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An Issue of Debate: China's Feedgrain Demand and Supply ¹

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Abstract

In the past decade or so, China's feedgrain demand and supply has drawn increased attention from both academia and government departments within and outside China. In this paper, we examine when and how China's feedgrain demand and supply became a topical issue and why it is important. We will highlight, from earlier studies, key findings regarding how much feedgrains China will demand and whether China can supply the amount demanded. We will also elaborate on the reasons for the vast discrepancies in China's feedgrain research findings and discuss the problems and difficulties encountered in studying China's feedgrain issues. The paper concludes by pointing out the areas where further research efforts are needed.

1. Introduction

It is increasingly recognised that feedgrain demand in China will become the major component of China's total grain demand in the future. Any increase in future grain demand in China will be mainly caused by an increasing demand for feedgrains (RGCFDS 1993, pp. 26, 89, Huang and Rozelle 1996, Findlay 1998, p. 32, Tian and Chudleigh 1999). On the other hand, it is held that China will not be able to meet the increased demand for feedgrains with its domestic supply (Crompton and Phillips 1993, Crook and Colby 1996, Tian and Chudleigh 1999).

Due to the importance of the issue for China and the world grain market, there has been increased research into China's feedgrain demand and supply. Researchers have attempted to tackle the issue from various angles with different methods and, not unexpectedly, have obtained different findings. A survey of the available literature on China's feedgrain demand and supply issue should be useful and will help to (1) understand the research status of the issue; (2) gain an overview of the major influences that affect China's feedgrain demand and supply; and (3) identify areas that require further research.

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For our survey, we searched the following electronic databases for literature in English: ABI Inform, Econlit, Expanded Academic Index ASAP, CAB, Current Contents, ABOA and Agricola. These databases are listed in an order that indicates their value in obtaining literature that has relevance to China's feedgrain issues. ABI Inform and Econlit contain more relevant articles compared to others. ABOA and Agricola contain very few articles that are relevant to our topic. Information contained in these two databases tends to be country specific; i.e., the former for Australia and the latter for the USA.

While some of the above electronic databases collect items written in Chinese, the literature in Chinese was searched mainly from Chinese publications. These include major research work published in book format and several leading journals, e.g., *Chinese Rural Economy*, *Problems of Agricultural Economics*, *Journal of Economic Research*, *China Feed*, and *China Animal Husbandry*. Our search reveals that majority of those who contributed to the discussion of China's feedgrain issues are from China and America; and that a large body of the literature was produced in the 1990s.

In the next section, we trace the emergence of China's feedgrain demand and supply as a topical issue and the nature of the issue. In Section 3, a conceptual framework is developed to aid in understanding China's feedgrain demand and supply. Section 4 reviews key findings from earlier studies regarding China's feedgrain demand and supply. We will discuss possible reasons for discrepancies in research findings and problems and difficulties facing China's feedgrain research. In this section, we will also briefly touch on whether the Chinese will eat more animal products or foodgrains and whether China will import feedgrains. The last section concludes by pointing out the areas for further research.

2. The Emergency and the Nature of China's Feedgrain Issue

Before the 1980s, feedgrain was not an "issue" in China. Till the late 1970s, China had great difficulty in producing sufficient foodgrain to feed its huge population and moderate imports of foodgrain had to be sought. Little grain could be spared to feed animals. Almost all of the pigs, which were the major source of China's meat supply, were raised with very limited feedgrains. Large working animals were, likewise, raised with minimum feedgrains. In many cases, the primary purpose of raising pigs was not for meat but for producing manure and for consuming table scraps. Consequently, the animal husbandry industry accounted for only a small portion in China's agricultural economy (varying between 6-15% of total agricultural output value, MOA 1983, p. 63). Not surprisingly, few bothered to pay any attention to the feedgrain issue.

Feedgrain emerged as an issue only after several consecutive years of good harvests in the early 1980s, which resulted in difficulties in selling, transporting and storing grains. After the need to feed the human population basically met, some grains could be spared to feed animals. CAAS (1985) and Liu (1988) are among the pioneers who tried to draw people's attention to feedgrain issues and to the development of China's animal husbandry industry. However, the feedgrain issue at that time was secondary and heavily dependent upon the country's overall foodgrain demand and supply. Grains could be used as feed only after foodgrain needs were met and the use of grains as feed was treated as a way to dispose of grains in excess of human beings' direct consumption. This attitude towards feedgrain is clearly demonstrated in the literature published in the 1980s.

Even in the 1990s, feedgrain was still not regarded as an "independent" issue. It continued to be discussed largely in the context of China's overall foodgrain demand and supply. Few feedgrain studies were carried out without making reference to the overall grain situation. In most cases, projections of China's feedgrain demand and supply were included in projections of China's total grain demand and supply. To a large extent, feedgrain is treated as a *residual* of China's total grain availability and the need for foodgrain (RGCFDS 1993, pp. 33, 179).

Understanding the importance of foodgrains in China's economy and the nature of feedgrain supply – a residual of total grain availability and the need for foodgrain – is crucial for those who are interested in China's feedgrain market. This helps to understand changes in the feedgrain market and possible related government policy changes.

In addition to the special nature of foodgrain and feedgrain in China, there are other social, economic, and cultural conditions peculiar to China that will impact on China's feedgrain demand and supply. It is thus useful to have a framework that depicts these major influences. We develop such a framework in the next section.

3. Conceptual Considerations

The following concepts and terms that are peculiar to China's situation are defined first to aid in the understanding of the complexity of China's feedgrain issues.

Grain Grain in China includes cereals (rice, wheat, corn, sorghum, millet and other minor cereals), tuber crops (sweet potatoes and potatoes only, not including taro and cassava), as well as pulses (soybeans only).

