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Animal Agriculture in China

A Report of the Visit of the
CSCPRC Animal Sciences Delegation

Edited by Jacob A. Hoefer and Patricia Jones Tsuchitani

Submitted to the Committee on Scholarly Communication
with the People's Republic of China

Commission on International Relations
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PREFACE

The Animal Sciences Delegation visited the People's Republic of China from June 11 to July 9, 1979, at the invitation of the Chinese Association of Agriculture. The delegation membership consisted of seven animal scientists, one veterinarian, and one agricultural economist. In addition, a China scholar whose speciality was anthropology was chosen to accompany the group. The visit was organized by the Committee on Scholarly Communication with the People's Republic of China (CSCPRC), a committee sponsored by the American Council of Learned Societies, the National Academy of Sciences, and the Social Science Research Council.

The delegation was selected to give coverage to both species and disciplinary interests. In surveying China's agriculture, attention to swine and poultry (ducks) was of highest priority, followed by cattle (dairy and beef), sheep and goats, horses and mules; finally, lesser attention was given to such species as water buffalo and rabbits. The disciplinary interests embraced nutrition, breeding, reproduction, economics, processing and utilization, and animal diseases.

The delegation recognized the difficulty of the assignment because of the confounding effect of so many species and disciplines; nevertheless it was the intent of the delegation to survey the animal-production practices and the animal science research and education of China in a manner that would be productive to both the United States and China within the physical limits of time and travel arrangements. Fortunately, the scientists in the delegation had a broad background of research and administrative experience, which gave them a good base from which to evaluate their observations of animal science and production in China. However, it must be noted that the very size of China, its enormous animal population consisting of many species, the variable environmental conditions, the variety of feedstuffs unfamiliar to U.S. scientists, a totally different distribution system, and a managed economy provided a set of conditions that preclude other than qualified observations.

All members of the delegation had some foreign experience, but none had been to China before. All of us were seeing animal production in China for the first time. We were fully aware of the constraints imposed by time and the limited number of scientists on the team balanced against the number of species and disciplines to be assessed and evaluated. We believed strongly that since we were the first delegation of animal scientists from the United States to visit China, the credibility of our report would depend on the itinerary developed jointly by the Chinese and us.

We had broad interests in production practices, research, technology transfer, and educational programs as well as specialized interests in reproduction, breeding, management, utilization, processing, and energetics for literally all species of economic animals, with heavy emphasis on swine and poultry. It was our intent to get the best possible exposure to a cross-section sample of Chinese animal agriculture. Based on our knowledge of Chinese agriculture, we submitted a suggested itinerary to the Chinese Agricultural Association. Included in this request were trips to the Inner Mongolia Autonomous Region and the Xinjiang Uygur Autonomous Region. We wanted to see some rural pastoral regions as well as the intensive agriculture practiced around major cities.

The Chinese authorities did not approve all our requests, but they did approve our visiting Inner Mongolia and enough other rural areas to ensure that we would have an opportunity to see and observe at close hand what we believe is a representative sample of Chinese animal agriculture.

Our Chinese hosts did everything within reason to accommodate to our needs. At each main stop we first heard about the details of the local arrangements and then were given the opportunity to suggest changes. We always took advantage of these negotiating opportunities to ensure that we would have a chance to see what we believed would contribute most to our survey. At no time did we believe that we were being deprived of access to animal science or production practices. We were always free to travel, to talk to anyone, and to take pictures.

Individually, and as a delegation, we are deeply indebted to our Chinese hosts, the Chinese Association of Agriculture, and specifically to

Yang Xiandong, Deputy Minister of the Ministry of Agriculture; Chairman of the Chinese Association of Agriculture

Cheng Shaojun, Vice Chairman of the Chinese Association of Agriculture; Chairman of the Chinese Society of Animal Husbandry and Veterinary Science; Vice Dean of the Chinese Academy of Agricultural Sciences

Cheng Peilieu, Vice Chairman of the Chinese Society of Animal Husbandry and Veterinary Science; Professor, the Chinese Academy of Agricultural Sciences

Wang Huaiman, Secretary in Charge of Foreign Affairs of the Chinese Association of Agriculture

An Min, Professor, Beijing Agricultural University

Liu Jinxue, Professor, Chinese Academy of Agricultural Sciences

Chu Weiyung, Interpreter

The latter four persons accompanied us throughout the entire trip of approximately 7,000 miles in continental China. Mr. Wang made all the travel arrangements and scheduled all visits; Mr. Chu served as a superior interpreter and contributed much sly humor, and Dr. Liu and Dr. An were invaluable in providing technical interpretation and background information about China's animal agriculture and also about China as a nation before and after Liberation (1949). The delegation will be forever indebted to all those mentioned above for making the trip a pleasure, an unforgettable experience, and a success.

