (total of 690 kg @ Rmb0.8 / kg)
- Average oilseed mix of 0.83 kg / head / day (started at 0.5 kg / day), of which:
 - Heat-treated SBC averages 0.55 kg / head / day (total of 100 kgs @ Rmb2.8 / kg)
 - RSC averages 0.28 kg / day (total of 50kgs @ Rmb 1.9 / kg)
- Crushed bone (calcium source) included at 0.1 kg / day

In addition to this stipulated mix, the household and another feedlot in the area added the following for a total average total feed cost of Rmb 7 / head / day

- 0.5 kg wheat husks @ Rmb 0.7 / kg
- 10 kg / day brewery waste
- 2.25 kg / straw
- 0.05 salt
- vitamins

The contract fattening system had met with problems in Jilin Province⁴³ but appeared to be working well in Guoyang County (Anhui Province)⁴⁴. It is conceivable that this system will gain in relative importance; quality control is better than in ‘common’ household production systems while overhead costs may be lower than those of ‘common’ feedlot systems. Again, much depends on future demand for quality beef.

Feedlots

Feedlots visited in up-country China⁴⁵ appear to be less grain-intensive than is the case in the U.S and Australia (see Appendix 5 for a summary of feed regimes in feedlots visited). These feedlots also appear to feed less

⁴¹ The contract system used by Dexin and other abattoirs in Jilin is a direct transplant from a model used very successfully by the Thai conglomerate Charoen Pokphand (called Zhengda in China). One of its joint ventures in Changchun City (Jilin Province) produces 16,000 broilers per day and exported US\$ 65m worth of poultry in 1996. Zhengda has more than 160 joint ventures in China, is probably the biggest of all foreign investors in China and the dominant player in the Chinese feed industry – an initial step to greater plans to corner the Chinese poultry industry through contract production (as it has in Thailand). Senior staff from a Zhengda joint venture in Changchun was charged with developing Dexin’s contract system.

⁴² Note that grain and oilseed prices in Jilin are lower than elsewhere in China. Stipulated feed regimes are therefore likely to be different in other regions.

⁴³ Unfortunately, construction of Dexin abattoir construction is behind schedule, despite having 20,000 head of cattle reaching – and in some cases – exceeding the stipulated weight, and has not yet opened for production. Moreover, it had only forward-sold about 225 tons of beef (the equivalent of about 1,000 cattle). As a result, the abattoir had effectively reneged on its contracts to producers. Households and feedlots contracted to Dexin were suffering financial losses as a result.

⁴⁴ An interesting and more successful type of loose contract system was described in Guoyang County (Anhui Province). The ‘Golden Triangle Yellow Cattle Beef Company’ produced 1500 tons of ‘Strong King’ brand processed, cooked, vacuum packed (fatty) beef last year. The company also operates an integrated abattoir. The company is now seeking to control quality and quantity of supply – it demands cattle 2 to 3 year old, fed on a soybean-based diet and free of any traces of disease or ‘poison’. The company pays outside suppliers a price premium of Rmb0.4 / kg dressed weight for cattle delivered to stipulation (and pays market price for by-products). It is also willing to provide a Rmb10,000 advance to feedlots or dealers able to guarantee the supply of 2,000 head of the specified cattle per year. Finally, it distributes Rmb50 coupons to township officials to pass on to household producers, which can be claimed for every head accepted by the company

⁴⁵ A limited number of very well-known feedlots located closer to the Beijing market – Hua’an and Husi for example – have established niche marketing channels, high-level contacts and sound quality control and management systems. These feedlots appear to be making solid

concentrate than that required to achieve weight gains necessary for high quality beef production demanded in markets like Japan and Korea⁴⁶. Despite the fact that average daily weight gains appear to be overstated by most feedlot managers, it still appears, as could be expected, that FCR's outlined by Liu, 1996 (above) are roughly equivalent to those being recorded in Chinese feedlots.

Is the proportion of cattle turned off through feedlots likely to increase into the future? With relatively low beef prices at present, the commercial viability of feedlots and enterprises contracting households appears to be questionable. With the exception of three feedlots visited – two of them privately owned – all others were operating well under capacity (see Appendix 5). In Anhui Province, a number of feedlots had been forced to close operations over the last year. As mentioned above, the major contractor-abattoir in Jilin had effectively reneged on contracts with households and feedlots.