Feedgrain Feedgrain mainly refers to coarse grain, including corn, sorghum, millet, barley, oats and other minor cereals. In recent years, a certain amount of rice and wheat has also been used as feedgrains – chiefly those of low quality.

Feed Feed in China consists of four main components: (1) feedgrains, (2) oilseeds meals, (3) by-products from grain processing (e.g., bran and husks, distiller's grains), and (4) any thing else that animals eat (e.g., meal left-overs, leaves, grasses and even crop straws). While the use of manufactured feed is increasing, most rural households feed their animals with available feed from their own farms.

Types of animal raising practices Animal raising practices in China may be put into three broad categories: (1) very small-scale traditional household backyard animal raising; (2) specialised animal raising households; and (3) larger-scale animal feedlots (NORHS 1998).

Will China import feedgrains and by how much? The answer clearly depends on the supply of and demand for feedgrain in China, which, in turn, requires for analysis of major influences that affect feedgrain demand and supply.

On the supply side, factors such as the prices of outputs and inputs, price expectations, technology, weather, and number of suppliers are expected to be important in China. There are other factors that need to be taken into consideration when addressing China's ability to supply feedgrains. Such factors include total grain production and government policy choices. As a residual of total grain output and foodgrain, everything else being constant, the higher the total grain output, the greater the supply of feedgrains. On the other hand, if, for food security purposes, the government policy emphasises the production of foodgrains coupled with compulsory measures, the supply of feedgrains may be limited.

On the other hand, demand for feedgrains is a derived demand. *Ceteris paribus*, the more animal products to be produced, the more feedgrains will be demanded. Holding the demand for animal products constant, the amount of feedgrains demanded will be inversely related to the feed-meat conversion ratio. Thus the amount of feedgrains demanded is influenced by the amount of animal products demanded and the conversion ratio. Any factors that affect the demand for animal products and the conversion ratio will affect the demand for feedgrains.

In addition to the conventional determinants of demand, some other factors must also be taken into account when assessing the demand for animal products in China; i.e., urbanisation, China's access to overseas meat market, and government's food consumption policy choices.

In recent years, the demand for meat by urban and rural residents is quite different in terms of both quantity and variety (as shown in Table 2 later). Urban residents consume more meat than their rural counterparts. Urbanisation may result in income changes and hence is related to the

income factor. Nonetheless, given the relatively low level of urbanisation in China at present, the speed and the extent of urbanisation in China still deserve special attention.

The government's food consumption policy choices can have an important influence on the composition of what people eat. In 1993, the government worked out a plan to improve the composition of food intake of its citizens and emphasised the need to increase the share of animal products (State Council 1993). All its total output targets for year 2000, except milk, were achieved or surpassed by 1999 (see Table 1, Panel A). The desired shares of various meat products out of total meat production were also achieved (see Table 1, Panel B). However, few of the per capita consumption targets were achieved by 1999 according to the State Statistical Bureau (SSB) (see Table 1, Panel C). However, it is believed that subjects in SSB household surveys tend to under-report their consumption and the SSB household survey does not include the amount of meat consumed away from home (Wang and Fan et al. 1999). According to the study by Wang and Fan et al., by 1998 per capita consumption levels have all surpassed the 2000 targets except in the cases of poultry eggs and aquatic products in rural areas (see Table 1, Panel C) (Wang and Fan et al. 1999). The above deliberation is to demonstrate that government policy must have been partially responsible for the increase in meat production and consumption and for the structural changes within the animal husbandry industry.

[Table 1 here]

Another important factor that needs to be taken into consideration is China's future access to the overseas meat market. After China joins WTO and if China can successfully export animal products to overseas markets, China is likely to produce more meat, making use of its abundant rural labour force.

As for the conversion ratio, it is primarily determined by a range of technological factors. These include species of the animal, use of additives, feed compositions, methods of animal raising (backyard, specialised, feedlot), and animal accommodation.

The above considerations can be intuitively presented in the following diagram (Figure 1).

[Figure 1 here]

In addition, unlike the situation in many developed countries, feedgrain is not necessarily the primary source of feed in China's animal feeding. For example, backyard animal raising is still predominant in China. Feed used to raise animals in this kind of practice may include anything that animals eat (such as meal left-overs, grasses, tree leaves, crop straws), and feedgrains typically account for a much smaller portion (Tian and Chudleigh 1999). Our recent surveys in rural China also reveal that some specialised animal raising households do not feed grains directly to animals. Instead, they use cereals, beans or tubers first for producing other products (e.g., liquors, starch products, bean curd) and then use the residuals to feed the animals (Liu et al. 2000). An increase in non-grain feed will reduce the demand for feedgrain and the use of such feed inevitably complicates any projection of China's feedgrain demand-supply balance.

4. Feedgrain Demand and Supply in China: Will China Import Feedgrains?

4.1 Feedgrain Demand and Supply: The Past Experience

Rapid economic growth in China since 1980 has led to a significant increase in the consumption of animal products by the Chinese (Crompton and Phillips 1993, Wan 1998, Tian and Chudleigh 1999). In rural areas, per capita meat consumption has increased from 9.4kg in 1981 to 16.4kg in 1999 (an increase of 74%). During the same period, eggs increased from 1.25kg to 4.3kg (242%), and aquatic products from 1.28kg to 3.82kg (198%). The corresponding figures for urban areas are 20.5kg to 24.9kg (21%), 5.22kg to 10.92kg (109%), and 7.26kg to 10.34kg (42%), respectively (see Table 2; again figures in Table 2 based on the SSB household surveys may under-report the actual consumption level as noted earlier). Consumption of poultry meat has increased rapidly but that of pork registered slowest increase in rural areas and has declined in

urban areas. In general, consumption of animal products by urban residents is much higher than that of their rural counterparts. On the other hand, it must be noted that any small amount of per capita increase in animal product consumption by rural residents represents a huge extra amount of that product demanded due to the huge population base (Wang and Fan et al. 1999).