The report that follows is a joint effort of the entire delegation with specific chapter responsibilities as indicated. It is a record of our general impressions of how the world's most populous nation is conducting its animal industry and its animal science. We make no claim of completeness for our survey. A complete study would require years of effort and a much larger task force. The report does represent a *first*--it is a report of the first animal science delegation of the United States to visit China with the specific intent of surveying China's animal industry. It is an honest report of the observations of a small team of specialists. Its value depends on the validity of our sample and the accuracy and interpretation of our observations.

/ CH
Jacob A. Hoefer
Chairman

The Animal Sciences Delegation at the tombs of the Qing Dynasty emperors, with hosts from the Chinese Agricultural Association (CAA). *Left to Right: Standing:* Wang Huaiman, CAA; Virgil Hays, Warren Foote, Jim Oldfield, Jake Hoefer, Neal First, Bob Bray, Pat Tsuchitani, Professor Cheng Peilieu, Ma Ling, CAA. *Kneeling:* Art Wolf, Bill Dean, Roy Van Arsdall. (*Missing from picture:* Jack Hyde.)

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Special acknowledgments are due to Dr. Timothy Chang of the Michigan State University Poultry Science Department, who was in China on special assignment and who accompanied the Animal Sciences Delegation for a period of 10 days and contributed greatly to the interpretation of observations; also to Mark Allen, Michigan State University Agricultural Experiment Station Editor, for editorial assistance; and finally to Patricia Jones Tsuchitani, Assistant Staff Director, Committee on Scholarly Communication with the People's Republic of China, who provided the coordinating touch needed to smooth out all difficulties and who created an atmosphere of understanding so essential to a trip of this kind. The delegation expresses its heartfelt appreciation to her.

A special note should be made concerning the untiring efforts of Dr. Cheng Peilieu to ensure that we were always comfortable, well fed, and not inconvenienced by travel arrangements. We are also deeply indebted to Dr. Cheng for writing a chapter providing a background perspective of domestic animals in China.

CONTENTS

1

A BRIEF INTRODUCTION TO CHINA AND ITS ANIMAL INDUSTRY

Jacob A. Hoefer

Visualize a team of 10 animal scientists from the United States seated at a round table with individual pots of tea and discussing China and its animal industry with their Chinese counterparts. The main issue is the fact that China has indicated its intention to improve the dietary protein intake of its approximately 1 billion people by doubling the per capita intake of meat by 1985.

To grasp the significance of doubling the per capita consumption of meat in China, it is necessary to review some history, geography, and socioeconomic-political facts about this, the most populous nation in the world.

Consider these facts:

- China is the oldest continuing civilization, dating back to 4,000 B.C.
- One fourth of the world's people, estimated at 900 million to 1 billion, live in China.
- China is the third largest nation in the world, after the Soviet Union and Canada. It is larger than the United States, larger than all Europe. Its territory encompasses approximately 2.4 billion acres.
- Almost two thirds of China is mountainous or desert.
- Eighty-five percent of the people live on one third of the land.
- Eighty to eighty-five percent of the people live in rural areas.
- Agriculture employs an estimated 80 percent of China's labor force.
- Almost all property is owned by the state central (government) or the collective (commune). There is very little private ownership except for personal property, e.g., clothing, household goods, bicycles; no land or motorized vehicles are privately owned.
- China is a socialist state, a managed economy with all decisions of consequence made at one or more of the several levels of government, i.e., production team, brigade, commune, county, province, and national. China has 22 provinces, 5 autonomous regions, 3 municipalities (Beijing, Tianjin, and Shanghai), and about 70,000 communes.
- China's climate ranges from tropical to temperate. The country extends farther north and south (18°N-54°N) and east to west (about 60° of longitude) than the United States.
- China's agriculture is very intensive, with double and some triple

cropping in the south and much irrigation wherever water is available. However, only 10-11 percent of China's land is arable.