Most officials at both central and regional levels say that increasing proportions of cattle are being turned off through feedlots. While this is not the case in at least one county visited (see Table 5), this growth might be a function of non-market forces. Regional government – far less concerned than central government about the 'grain issue' in China – actively encourages (through policy and funding) intensive-feeding cattle production systems. Feedlots and contract-fattening abattoirs are always included in regional (especially county and prefecture) beef agro-industrialisation plans because large-scale, commercialised Dragon Head enterprises are seen as necessarily desirable. With very few exceptions, these newly established feedlots are government-invested and managed by people from or associated with the regional (county or prefecture) Animal Husbandry Bureau, Ministry of Agriculture or the Foodstuffs Bureau, Ministry of Internal Trade.

A number of factors will determine the viability of concentrate-intensive systems into the future.

- Beef prices – particularly in the higher end of the market
- Ability to develop better management practices and levels of market integration
- Changes in the price and availability of concentrate. Feedlots may prove to be more viable in the grain-surplus province of Jilin.
- Efficiency in comparison with household producers. Household producers lack production expertise but have lower overhead costs and, most importantly, are much more flexible in their ability to adjust production inputs and outputs to suit different market conditions than are concentrate-intensive producers.

Feed companies – beef mixes

A very small proportion of feed consumed by cattle in China is fed in manufactured form (that is, bought from feed companies, bagged and mixed). To reduce capital outlay, feedlots usually mix feeds either in small on-site mills or in cement mixers, while household producers usually mix feed ingredients by hand. Cattle, for example, do not figure in statistics on compound feed consumption by livestock type. Cattle are placed in the 'other category' that includes horses, sheep, goats and rabbits which, together, accounted for 1.2 million tons of manufactured feed in 1995. Compound feed used in the pig, layer, broiler and fish industries (in order of importance) totalled close to 41 million tons in 1995. A much higher percentage of manufactured feed is fed to pigs and, in particular, broilers and layers. Producers in these industries are slowly acknowledging the benefits – in terms of superior nutritional value and economic margins – of feeding manufactured feeds⁴⁷. Animal nutritionists and government officials alike advocate the use of feeds on the grounds that it increases the efficiency with which animal feeds are utilised.

The same notion is also being extended to the beef cattle industry. Again, all beef agro-industrialisation projects integrate a Dragon Head feedmill into industry development plans. One such enterprise, used as a case study here, is the Jinming Feed Company in Guoyang County, Anhui Province.

commercial gains from their integrated feedlot / abattoir operations. Ministry of Agriculture Informationstatistics show that there are at least 50 and perhaps 80 feedlots in China with a capacity to feed more than 1,000 head at any one time. One in Yunnan Province has stated capacity of 30,000 head but slaughtered only 31,000 in 1996. It is difficult to calculate how figures on stock on feed at any one time convert to turnoff figures (and vice-versa) because sources often neglect to specify the length of time cattle are fed. Figures on the scale of production also often cite feedlot capacity rather than actual capacity used and, as discussed below, there is usually a big difference between the two.

⁴⁶ This is an issue because officials of nearly all beef agro-industrialisation projects have plans to sell in these and other export markets.

⁴⁷ The Chinese feed industry is now the largest in the world. While the majority of feedmills in China are state-owned, as of 1996, the industry was the core investment sector of China's biggest foreign investor (Sino-Thai conglomerate, Charoen Pokphand (*Zhengda*) and China's most successful privately-owned company, 'Hope Group' (*Xiawang jituan*)).

This Feed Company is one of four parts of a conglomerate that also processes vegetable oils, wheat and peanuts. It is owned and managed by the Foodstuffs Bureau (*liangshiju*) of the Ministry of Internal Trade at county level. Jinming Feed Company opened in 1984 and, since 1991, produces pellets only at a capacity of 10 ton per hour in eight-hour per day shifts. Actual production is 8,000 ton per year. Of all the feed sold by the company, 60% is for chickens, 35% for pigs and the rest for ducks, fish and cattle. Total cattle feed sales are only 10 tons per year.

Despite the fact that Guoyang, together with neighbouring counties, is a highly intensive cattle producing regions and that the company has more than 50 retail outlets in the region, the manager of the Jinming Feed Company is very circumspect about the likelihood of ever selling much cattle feed. He says that cattle producers are unlikely to change prevailing attitudes to justify feeding higher quality feeds to cattle. Table 5, which shows that large-scale producers in Guoyang are struggling in a relatively stagnant cattle and beef market, is also important.