[Table 2 here]

The steady increase in demand for animal products in China has so far been warranted by the increase in China's domestic supply. The increase in animal products in China in the past two decades, as reported in the government-published statistics, is most impressive. Total meat production increased from 19 million tonnes in 1985 to almost 60 million tonnes in 1999, an increase of over 200%. Comparing 1999 and 1985, milk production increased by 179% while aquatic products increased by 485% (some believe that production statistics in government publications have been inflated, see Section 4.3.3). Among those animal products, the increase in beef, poultry meat, and farmed aquatic products has been the fastest (see Table 3).

[Table 3 here]

The demand for, and the production of, the huge amount of animal products have generated a strong and growing demand for feedgrains. Surprisingly, in the past two decades China's feedgrain import was minimal. In fact China was a net exporter of feedgrains in most years (Xin and Tian 2000). Clearly, China's domestic supply must have also increased. Then, roughly how much feedgrain had been demanded and supplied in the past years? Few could give an accurate answer.

According to Cheng and Wang (1997), feedgrain has been the primal component of feed in China in recent years, being about 70%. However, feedgrain production is not an independent industry and there are no reliable statistics about the actual amount of feedgrain supplied and demanded in China. In its 1993 document, the government asked to change from the dual grain – cashcrop production pattern to a grain – feed – cashcrop production pattern. The motive was to let feed production become an independent industry. The government also wished to have production statistics of feed crops separately reported (State Council 1993). So far, the progress has been slow.

Nevertheless, there have been attempts to gauge the amount of feedgrains consumed. Two basic approaches are used: the demand approach and the supply approach. The former estimates the amount of feedgrain demanded and the latter the amount of feedgrain available or supplied. When using the former, feedgrain demanded is equal to the outputs of animal products multiplied by estimated feed conversion ratios based on practice in China or overseas countries (Cheng and Wang 1997, p. 115). The demand approach, however, encounters a number of difficulties. First, the reliability of China's animal product output data represents a problem (see Section 4.3.3 for more details). Second, few reliable feed-meat conversion ratios are available. Further, no reliable data exist that indicate the proportion of different kinds of animal raising practices. Finally, for each kind of animal raising practice, especially the traditional backyard animal raising, there is a lack of data to show the proportion of feedgrain out of total feed. These limitations make the demand approach less often used and the corresponding results are suspicious. The Ministry of Agriculture, according to Garnaut and Ma (1992, p. 75), used this approach and obtained the results as reported in Table 4. The results are rather different from those obtained employing the supply approach, see, for example, the estimation of feedgrain supplied for 1980 to 1994 by Cheng and Wang (1997).

[Table 4 here]

The supply approach involves deducting human consumption, seeds, industry usage, and storage wastage and so on from total grain output. The residual is treated as total feedgrain supply. Some believe that this approach is more appropriate for China (Garnaut and Ma 1992, p. 77, Cheng and Wang 1997). Using this method, RGCFS (1993, p. 180) estimated the amount of feedgrain available in 1987 was 86 million tonnes, accounting for 21% of total grain output. Cheng and Wang (1997) provided an estimation of feedgrain supplied for 1980 to 1994

(included in Table 4). Their estimate of feedgrain supply was 59 million tonnes in 1980 and 134 million tonnes in 1994, an annual growth rate of 6%. According to their results, the portion of feedgrain out of total grain output was 18.5% in 1980 and it increased to 30% in 1994. Garnaut and Ma (1992, p. 77) believe this same portion was 22% (92 million tonnes) in 1987 and 25% (115 million tonnes) in 1990.

The supply approach proponents obtained similar results (see Table 5 below). Taking 1987 as an example, the estimation by Cheng and Wang (1997) was slightly higher than the other two. They deduct human consumption, seeds, industry usage, and storage wastage from total grain output to reach the supply of feedgrain. In addition to these deductions, Garnaut and Ma (1992) also deduct the grains used for producing Chinese spirits. RGCFS (1993) goes even one step further by deducting the amount of grains consumed by the unregistered population.

[Table 5 here]

The proportion of feedgrains out of total grains suggested by the above authors seems to be acceptable. According to a recent interview with Mr Zheng-Hai Yang, Director of the Feedgrains Division of the Department of Animal Husbandry in China's Ministry of Agriculture, the proportion is around 33% in 1999. In the past years, this proportion would have increased by about one percentage point each year (Yang, Z.H., personal interview, 14 September 2000). If this judgement is plausible, the proportion in 1990 would be about 24% (see Table 6), which is close to that of Garnaut and Ma (1992) and Cheng and Wang (1997). Compared to others, the amount of feedgrains available as given in Table 6 is perhaps a reasonable estimate. Note the closeness between the estimates for 1987 in Table 6 and that by RGCFS (1993) in Table 5.

[Table 6 here]

4.2 Feedgrain Demand and Supply: The Projections

Table 7 summarises projections from available studies. It is noted that the number of feedgrain demand and supply projections for China is limited, particularly those for years beyond 2000. Also, the majority of the available studies seem to lack rigour in their research work.