- Annual per capita consumption of meat is 8 kg (17.6 lb), estimated to be 90 percent pork with the balance other red meats.
- Annual per capita consumption of poultry products and fish is estimated to be approximately 3 kg each.
- Animal populations are estimated to be

Swine	300 million	
Large Animals	94 million	(cattle, horses and mules, water buffalo, camels)
Sheep and Goats	170 million	
Poultry	1.4 billion	

- China has achieved basic dietary self-sufficiency in food production--a highly significant achievement.
- China has vast, although unmeasured, pastoral areas that appear to be largely undeveloped.
- China has enormous energy resources--known coal reserves, undeveloped oil, and hydroelectric power.

China is big in all its dimensions--area, resources, production, number of animals, problems, and of course, population.

Before addressing the delegation's survey of China's animal industry and the implication of doubling the production of meat, it should be noted that China has established a public policy of *four modernizations*: agriculture, industry, science and technology, and national defense. Food production is of paramount importance to the Chinese. It is crucial to their survival, and the current Chinese leadership recognizes this; hence great importance is attached to agriculture as the most important industry in China.

It should likewise be noted that China is undergoing a massive reorganization at all levels of government following the overthrow and downfall of the Gang of Four. The reorganization at the research and education level was particularly evident to us. The Cultural Revolution of 1966-1976 was a disastrous period for science and technology, for education, and for agricultural research throughout China. Time and again, at all levels--the brigade, the commune, the college, the research institute, wherever we met with people--we heard about the *10 lost years* when progress was stopped or stalled by the policies invoked during the Cultural Revolution. During this period, many of the scientists and professors were sent to the field to gain "practical experience."

China is now making strenuous efforts to recover from the economic and educational setbacks associated with the Cultural Revolution. Scientists and technicians are now held in high regard, and it is no longer popular to be anti-intellectual. Education and educators, researchers and professors are viewed as positive contributors to China's modernization.

Colleges and universities are now opening their doors and enrolling students based on ability as determined by competitive national examinations. Research institutes closed during the 1966-1976 period are being reactivated. Laboratories that are substandard with obsolete equipment are in the process of being equipped with more modern instrumentation. The scientists we met displayed a positive attitude and projected optimism about the future. They appear to be completely sincere in their efforts to establish research and education programs that address national priorities.

During the 10 lost years, many professors and research scientists and technicians worked in the fields, but it is evident that reading the scientific literature whenever it was available was a high-priority activity. We were impressed with their knowledge of animal science research world wide. They freely admit that their science and technology are far behind those of the western world, and they express the hope that the United States, with its vast resources, will be able to help China in its modernization program, especially in agriculture.

Historically China has always turned inward with the intention of being self-reliant and independent of foreign influences. China is now eagerly seeking foreign technology and is negotiating agreements that indicate that China is now firmly committed to a program of acquiring foreign science and technology on a massive scale.

We participated in numerous seminar-discussion sessions with Chinese peer groups in which there was a free discussion of animal science research activities going on in each country. In addition to the seminars, several major lectures were given. The subjects of these academic exchanges ranged over a broad area from mission-oriented basic animal science research to practical management production problems. Species and disciplinary areas received essentially equal time in these discussion sessions.

China is a nation of extremes in its agricultural resources and its climatic environment. Variations in soil, temperature, rainfall, and variety of plants and crops, and the numbers of animals and breeds of livestock all exceed what we have in the United States.

The agricultural production is organized around communes and some private production (households). The commune is a geographic and political community with all resources held in common. The commune is literally responsible for everything that happens within its boundaries, e.g., its agricultural production, industry (factories), commerce, education (it has its own schools), health (hospitals or clinics), culture, and entertainment. There will be villages and towns within the commune. The communes we visited ranged in population from 10,000 to 75,000 people. Everyone is on a work or production team with specific responsibilities (e.g., swine, dairy, rice, ducks, transportation, factory).

The production teams vary in size but usually range from 20 to 30 households (±100 people) and are further consolidated into brigades that ultimately make up the entire commune. Production quotas are established by the government for the commune. However, within the commune the leadership may set brigade and production team goals. Workers are encouraged to exceed production quotas because this benefits both the commune and its individual members.