If cattle producers do start to use manufactured feed, however, the mix in Fuyang Prefecture will probably resemble the following:

Table 4. Beef cattle mixes for Jinming Feed Company, 1997

Ingredients	Fattening mix (%)	Calf mix (%)	Cost of ingredients (Rmb per kg)
Corn	53	38	1.1 – 1.2
Rapeseed cake	6	5	1.24 – 1.26*
Cottonseed cake	5	5	1.24 – 1.26*
Wheat bran	30	30	0.9*
Soybean cake	1.4	13	2.88 – 2.9*
Additives**	4.6	9	7.60
% protein	13.5	17	
Mix sells for:	Rmb 2,000 per ton	Rmb 2,200 per ton	

Source: Jinming Feed Company

*This actually means market price because the company gets all its oilseeds and wheat bran from integrated factories.

**Additives (minerals, vitamins and anti-biotics make up 1% of feed mixes and is bought from Zhengda who also provide technical advice⁴⁸.

Scale of production

Estimating the scale of cattle production is important because there is a positive relationship between the number of cattle raised by any one producer and the quantity and quality of feed given to cattle within that production unit. A series of citations and tables are provided below. Collectively, these show that cattle are produced on range of scales in different regions, but that the overall scale of production in China is small.

Officials of the Department of Animal Husbandry estimate that 10% of all cattle turned off in China, are turned off through 'feedlots'. It is important to note, however, that specialised households are often classified as 'feedlots' Ke (1997) assumes that 10% of cattle are raised in herds of more than 10⁴⁹. In many ways, the lack of distinction between 'feedlots' and specialised households which raise more than 10 head, is an accurate reflection of production practices in the agricultural region (cattle are, for example, tethered for most of the day and housed at night in households). As discussed above, however, feeding practices in households and feedlots differ considerably. Appendix 6 shows the extent of data kept at a national level on the scale of cattle production in China. It is difficult to determine the proportions of cattle each category because information on neither absolute cattle numbers, nor the average number of cattle in each category, is provided.

Officials of the Ministry of Agriculture have a target to produce more than 15% of Chinese cattle in herds of more than 10 head. This will bring the scale of production in the cattle industry closer to that of the pig industry. Indeed, as an animal husbandry industry, which, from a stronger base, began commercialising about a decade before the beef and cattle industry, China's swine sector might provide an insight into how the Chinese beef and cattle industry might develop. Appendix 7 shows clearly the relatively small scale of production on which pigs are raised in China. In 1995, 85% of all pigs in China are raised in non-specialised households on a 'very small'

⁴⁸ On a related note, it is clear that industry players see growth in the additives sector of the cattle feed industry. Not only Zhengda, but another Thai company and a range of entrepreneurial academics, aggressively market feed additives to receptive feedlots and contractor abattoirs. The abuse of additives and, in particular, artificial growth promotants – used widely in the pig industry in a bid to replace solid nutrition from feed – constitutes an important potential problem in the Chinese beef industry.

⁴⁹ There also was a directive passed down by the Anhui Animal Husbandry Bureau that any producer with more than 10 head of cattle is to be classified as a 'scale producer'. The meaning of this term could easily be extended to mean 'feedlot'

scale (less than 10 head). The proportions differ from 87.5% in Sichuan Province (the largest pig producing province in China) and 77.64% in the economically developed province of Fujian (Statistical Summary of State Agriculture, 1993-1995)⁵⁰. While Appendix 7 shows that the number of pigs, the total number of pig-producers and the number of 'very large' pig-producing enterprises rose significantly between 1993 and 1995, the average scale of pig production (3.25 in 1995) has changed very little and, in fact, decreased over 1993 levels (3.31). As stated above, 'very small' non-specialised households remain predominant in China's pig industry and their role diminished only by very small increments over these three years. Similar patterns may emerge in the beef and cattle industry (see feedlot sections above).

The Animal Husbandry Bureau of Anhui, a major beef-producing province in the Zhongyuan Beef Belt, estimates that the proportion of cattle raised in feedlots (loosely defined) in the province had risen by about 1% per year since 1992. In 1996, 5% of all cattle turned off in Anhui were fed in 'scale' production units (defined as producers holding more than 10 head at any one time) and officials say that this may reach as high as 7% into the future.