[Table 7 here]

There are discrepancies in both demand and supply projections and the discrepancies in the former are much greater than those in the latter. Taking 2000 as an example, projection for feedgrain demand ranges from the lowest, 109 million tonnes, to the highest, 222 million tonnes. On the supply side, it ranges from the lowest, 125 million tonnes, to the highest, 150 million tonnes. The larger difference in demand projection is perhaps understandable because some factors affecting demand may be more uncertain than those affecting supply. Possible reasons for the discrepancies are discussed in the next section. Given the fact that China's import of feedgrain and total grain import was small in 2000, the actual feedgrain usage should be roughly equal to the available supply, unless there was a major draw-up from stocks. Based on Table 6 above, the available supply of feedgrain in 2000 is about 170 million tonnes. Thus, all the supply projections underestimated the supply for year 2000. On the other hand, the demand projections by Garnaut and Ma (1992, normal growth scenario) and Cheng et al. (1997) are very close to the actual supply.

In short, existing projections indicate that demand is greater than supply, thus feedgrain imports are needed. However, there exist substantial discrepancies in projections of the gap between feedgrain demand and supply. As projections are meant to guide future policy initiatives and market activities, the accuracy of such projections is of utmost importance. Clearly, some of the projections (as for 2000) are far from the actual picture. Why then are there such discrepancies?

4.3 Explanation of Discrepancies in Projections

The conceptual framework presented in Section 3 highlights the many possible factors that may affect the demand for or supply of feedgrains in China. Variations in any such factors will affect China's demand for or supply of feedgrains and thus the projections in demand and supply of feedgrains. In this section we will focus on several major variables and examine how they may affect China's feedgrain demand and supply projections.

4.3.1 Demand side

On the demand side, feed-meat conversion ratios, income and income elasticities, and animal feeding methods are the major factors that may cause differences in feedgrain demand projections.

Conversion ratio Which ratios are to be used in feedgrain demand projections? There do not seem to be many commonly accepted ratios. It is believed that too little attention has been given to studying feed-meat conversion ratios (Cheng and Wang 1997, Findlay 1998, p. 28). However, feed-meat conversion ratios are indispensable for any feedgrain demand calculations or projections. Consequently, many have tried to figure out the likely conversion ratios for their research work and, not surprisingly, there have been differences between such ratios and in some cases the differences are large (see Table 8). For example, Liu et al. (1988) believe the conversion ratio for pork is about 8 while the commonly held ratio is about 3.5-4. Given the use of such vast different conversion ratios, the difference in projected feedgrain demand is unavoidable.

[Table 8 here]

Animal feeding practices An important factor that contributes to the uncertainty of feed conversion ratios is the various kinds of animal feeding practices. The ratios for the three major animal feeding methods are believed to be different (NORHS 1998). NORHS (1998) believe that specialised households have a lower feed-meat conversion ratio while the backyard raising has a higher conversion ratio (see Table 8). However, others argue that backyard raising has the smallest conversion ratio because this practice uses less feedgrains (Guo et al., re-cited from Zhang, X.H. 1998, Zheng-Hai Yang, personal interview, 14 December 2000). To date, it seems few are in a position to offer any such ratios that are authoritative and representative of the three kinds of practices. It is especially difficult to estimate conversion ratios that are close to backyard raising conditions. There are millions of rural households practising backyard animal raising and animal raising conditions are different between regions.

Conversion ratio is only one way through which the three kinds of animal raising practices affect feedgrain demand projections. There are at least other two aspects in which they affect feedgrain demand projections, i.e., (1) feed composition and (2) the proportion of the three kinds of animal raising practices.

Different practices are likely to have different feed compositions. It is commonly believed that backyard raising uses less feedgrains and manufactured feed stuff compared to specialised households and feedlots. However, there is very limited reliable data on the composition of feed used by different practices (Tian and Chudleigh (1999) provide a feed composition for pig production by backyard raising and specialised households). Without such information, feedgrain estimation and prediction are difficult.

There is also a lack of information about the proportion of different kinds of animal feeding practices. As noted above, different types of animal feeding practices have different feed compositions and feed-meat conversion ratios. Without reliable information about this proportion and when estimates are used – and these are likely to vary in each study – it is not unexpected that different results are produced.

Income elasticities Income and income elasticities are believed to be two most important factors that affect demand projections (Wan 1996b). While income elasticity is crucial, its estimation, especially in the case of China, often is not an easy task. Due to data problems (which will be further elaborated below) and different modelling techniques, estimated income elasticities of demand for the same product may be quite different (Wan 1996a). It can be seen from Table 9 that significantly different income elasticities have been produced. For example, in the case of pork, Lewis and Andrews' income elasticity is four times that of Wang and Fan et al. and in the case of fish theirs is about ten times that of Wang and Fan et al. for rural people and seven times for urban people.

[Table 9 here]

Such differing income elasticities, holding income growth the same, will lead to different estimates of demand for animal products (see Table 10). Note, in Table 10, the difference between different projections for animal products demanded for year 2000 and also compare these projections with the actual consumption of animal products in 1998 reported in Wang and Fan et al. (1999). Also note that, in Table 10, the projection for the year of 2005 by Wang and Fan et al. (1999) is even higher than the projection for year 2010 by Huang and Rozelle (1998). If the projections of animal products demanded are different, feedgrain demand projections would be different.

[Table 10 here]

4.3.2 Supply side

Total grain supply, the use of new technologies and government policy changes are among the major factors that lead to feedgrain supply projection differences.

Total grain supply As indicated earlier, feedgrain is a residual of total grain supply and grain usage. Generally, non-feedgrain usage is unlikely to change drastically between years. However, total grain supply can be affected by the current harvest, release from stocks, and imports. This leads to great uncertainty of feedgrain supply projections.