It is evident that capitalistic incentives are being used in the reward system employed because wage scales vary with skill and output and individual work points are earned, which translate into personal income. It also appears that commune leadership has considerable flexibility in decision making with regard to commodity production, management and cultural practices employed, factory development, etc., although there must be coordination and approval obtained at some higher level when major projects are involved. The commune leadership usually comes from the ranks, i.e., the leaders usually have brigade leadership experience, and there is an election process.

Family members (a private household) are provided housing and health care at low cost. The household also has a small plot of land, which is cultivated intensively and also serves as space for some chickens and possibly several pigs, which the family purchases as weanlings from the communes. In some communes private production makes up as much as 50 percent of the total production; however, the trend is toward collective production because only the commune can provide the resources needed to adopt any large scale technology associated with modernization.

The conclusions we reached must be viewed as general observations only, made by a team of U.S. animal scientists with no previous experience in China. We are, however, well-qualified observers in our specialities, and the conclusions are based on 28 days of intensive travel--some 7,000 miles in five provinces, one autonomous region (Inner Mongolia), and eight cities; visits and discussions at ten research institutes, three colleges, two provincial institutes, fifteen communes, eight state farms, and a dozen households; and numerous in-depth conversations with the leaders of the Chinese Association of Agriculture, the Chinese Academy of Agricultural Science, and the national Ministry of Agriculture.

We asked to see a cross section of China's animal industry, and we are satisfied that we saw a reasonably representative sample of the swine, poultry, and dairy industries; but we had only a limited opportunity to see grazing animals, i.e., beef, sheep, and goats. We had 5 excellent days in Inner Mongolia and saw vast grazing areas and some sizable herds, but this was admittedly a very small sample from which to extrapolate the grazing animal potential for all China. With respect to a "cross-section sample," we are indebted to our Chinese hosts, the Chinese Association of Agriculture, for their efforts in making all travel arrangements and contacts.

All our requests were given serious consideration, and in many cases our hosts were able to adjust our schedule, permitting us to make unscheduled visits. The flexibility to make changes at the local level was a pleasant surprise. This suggests that the Chinese are sincere in their desire to learn through open and honest dialogue. We believe that they did their best to show us what we wanted to see and that there was no deliberate attempt to conceal or misrepresent their research or their production practices. They did an extraordinary job of expediting the entire trip, which was no small feat considering the distances we traveled and the constraints of a society organized like that in China. The friendliness, hospitality, and generosity of our hosts, coordinators, and interpreters made us feel welcome and made the trip an extremely pleasant experience.

2

A BACKGROUND PERSPECTIVE: SOME NOTES ON THE CHARACTERIZATION AND DISTRIBUTION OF DOMESTIC ANIMALS IN CHINA

Professor Cheng Peilieu
Chinese Academy of Agricultural Sciences
Beijing, People's Republic of China

The development and improvement of domestic animals began in earnest following the Liberation in 1949, with the founding of New China.

The number of arm animals in China at the end of 1979 was as follows:*

Pigs	301.29 million
Sheep	169.94 million
Large animals (including sheep and goats)	93.89 million

I would like to discuss here the distribution, types, and breeding of domestic animals in China from the viewpoint of ecology.

The huge size of China's territory must be appreciated; it encompasses more than 5,000 km from east to west and more than 5,500 km from north to south, with a total area of 9.6 million km^2. Additionally, its complex topographical and climatic conditions exert a great influence on the distribution of domestic animals in China.

The plateaus of the north and west are noted for their high altitude and cold, arid climate. These conditions have contributed to the formation of different classes of natural grasslands and, in turn, shaped the natural environments of the domestic animals in the pastoral area. The east and south are noted for their temperate, moist climate, fertile soil, and well-developed agriculture, which helped form the natural environments of the domestic animals in the agricultural area.

This is a revision of "The Livestock Industry of China," an invited lecture delivered at the plenary session of the International Stockmen's School, under the sponsorship of the Agriservices Foundation, in January 1979, at San Antonio, Texas. The present manuscript is an excerpt of another detailed paper, "A Study on the Ecology of Domestic Animals of China."

Professor Cheng was one of the hosts for the Animal Sciences Delegation. He graciously consented to publish this revised paper in our trip report.

*Data are from the State Statistical Bureau of China, June 27, 1979.