This may prove to be the case. Table 5, however, shows a more detailed picture of how this 7% of 'scale producers' might be constituted into the future.

Table 5. Scale of production in Guoyang County

Scale of production (av. no. of cattle on feed at any one time)	Proportion of feedlot cattle – 1996	Proportion of feedlot cattle – 1995	Notes
> 5 head (households)			Said to be 8,000 of these
< 40 head (feedlots)	60%	58 – 59%	
40 – 100	30%	20%	Said to be 48 of these
> 100	10%	21 – 22%	The largest lot holds 160 head

Source: personal communication with county officials

These are revealing statistics, which equate with anecdotal evidence gathered not only from Guoyang County but also throughout Fuyang Prefecture. While the percentage of cattle raised in medium-scale feedlots (40 to 100 head) increased significantly, the proportion of cattle raised in large scale feedlots (more than 100 head) decreased by about the same amount. With cattle and price decreases in 1995, large feedlots either reduced their cattle numbers or closed their operations.

A different picture again emerges in the grain-surplus prefecture of Liaoyuan in Jilin Province. Prefecture officials say that 33% of all cattle turned off in Liaoyuan are finished in feedlots – households produce the rest. Within Liaoyuan Prefecture, Dongliao County officials said that there are 65,000 cattle-raising households in the county – the average number of cattle per household is 2.3 head. There are 50,000 households with an average of 1.8 head (used mainly for draught). Another 15,000 households (25% of cattle-raising households) raise an average of 5 head. There are 4,800 household feedlots in the county which normally hold around 20 head and turn off an average of 9.3 head / year. Another 4,000 households operate under the '5x3x3' model – they have 5 female cattle, which give birth to 3 calves, which generates an income of 3,000rmb. One feedlot can feed 122 cattle at a time (feedlot No. 5 in Appendix 5).

In summary, while it would appear that while there are some large-scale feedlots in China, the average scale of production is low – probably lower than the pig industry.

Conclusion

Concentrate feed consumption in the Chinese Beef and Cattle Industry has important implications not only for the grain consumption and the grain balance in China, but also for the development of the industry itself and for Chinese policy-makers in the animal husbandry industry. Because of the small-scale on which cattle are

⁵⁰ Chickens are raised on a much more commercialised basis. In 1995 for example, 55.83% of all chickens were raised in enterprises that hold between 10,000 and 100,000 birds (classified a large—but not very large – scale enterprise) (Statistical Summary of State Agriculture, 1993-1995)

produced in China and the low level of concentrate feed used in these extensive production systems, the ‘Straw for Beef’ Program appears to meeting grain-saving objectives. This may change, however, if – encouraged in particular by regional beef agro-industrialisation plans and a higher value beef market – more intensive production regimes gain in relative importance. In this case, much higher quantities of grain and oilseed feeds will be fed to cattle in an inefficient way. This may develop into a policy dilemma for Chinese policy-makers within five to ten years.

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Appendixes

Appendix 1. Feed Grain and Oilseed Consumption (million tons) in Selected Industries With Feed Utilisation Improvements from Better Feed Conversion

Year		1993		2000		2010	
		Grain and oilseed used (m t)	% share of total*	Grain and oilseed used (m t)	% share of total*	Grain and oilseed used (m t)	% share of total*
Without better FCR's***	Pigs	103.7	58.7%	151.3	51.2%	174.0	42.6%
	Cattle**	14.1	8.0%	31.4	10.6%	41.7	10.2%
With better FCRs	Pigs	103.7	59.3%	140.9	51.7%	161.4	44.9%
	Cattle**	14.1	8.1%	31.4	11.5%	41.7	11.6%

Source: Extracts from World Bank, 1993, pp. 127-8.