New technologies New technologies may increase yield and total grain supply holding sown area unchanged. For example, since the early 1990s, plastic film has become widely adopted in corn production in China. This allows earlier sowing and thus extends corn growth period and as a result raises yield. However, the advent of new technologies, the scope of their adoption and their effects on output may not always be easily anticipated. This makes it difficult to incorporate with a great accuracy the impact of new technologies in the prediction of grain production and thus the availability of feedgrains.

Government policy changes When the government policy emphasises the importance of grain production, as in 1995 with the institution of the so-called "provincial governor grain-bag responsibility system", total grain supply is likely to increase, although at the expense of other agricultural crops. Given the fact that the Chinese government has been so sensitive about China's grain supply, it is likely that the government will shift its policy attention to increasing grain production whenever deemed necessary. However, it is difficult to anticipate when and to what extent the government may introduce some changes to its grain production policy.

4.3.3 Data and conceptual problems

Another important aspect that contributes to projection discrepancies is due to data problems, as discussed below.

Data availability Some data are simply not available. For example, the amount of feedgrain available from each year's harvest has not been collected separately. Data on proportions of three kinds of animal feeding practices are very limited. Detailed information about feed composition for different kinds of animal feeding methods, especially for backyard animal raising, is hardly

available. There are no well-studied feed-meat conversion ratios for various kinds of animals under different feeding conditions.

Data coverage In some cases, one cannot be sure about the exact coverage of some data. For example, when referring to feedgrains, exactly what products are covered or included as feedgrains is not clear. Also, in the past years, specialised household animal raising is fast emerging. Then, what kind of households would be treated as specialised and what is the criterion for separating specialised household animal raising from general household backyard raising? Again, this is not clear.

Data reliability It has been well known that many Chinese data suffer from inaccuracy or unreliability. One typical example is the arable land area in China. In November 1999, the government officially acknowledged that the arable land area in China was more than previously claimed. Accordingly, the government adjusted it from 100 to 128 million hectares. This would affect the reported yield level and the sown area.

Quite often, statistics may be under or over reported. Zhong (1997) believes China's meat production statistics could have been inflated by 50% or even higher. Lu (1998) believes output of meat, poultry eggs and aquatic products for 1981-1995 could have been inflated by at least 40%. Colby, Zhong and Giordano (1999) also believe that China's official meat production statistics have been overstated. However, Yuan (1999) disagrees with these claims and argues that the level of inflation for meat output is significantly below 40%. Jia (1999) even believes that the previously published meat production statistics are reasonable and there is little inflation.

In light of the increasing gap between production and consumption data of various animal products by 1995 and 1996, in its 1997 official publications, the government adjusted 1996 meat output figures downwards but without any due explanations. On the other hand, in its 1998 official publications, the government adjusted 1997 meat output figures upwards and eggs and milk output downwards. The details of the adjustments of various animal products are given in Table 11 below.

[Table 11 here]

Table 11 shows that the 1996 downward adjustment was by as much as 22% with beef being the highest, 28%. Egg output for 1996 was adjusted slightly upwards but for its 1997 output, it was adjusted downwards by almost 11%, making 1997 total egg output lower than that of 1996.

After these adjustments, then, how close are those government-published output figures to the real output levels? According to Yuan (1999), for those figures prior to 1996 where no adjustment was applied, pork, beef and mutton output would remain over-estimated by about 20% while poultry and egg output would remain over-estimated by as high as 45%. However, milk output level is believed to be little inflated. Yuan (1999) believes pork, beef and mutton output figures *since* 1996 are reasonable although poultry and egg output remain inflated to some extent.

Given such data problems, surrogates may be used in the case of data unavailability. In many other cases, data without reliability or data without clear coverage boundaries may be used. When this is the case, deviations in predictions are bound to take place.

Conceptual problems Another problem related to data is conceptual or definitional. The above mentioned data coverage problem is largely related to this. The other example is the calculation of feed-meat conversion ratio. While it is commonly held that live weight should be used when calculating feed-meat conversion ratios, CAAS (1989, p. 43) used carcass weight in deriving its predicted conversion ratios for year 2000. In addition, what feed is used as the numerator to calculate the conversion ratio? All the feed material the animal eats, processed industrial feed (which contains grains), or feedgrains only? If feedgrain only is used as the numerator, the derived conversion ratio would be lower (see, for example, CAAS 1989, p. 43).

4.4 Projecting China's Feedgrain Demand and Supply: The Other Unknowns

The elaboration above highlights the difficulty and complexity in projecting China's feedgrain demand and supply. There are other unknowns or challenges that add to this difficulty and complexity, especially for future studies in this area.

4.4.1 Government food policy

During the four decades prior to the 1990s, the government's food policy was largely dictated by the principle of grain self-sufficiency. Since the early 1990s, with the eased food situation, the government has started to encourage people to have a balanced diet and to eat more animal products.

Then, will the Chinese eat more animal products in the future? This will be largely influenced by consumer income growth and market forces. However, government food policy choice is another important factor. Given China's long-time centrally-planned system, government's policy can still to a great extent encourage or discourage people from eating more or less animal products. The mentality that, due to China's limited agricultural resources, Chinese people should not or cannot afford to eat more animal products is still strong in China (see, for example, RGCFS 1993, p. 88, Chen Xiwen in Lin, Chen, et al. 1995, p. 5, Ministry of Agriculture Soft-Science Committee 1998, p203). Such viewpoints, held by some influential figures, may influence policy choices.

If the Chinese should be able to afford to eat more animal products, where would these products come from? Increase domestic animal feed production to produce more animal products, import feedgrains, or import animal products? Surely, the Chinese government's future food policy directions and choices will have an important bearing on this and will make any feedgrain studies for China more complex.