I. DISTRIBUTION OF DOMESTIC ANIMALS

Distribution of Domestic Animals in the Pastoral Area

The Chinese pastoral area occurs mainly in the Inner Mongolian Plateau of the north and the Xinjiang and Qinghai-Xizang (Tibet) Plateau of the west. The remarkable differences in geography, climatic conditions, and soil and vegetation types all contribute to the difference in the distribution of domestic animals.

1. *Forest Grassland Belt*

There is a forest grassland belt in the western part of northeast China and in the eastern part of Inner Mongolia. The winters are long, cold, and arid; the summers short and moist; the soil is fertile, and pastures grow well. This area is especially suitable for raising horses, cattle, and sheep and is one of the main centers of the livestock industry.

2. *Steppe*

In the western parts of the Inner Mongolian Plateau and the "yellow soil" plateau, the altitude is high and the annual rainfall is about 250 mm. There are few vegetation types and little grass, so the steppes are suited mainly for sheep.

3. *Desert Steppe*

The area of the north of the Tibetan Plateau is even more arid, with an annual rainfall under 150 mm. This area includes part of the Gobi Desert and is devoted mainly to raising sheep and camels. It contains about one third of the nation's sheep and 53 percent of the nation's camels.

4. *Desert*

The mountainous areas of the west, where the temperature and rainfall change with the altitude and topography, are used mainly for raising sheep. In the high-altitude areas, there are also yaks, which are well adapted to the high mountains.

5. *Qinghai-Xizang Plateau*

The elevation is 4,500-5,500 m, with an average yearly temperature below 0°C and 200-400 mm of rainfall. It is high, cold, and arid and is mainly used for Tibetan sheep and yaks.

The pastoral areas of China are mainly in the north, northwest, and southwest, where the national minorities dwell. They keep animals to produce meat, milk, and pelts. The animals graze on grasslands year round, with very little feeding or management care. The nomadic way of life still prevails in some of the areas, and the animals are still subjected to the menace of either drought or heavy snow. Animal husbandry is still in the state of "relying on heaven."

Distribution of Farm Animals in the Agricultural Area

The agricultural area of China is found largely in the northeast, north China, and the middle and lower regions of the Yangtze River, i.e., the "Three Great Plains," and also in the yellow soil plateau. The distribution of farm animals found there has its own particular characteristics.

The northern agricultural region belongs to the temperate belt, producing mainly wheat, corn, sorghum, and beans; thus it provides a variety of agricultural by-products for the animals. The main draft animals are horses, donkeys, mules, and yellow cattle. The small animals are predominately pigs and sheep.

The southern agricultural region belongs to the southern temperate belt and the northern subtropical belt, characterized by plentiful rainfall. This is the basic rice-producing area of the country. The main draft animals are water buffalo and yellow cattle. Small animals are mainly pigs and poultry.

The animal industry in the agricultural areas, compared with that in the pastoral areas, has the following characteristics: the management is more intensive, the husbandry standards are higher, and most of the animals are kept in sheds.

Although the pastoral area is larger than the agricultural area, about five sixths of China's total livestock is distributed in the agricultural area. This includes about 95 percent of the nation's swine, most of the draft animals, 72 percent of the cattle, more than half of the horses, 70-80 percent of the nation's donkeys and mules, and one fourth of the sheep.

II. INDIGENOUS BREEDS OF DOMESTIC ANIMALS

China has mountains and plains and temperate and subtropical belts. These natural conditions are varied and quite complicated: there are pastoral and agricultural areas and also areas intermediate between them. Therefore feeding and management practices differ widely. Animal-production requirements of the Chinese people also differ; hence the direction and methods of selection also differ. Different animal breeds have gradually evolved under the influence of these factors, and they have different heritable characteristics and productive abilities.

The following examples may illustrate how different animal breeds were formed under different ecological conditions:

Horses

1. Mongolian Horses of the North and Kazakh Horses of the West

All of them share the valuable characteristics of remarkable adaptability to unfavorable environment and the ability to graze year round and to withstand harsh feeding conditions. They can survive, with neither sheds nor supplementary feeds, even in temperatures below -40°C in severe winters.

a. Mongolian Horse This is one of the most important breeds of horse in our country. It is widely distributed throughout the northeast, north China, and the northwest. It is a dual-purpose horse, used primarily for riding, including Mongolian traditional racing, and for carting. The average height at the withers of mares is 127 cm. The Uchumucin horses, which are kept on better pasture, are taller (male, 135 cm; female, 129 cm) and have better conformation.

b. Kazakh Horse They are taller and more durable than the Mongolian horse (male, 136 cm; female, 133 cm), and they can be used in harness. The local inhabitants have a tradition of drinking mares' milk. A Kazakh mare will produce approximately 600 kg of milk during a lactation period of 3-4 months.