* Percentage share of total grain consumption including human and other livestock

**Includes cattle other than dairy cattle and buffaloes

*** See title for precise terminology. FCRs are not stated

Appendix 2. Influence of increasing cottonseed cake (CSC) supplementation levels

Henan						
CSC	0.0	1.0	2.0	3.0	4.0	
Number of animals	8	8	8	8	7 (1)	
Initial weight (kg)	182±31	183±18	183±24	183±211	183±20	
Final weight (kg)	205±36	237±27	242±35	258±18	262±13	
Daily gain (g)	250±73	600±151	655±141	845±233	883±268	
Dry-matter intake (% of liveweight)						
- straw (2)	2.6	2.5	2.1	1.9	1.3	
- CSC	0.0	0.4	0.8	1.2	1.6	
- total	2.6	2.9	2.9	3.1	2.9	
Feed conversion rate (3)	20	10	10	8.0	7.0	
Hebei						
CSC (kg)	0.0	0.25	0.5	1.5	2.0	2.5
Number of animals	10	10	10	10	10	10
Initial weight (kg)	137±23	159±18	183±42	192±43	175±33	194±50
Final weight (kg)	143±21	193±22	231±44	263±47	250±41	274±50
Daily gain (g)	63±48	370±133	529±150	781±165	829±165	892±76
Dry-matter intake (% of liveweight) (4)						
- straw	2.7	2.5	2.3	2.0	1.8	1.7
- CSC	0.0	0.1	0.2	0.5	0.8	0.9
- total	2.7	2.6	2.5	2.5	2.6	2.6
Feed conversion rate	60	12	10	7.0	7.0	7.0

Source: Dolberg and Finlayson, 1995, p.16

(1) One sick animal was excluded from the calculations

(2) Straw was aerated one day prior to feeding. Dry matter was 82 percent

(3) Units of dry matter consumed to produce one liveweight unit

(4) 88 percent dry matter in the straw and the cottonseed cake. The straw was treated with anhydrous ammonia

Measurements were taken in the last ten days of the trial

Appendix 3. Production regimes of cattle-producing households in Wangtuan Township, Lixin County and Xinji Township, Mengcheng County, Anhui Province, 1997*.

Household	Land (mu)	Cattle	Pigs	Chicken	Feed for cattle grown on-farm (kg / day)					Feed bought off-farm ?
					Cereals	Oilseed	Wheat bran	Sweet potato	Straw**	
1	20	10 (3 cows)	3 sows	0						Small amount concentrate
2	6	10	0	0	All sold on open market					0.55 kg / day wheat meal
3	10	11 (3cows)	4 (1 sow)	0						
4	12	4 (3cows)	11 (1 sow)	150 broilers	1 kg total				10kg	
5	7.5	3 (1 cow)	0	0	0.5 kg corn	0.5kg SBC (winter only)	0.5 kg	0.75kg	5 kg	No
6	16	5 (3 cows)			1-1.5 jin total				Winter 6-7kg Summer 5	
7	18	10 (9 cows)			1kg corn	Small amounts of CSC, wheat bran, sweet potato chips				Straw
8	13	5 (3 cows)			1kg total in summer 1.5 total in winter				Summer 1 3-8.5kg	
9	15	7 (4 cows)	7 (2 sows)		Cows 0.5kg corn, 0.75kg sorghum. Grower 0.3kg corn, 0.3kg sorghum				5 kg for (less for grower cattle)	Straw

Source: personal communication with householders, 1997. Similar information for other fieldwork regions was compiled. This presents data from Lixin and Mengcheng counties because: a) it complements studies on straw-feeding practices in Liu and Chen (1998), Zhang et al. (1995) and Shi and Wen (1997), and; b) practices in these counties appear to be representative of those in most model beef-producing areas in the Zhongyuan Beef Belt. There does not, however, appear to be a published household-level study of concentrate-feeding practices for cattle in China.

* Households 1-5 are from Wangtuan Township, Lixin County. Households 6-8 are from the neighboring County of Mengcheng, Xinji Township. Lixin County is one of eight model beef-producing counties in Fuyang Prefecture and targeted under poverty alleviation schemes. Mengcheng is the biggest beef-producing county in China.