4.4.2 Technological choices

China's future demand for, and supply of, feedgrains can be greatly affected by the technological choices. Many believe that if feed conversion ratio is improved by a small margin, the potential savings in feedgrains can be enormous (Zhang and Lu 1997, Ministry of Agriculture 1998 p. 16-17). Many have explored the ways in which this can be achieved; for example, the use of additives, the extension of improved varieties, better accommodation for animals in northern China for the winter season (see, for example, RGCFS 1993, pp. 44-46; He and Wang 1993). On the other hand, with the use of improved technologies, there is also potential to increase feedgrain supply (Tian and Chudleigh 1999, Tian and Wan 1999; Qing, X.G. 1998). How fast technologies will become available and to what extent they will be applied to industries remains to be seen but will certainly complicate feedgrain demand and supply studies for China.

4.4.3 China's access to international markets

If China can export more animal products it will definitely import more feedgrains. China's access to international markets is critically dependent upon (1) its acceptance to the WTO and (2) the acceptance of its products by overseas consumers. At present, China's animal product export, except poultry meat, is limited and gains almost no access to markets of developed countries. How fast China can improve its animal product health standard is uncertain.

4.4.4 Regional differences

Being such a vast country, there are regional variations in many aspects that affect feedgrain demand and supply. For example, different climatic conditions affect both cropping patterns (thus the availability of feedgrains) and animal growth (i.e., severe or mild winter, thus affecting feed conversion ratios). Availability of non-grain feed resources in a region affects the composition of feed. Animal raising methods in different regions, especially under the backyard practice, may lead to different efficiencies.

These factors tend to contribute to different feed conversion ratios. Table 12 clearly shows that the feed-pork conversion ratios are different in different regions. Liaoning experiences severe cold winter, the ratio is thus high in that province. On the other hand, in some southern provinces, perhaps due to warmer weather conditions and availability of non-grain feed, the ratios are commonly low, e.g., in Guangdong, Zhejiang and Hunan (it seems Guangdong's ratio was too low to be realistic).

[Table 12 here]

In different regions, consumer preferences for meats are also different. In some regions, preference for one kind of animal meat may be stronger than that for other meats. Even for the same kind of animal meat, one region may prefer to have more fat meat than lean meat. All this affects the kinds of feed needed and the feed-meat conversion ratios.

A good understanding of all regional differences may prove to be difficult and very costly but is essential. Without it, it is hard to gain real insight into China's feedgrain issues. Some have realised the importance of looking into China's regional differences (RGCfMR 1998, Qin and Tian 2000) but few have actually made a serious effort in this regard.

4.4.5 Changes in tastes and preferences

If China's economy continues to grow as in the past two decades, changes in consumers' tastes and preferences are expected to continue (Wan 1998). Rural consumers and urban low-income consumers are likely to consume less cereal but more animal products. Higher-income consumers are likely to consume less ruminant meats but more poultry and aquatic products. When the former takes place, there will be less direct cereal consumption which will then increase the supply of feedgrain. When both the former and the latter take place, the increase in meat consumption by rural and urban low-income consumers may be to some extent offset by the reduction in meat consumption by higher income consumers; the latter is likely to shift to consume more vegetables, fruits and dairy products (Wang and Fan et al. 1999). To gauge the speed and the extent of changes in consumers' tastes and preferences and the likely offsetting effect is not easy. These changes will complicate feedgrain demand and supply projections.

4.5 Will China Import Feedgrains?

The survey shows that it is generally held that the demand for feedgrain in China in the coming decades will exceed supply. Thus, China is likely to import feedgrains. The question is how much China will import. Some believe China will not need to import a lot of feedgrains. One reason for this is that when feedgrain is in shortage, its price will rise. Those backyard practices – which are still dominant in China – will substitute feedgrain with other feed (Zheng-Hai Yang, personal interview, 14 December 2000). Others believe that China will import a large amount of feedgrains, for example, Garnaut and Ma (1992); Crompton and Phillips (1993); Crook and Colby (1996); Findlay (1998); USDA (1998). Tang and Zheng (2000, p. 209) believe that, after China's joining the WTO and as a result of reduced tariff rates, China's coarse grain imports will increase significantly. However, despite the fact that China has made commitments in WTO

negotiations to open up its agricultural markets, how those commitments will be implemented remains to be seen.

5. Concluding Comments

The past two decades have seen increased attention paid to the study of China's feedgrain issue. There exists a reasonable amount of literature dealing with this important issue. This survey shows that studying China's feedgrain demand and supply is a difficult and complex exercise. That is why existing studies have produced quite discrepant findings. Data availability, data coverage, data reliability, model choice, and researchers' understanding of China's feeding practices are all fundamental to the discrepancies. These factors are responsible for deriving, and thus the subsequent use of, different income elasticities, animal product demand projections, feed-meat conversion ratios, which then led to the vastly different projections on China's feedgrain demand and supply.

People's interest in China's feedgrain issues lies in the size of the gap between feedgrain demand and supply and whether China may need to import feedgrains in the decades to come. The survey shows that it is generally held that China's domestic feedgrain supply will not be able to meet the demand and thus there will be feedgrain imports. However, how much to import remains debatable.

To ensure research findings to be most realistic and of relevance to policy-making and to marketing activities, there are a number of areas to which future studies should pay attention.