2. Horse of the High and Cold Region--The Hochu Horse

In the eastern part of the Qinghai-Xizang Plateau, the altitude is high (about 3,500 m) and the temperature is low (yearly average, 0.9°C), but the climate is temperate and moist in the summer (annual rainfall, about 600 mm), and the grasses grow well in the meadows. Under these particular conditions, the Hochu breed has developed a comparatively large body size (height: male, 141-143 cm; female, 134-139 cm) and is of the saddle/harness dual-purpose type.

3. Horse (Pony) of the Southwest Mountainous Area

Although the altitude is fairly high (about 2,000 m) on the Yunnan-Guizhou Plateau of the southwest, the area is temperate and moist the year round (average yearly temperature, 13-15°C; average yearly rainfall, about 1,000 mm). The topography consists of high mountains interlaced with arable lands in the valley. The mountains are steep and the paths uneven. Historically, the people have had to depend on horses as pack animals for transportation in the mountainous regions. It is with this background that the horses have gradually adapted to the local conditions and requirements.

The common features of the horses in the southwest are small size (height at withers: male, 119 cm; female, 117 cm), narrow chest (chest index, 114 percent), slender limbs (cannon bone girth: male, 15 cm; female, 14 cm), but the joints are strong and the hoofs hard. The ability of this horse to climb mountainous paths swiftly makes it suitable as a pack animal in long-distance transportation.

Native Yellow Cattle

1. *Mongolian Cattle and Kazakh Cattle of the Pastoral Grasslands*

The common features of the pastoral grassland cattle are:

a. They are well adapted to the local conditions; they graze year round in severe weather and under unfavorable feeding conditions.
b. They have an ability to fatten quickly. They may consume their body reserves in a severe winter, leaving them weak and poor, but they recover quickly after the fresh grasses come in May.
c. Although these cattle are a triple-purpose breed, i.e., meat, milk, and work, their milk-producing abilities are rather limited because of their small size. Milk production of Mongolian cattle is approximately 600 kg in a 5-6 month lactation period, whereas that of Kazakh cattle is higher, about 880 kg. The fat content of the milk in both breeds is comparatively high, about 5 percent.

2. *Yellow Cattle of the Agricultural Area*

The environmental conditions and therefore the breed characteristics of the yellow cattle of the agricultural area are entirely different from those of the pastoral area. The lower basin of the Yellow River is the chief yellow cattle-producing area. The elevation in the south temperate belt is comparatively low (50-400 m); the climate is temperate (yearly average temperature, 13-15°C) and moist (annual rainfall, 550-800 mm). The agriculture is well developed, and many different agricultural by-products are used for animal feeding. The cattle are well managed, and all have housing. Some regions grow alfalfa (lucerne) for feeding cattle. The yellow cattle, e.g., the Chingchuan, Nanyang, Chinnan, and Lusi cattle, are the main draft power for agriculture and are selected as work/meat or meat/work dual-purpose animals.

Because of the similarity of their environmental conditions and the traits for which they are selected, the above breeds of yellow cattle have the following common characteristics:

a. They possess comparatively large body size and strength for their role as a draft animal.
b. The bull has a small hump, and the forequarters are more developed than the hindquarters.
c. They are well muscled, with fine-quality meat.

The body weight and measurements of these breeds are also similar and are briefly summarized as follows:

Measurements	Mature Male	Mature Female
Height at withers (cm)	140	120-125
Chest index (%)	about 140	about 140
Liveweight (kg)	550	350 and over
Highest body weight (kg)	983	728

3. Yellow Cattle of the Subtropical and Tropical Belts

The climate of the southern subtropical and northern tropical belts is quite warm and highly humid (average rainfall, 1,000 mm and more; relative humidity, about 85 percent).