** Grass is added in summer

Appendix 4. Crop production information from farmer No.5 (Appendix 2),:

Area	Crop	Sowing	Harvest	Yield	Fertiliser	Straw
7 mu	Wheat	Early Sept	end April	4500 jin	Seed per mu = 20-25 jin Fert. per mu 20-25 jin	8-9000 jin dry matter
5 mu	Corn	June 10	mid Aug.	4500 jin	Seed per mu = 3-4 jin Fert. per mu 100-150 jin chemical fertiliser? no idea of content	5,000 jin dry matter, value 1.4 yuan per jin
1 mu	Sweet potato	June 10	end Aug.	1 mu gives 3 to 4000 jin	Seed 100 jin per mu	1,500 jin per mu dry matter, value 1.4 yuan per jin
1 mu	Soybean	June 10	end Aug.	1 mu gives 200 to 300 jin	Seed 12-13 jin per mu	3-400 jin per mu, value 0.35 yuan per jin
0.5 mu	Cotton	End April	August	1 mu gives 60 to 70 jin	Seed 3 jin/mu Fertiliser 100 jin per mu	7 yuan per jin

Source: personal communication with farmers. Farmers from Wangtuan Township in Lixin County followed an essentially similar mixed cropping regime

Appendix 5. Feed mixes in selected up-country Chinese feedlots

Feedlot / region	Cattle numbers		Feed (kg / head / day)**					Days on feed	Av. daily liveweight gain (kg / head)**
	Capacity (head)	1997 (head)	Corn	Oilseeds	Wheat bran	Brewery / distillers waste	Straw		
1. Kezuohou Banner, IMAR	3,000 / year	1-2000 / year	1.5-2.5	0.25-0.5 SBM & castor oil		Yes	15 (untreated)	90-100	1.4
2. Kezuozhong Banner	1,000 / year	1,000 year	1 (crushed)	0.5 castor oil cake			6-7 (corn stalks)	210-220	
3. Tongliao City, IMAR (private)	800 / year	600 / year average	2.5	Negligible		25	Yes	90	1.25
4. Kezuohou Banner, IMAR	2,000 / year	1,000 / year	2 (crushed)	1 castor oil cake			5	180	1.2-1.3
5. Dongliao Prefecture, Jilin		250 / year	4.5	1.25 SBC	1	10	12.5	195	1.2
6. Mengcheng County, Anhui	1,000 / on feed		400 / line			1-5kg total	No	7	
7. Mengcheng County, Anhui	300 / year	300 / year	0.4			0.4 SBC 0.2 castor oil 0.2 CSC	0.5	2	1.2 (Simmental cross cattle)
8. Xinle City, Hebei	(50,000* / year)		3	3	1	0.75	5		1.5

Source: personal communication with feedlot managers. Gaps indicate unavailable information

* Figures provided appear particularly questionable

** Feedlots do not usually weigh feed or cattle. Managers have a tendency to overstate weight gains and feed conversion efficiency. For these reasons, FCR's are not included in this paper.

Appendix 6. Number of enterprises in scale categories in selected provinces

Unit: No. of cattle producing enterprises

	No. of cattle held	1 – 5	5 – 50	50 – 100	100 – 1000	> 1000
Province						
IMAR		423500	27800	575	740	16
Anhui		985600	21650	2640	156	18
Shandong		2145000	36854	3520	38	17
Henan		2380636	42106	2104	24	11
Hebei		1054100	18560	1680	500	20
Liaoning		561200	46000	1589	890	35

Source: East West Consulting, 'China's Beef Market' (figures derive from the Ministry of Agriculture Information Department)

Appendix 7. Scale and ratio of pig raising enterprises in China, 1993-1995

Year	Type of enterprise	>10,000 Very large enterprises	200-10,000 Large enterprises	10-200 Specialised HH	<10 Non-specialised HH	Total
	Item					
1993	Number of pig producers	107	96,140	2,542,972	116,015,000	118,654,219
	Number of pigs (head)	1,519,400	17,112,900	35,601,600	338,765,100	392,999,000
	Proportion %	0.38	4.40	9.00	86.22	100
	Average Scale	14,200	1,780	14.00	2.92	3.31
1994	Number of pig producers	109	10,340	2,649,636	130,964,000	133,624,049
	Number of pigs (head)	1,613,200	19,371,200	37,891,000	335,740,000	414,615,400
	Proportion %	0.39	4.67	9.14	85.80	100
	Average Scale	14,800	1,874	14.3	2.72	3.10
1995	Number of pig producers	114	12,100	2,743,814	133,607,000	136,063,014
	Number of pigs (head)	1,833,800	22,084,600	42,335,200	375,437,400	441,691,000
	Proportion %	0.42	5.00	9.58	85.00	100
	Average Scale	16,085	1,825	15.10	2.81	3.25

Source: Statistical Summary of State Agriculture, 1993-1995