(1) Regional focus Only if regional characteristics are carefully taken into consideration, can useful insights be gained in understanding China's feedgrain issues. Previous studies have dealt with China's feedgrain issues largely at the aggregate national level. Studies at the regional level are called for. The following regional characteristics are worth looking into:

- Differences between three kinds of feeding practices and between regions.
- Conversion ratios between different feeding practices and between regions.
- Proportion of different feeding practices at the regional level and its change over time.
- Income elasticities of demand for various kinds of animal products at the regional level and for rural and urban consumers.
- Consumer preferences between rural, and urban and between regions.

(2) Away from home consumption Few serious studies have been conducted in this area, yet this may account for a significant part of animal product consumption of the Chinese. In recent years, dining in restaurants has become more and more popular. Without an insight into this area, the whole animal product demand picture may be skewed.

(3) Feedgrain use in the farming of aquatic products Table 3 shows that the farming of aquatic products using the sea or inland water has grown drastically. Grain accounts for about 80% of the feed used for aquatic farming. Currently, very limited attention has been devoted to this area.

(4) Rural demand for animal products Given the huge size of the rural population, the potential of demand for animal products by rural residents can be enormous. A small increase in per capita consumption of an animal product will be translated to a large total quantity demanded. Increased effort needs to be devoted to studying rural demand for animal products.

References

- Cai, H.O., Brown, C., Longworth, J. and Wan, G.H. (1999), 'A demand analysis of ruminant-meat, pork and poultry-meat by Chinese households segmented by three income strata', in Zhou, Z.Y., Chudleigh, J., Wan, G.H. and MacAulay, G. (eds), *Chinese Economy towards 21st Century*, Vol. 1, The University of Sydney, Sydney, pp. 145-159.
- Cheng, G.Q. and Wang, J.M. (1997), 'An estimation of feed demand and supply in China', in Zhu, X.G. (ed.), *A Study of China's Grain Issues*, China Agricultural Press, Beijing, pp. 114-124.
- Cheng, G.Q., Zhou, Y.H., Wang, J.M. and Shi, Z.L. (1997), 'Feed demand and supply in China', *Problems of Agricultural Economics*, No. 5, pp. 25-29.
- CAAS (Chinese Academy of Agricultural Sciences) (1985), *Study of the Development of Grain and Cash Crop Production in China*, Vol. 4, CAAS, Beijing.
- CAAS (1989), *Research on China's Grains*, China Agricultural Science Press, Beijing.
- Chinese Rural Economy (1995), 'China's grain prospects and strategies: Summary of a symposium', *Chinese Rural Economy*, No. 8, pp. 3-18.
- Colby, H., Zhong, F.N. and Giordano, M. (1999), 'A review of China's meat production', *Agriculture in China and OECD countries: Past Policies and Future Challenges*, OECD Proceedings, pp.185-213, Paris, France.
- Crompton, P. and Phillips, B. (1993), 'Effects on feed grains of China's rising demand for livestock products', *Agricultural and Resource Quarterly*, Vol. 3, pp. 242-253.
- Crook, F.W. and Colby, W.H. (1996), *The Future of China's Grain Market*, USDA Agriculture Information Bulletin No. 730.
- Editing Committee of MOA (1991), *Proceedings of International Symposium on Food, Nutrition and Social Economic Development*, China's Science and Technology Press, Beijing.
- Findlay, C. (ed.) (1998), *Grain Market Reform in China: Global Implications*, ACIAR Technical Report No. 43, Australian Centre for International Agricultural Research, Canberra.
- Food Study Group (1991), *A Study of Medium- and Long-term Strategies for China's Food Development*, Food Study Group, Beijing.
- Gao, R. (ed) (1990), *Symposium of China's Fishery Economy*, China Agricultural Press, Beijing.
- Garnaut, R. and Ma, G.N. (1992), *Grain in China*, East Asia Analytical Unit, Department of Foreign Affairs and Trade, Canberra.
- He, C.M. and Wang, J.M. (1993), 'Reflections on animal husbandry development in the three provinces of north-east China', *Problems of Agricultural Economics*, No. 2, pp.44-48.
- He, X.R. and Tian W.M. (2000), 'Livestock consumption: Diverse and changing preferences', in Yang, Y.Z. and Tian, W.M. (eds), *China's Agriculture at the Crossroads*, Macmillan Press, London, pp. 98-117.
- Huang, J.K. and Rozelle, S. (1996), 'China's grain at the turning point to the twenty-first century: Retrospect and prospect', *Chinese Rural Economy*, No. 1, pp. 17-24.
- Huang, J.K. and Rozelle, S. (1998), *China's Grain Economy to the Twenty-First Century*, China Agricultural Press, Beijing.
- Jia, Y.L. (1999), 'Factors constraining China's animal husbandry development and their macro adjustments', *Chinese Rural Economy*, No. 1, pp.40-45.
- Lewis, P. and Andrews, N. (1989), 'Household demand in China', *Applied Economics*, No. 21, pp. 793-807.
- Lin, Y.F. and Chen, X.W. et al. (1995), 'Prospects and strategies of China's grain: A symposium', *Chinese Rural Economy*, No. 8, pp. 3-18.
- Liu, J. (1988), 'Strategic issues for the development of animal husbandry', *Chinese Rural Economy*, No. 2, pp.5-12.
- Liu, S.B., Chang, J.W. and Yang, T.K. (1988), 'What strategies should China adopt to develop its animal husbandry industries?' *Chinese Rural Economy*, No. 1, pp.31-33.

- Liu, X.A., Wang, L., Teng, H.Y. and Guo, Q.F. (2000), 'Household animal raising practices in rural China: A case study of Gongzhuling city in Jilin province', AARC Working Paper, the University of Sydney.
- Lu, F. (1998), 'On discrepancies between production and consumption data of China's agricultural products and artificial inflation in production statistics', *Chinese Rural Economy*, No. 10, pp. 47-53, 71.
- Lu, X.J. (1989), 'Strategic choice for the development of animal husbandry in China: Improving productivity of individual production entities', *Problems of Agricultural Economy*, No. 6, pp. 40-42.
- MOA (Ministry of Agriculture) (1983), *Agricultural Economy Statistics*, Ministry of Agriculture, Beijing.
- MOA (ed) (1988), *Development Strategies of China's Animal Husbandry Industries*, China Outlook Press, Beijing.
- MOA, *Statistics of China's Animal Husbandry Industry*, various issues. China Economic Press, Beijing.
- MOA (1998), *Agriculture Action Plan for China's Agenda in the Twenty-First Century*, China Agricultural Press, Beijing.
- Ministry of Agriculture Soft-Science Committee (1998), *Studies on Inerratic Issues of Agricultural and Rural Economic Development in China* (zhongguo nongye he nongcun jingji guiluxing wenti yanjiu), China Agricultural Press, Beijing.
- NORHS (National Office for Rural Household Surveys) (1998), 'A comparative study of production efficiency and profitability of various animal raising practices', *Reference Materials for Rural Economic Research*, No. 8, pp. 20-25.
- Pinstrum-Anderson, P. et al. (1991), 'Changes in incomes, expenditures, and food consumption among rural and urban households in China during the period of 1978-88', in proceedings of International Conference on Food, Nutrition, and Social-Economic Development, Beijing.
- Qin, F. and Tian, W.M. (2000), 'Feeding the livestock: Technological choice, trade policy and efficiency', in Yang, Y.Z. and Tian, W.M. (eds), *China's Agriculture at the Crossroads*, Macmillan Press, London, pp. 78-97.
- Qing, X.G. 1998, 'Attention should be paid to the development of feed rice', *Chinese Rural Economy*, No. 8, pp.28-32.
- RGCDFS (Research Group for China's Medium- and Long-term Food Development Strategies) (1993), *China's Medium- and Long-term Food Development Strategies*, China Agricultural Press, Beijing.
- RGCFMR (Research Group for China's Feedgrain Marketing Reforms – Siliaoliang liutong tizhigaige yanjiu ketizu) (1998), 'A study on the reform of China's feedgrain marketing system', *Chinese Rural Economy*, No. 8, pp. 33-40.
- State Council (1993), 'Guiding principles for China's dietary structural reforms and development in the 1990s', State Council of PRC, Beijing.
- SSB (State Statistical Bureau of China), *China Statistical Yearbook*, various issues, China Statistical Press, Beijing.
- Tang, Z.P. and Zheng, Z.H. et al. (2000), *China's Joining the WTO and the Opening Up of Agricultural Markets*, China Foreign Economy and Trade Press, Beijing.
- Tian, W.M. and Chudleigh, J. (1999), 'China's feedgrain market: Development and prospects', *Agribusiness: An International Journal*, Vol. 15, No. 3, pp. 393-409.
- USDA (1998), International Agricultural Baseline Projection into 2007.
- Wan, G.H. (1996a), 'Using panel data to estimate Engel functions: Food consumption in China', *Applied Economics Letters*, Vol. 3, pp. 621-624.
- Wan, G.H. (1996b), 'Income elasticities of household demand in rural China: Estimates from cross-sectional survey data', *Journal of Economic Studies*, Vol. 23, pp. 18-34.

- Wan, G.H. (1998), 'Nonparametric measurement of preference changes: The case of food demand in rural China', *Applied Economics Letters*, Vol. 5, pp. 433-436.
- Wang, H. and Huo, Q.G. (1996), 'China's grain and animal product production' *China Feed*, No. 10, pp. 6-8.
- Wang, J.M. and Fan, Y.L. et al. (1999), 'A study on animal product consumption by rural and urban residents in China', Chinese Academy of Agricultural Sciences, Research Report for a project commissioned by the Ministry of Agriculture, Beijing.
- Xin, X. and Tian, W.M. (2000), 'Feedgrain production and marketing patterns in China', China Agricultural University, in progress.
- Yuan, X.G. (1999), 'Are China's animal product output figures inflated?' in Wang, J.M. and Fan, Y.L. et al. (1999), 'A study on animal product consumption by rural and urban residents in China', Chinese Academy of Agricultural Sciences, Research Report for a project commissioned by the Ministry of Agriculture, Beijing.
- Yu, J. (ed) (1991), *Study on Rationalisation of China's Food Structure*, Research Institute of Aerospace Ministry, Beijing.
- Zeng, Q.L. (1988), 'On issues of livestock production', *Problems of Agricultural Economy*, No. 12, pp.27-28.
- Zhang, X.H. (1997), 'Relationships between grain production and the development of livestock industry in China', *Reference Materials for Rural Economic Research*, No.7, pp. 43-48.
- Zhang, X.H. (1998), 'An analysis of household pig raising situation and economic return in China', *Chinese Rural Survey*, No. 1, pp. 53-61.
- Zhang, X.H. and Lu, M. (1997), 'Pig production scale and feed conversion ratios', *Chinese Rural Economy*, No.10, pp.63-66.
- Zhong, F.N. (1997), 'An analysis of the level of artificial inflation in China's meat output statistics and the causes of inflation', *Chinese Rural Economy*, No. 10, pp. 63-66.
- Zhou, L. (1993), 'Continual increase in China's livestock production: The reasons explained', *Chinese Rural Economy*, No. 5, pp. 27-29.
- Zhu, et al. (1991), 'Food consumption and food acquisition behaviour among rural households in China', in proceedings of International Conference on Food, Nutrition, and Social-Economic Development, Beijing.