These breeds have the following common characteristics:

a. The bulls have prominent humps (height, 8-15 cm).

b. The skin is thin and pliable, and the texture of the hair coat is fine. The cattle can withstand heat and humidity.

c. They graze year round and can withstand harsh feeding conditions.

d. They have a relatively small body size (height for females, 102-111 cm), with slender legs and hard hoofs. They can move swiftly and climb steep hills.

In summary, we find that the influences of different climates, feeding and management, and selection have resulted in the following obvious breed differences among Chinese yellow cattle:

a. The yellow cattle of the northern pastoral area are well-adapted to their local environments, especially to the severe climate and poor-quality pastures. Therefore they are comparatively smaller in body size and lower in productivity.

b. The agricultural area of north China has a favorable climate, and agriculture is well developed. Thus large, strong cattle have resulted from a favorable environment, better feeding conditions, and selection for larger body size, muscling, and strength.

c. Farther south, there is a tendency for the body size of the yellow cattle to be smaller as the ambient temperature gradually increases. Cattle of the southwest have a smaller body size and finer bones and are well adapted to the mountainous, vertical topography of this area.

Water Buffalo

The ratio of water buffalo to yellow cattle in China is 1:3. Geographically, the buffalo are distributed primarily in the southern rice-producing areas where the climate is warm and moist (annual average temperature, 13-15°C; rainfall, 1,000 mm and more).

The climatic conditions, feeding, and management practices of the various buffalo-breeding areas are basically similar; the differentiation of the buffalo into breeds (or types) is neither so obvious nor so complicated as that of the yellow cattle. However, the body size of buffalo gradually becomes smaller as the ambient temperature increases from north to south.

Some breeds of buffalo have a long history of relatively high milk-producing ability. For example, buffalo cows in Wenzhou and Guangdong produce approximately 750 kg of milk in a lactation period of 8-10 months, with a fat content as high as 9.1-11 percent.

Yaks

Most of the yaks in China are located in the high and cold mountainous areas, at elevations above 3,000 m on the Qinghai-Xizang Plateau and the mountainous areas of its neighboring provinces. The yak can graze on the alpine grasslands during winter when they are covered with deep snow. Conditions are rigorous even for Tibetan sheep. Although the yaks will lose weight during the winter, they recover and gain weight rapidly with the coming of spring grass.

The yak has long, coarse hair, which acts as insulation, all over its body. Some of this hair may even touch the ground (the shoulder hairs are about 20-40 cm in length). In addition, the animal grows a dense woolen undercoat for winter protection.

Probably because yaks have always lived on rarefied air in high altitudes, the number of red blood cells and the amount of hemoglobin of the yak are about 50-100 percent higher than those of the yellow cattle.

Sheep

In China, sheep can be divided into three main categories: *Mongolian sheep* in the grassland area of Northern Inner Mongolia, *Kazakh sheep* in the desert and mountainous areas in western Xinjiang, and *Tibetan sheep* in the southwestern part of the Qinghai-Xizang Plateau. All these are coarse-wool sheep.

However, as the sheep were subjected to the influence of their respective natural environments and artificial selection, a number of breeds (or types), each with its own particular characteristics, evolved from these three categories. Because of the sharp seasonal contrast in plant growth in the pastoral area, and the continuous selection of fat animals for breeding by the herdsmen, the fat-tailed sheep gradually evolved. They have an ability to fatten quickly and to deposit fat in the tail or rump. For example, the Fuhai big-tailed (or fat-rumped) sheep of the Kazakh sheep category, under the influence of the natural environment and artificial selection, gradually formed its fat tail (weight, 7 kg).

However, sheep in agricultural areas are quite different from those in pastoral areas. Mongolian sheep in Ningxia, for example, in the arid and temperate climate (annual average temperature, 9°C; rainfall, less than 300 mm) with a vegetation consisting mainly of sand plants and saline plants, and with year-round grazing, have gradually evolved into Tai sheep. The month-old lambs are famous for an evenly crimped, beautiful pelt. The Tai Lake area has a warm and moist climate (annual average temperature, 16°C; rainfall, 1,000-1,200 mm) and fertile soil. It is known as the "land of fish and rice." The sheep are penned in sheds and supplied with a variety of feeds, and gradually a breed has developed that is noted for its high prolificacy (twin lambs are usual; triplets and quadruplets are not uncommon).

The differentiation of the Mongolian sheep in the agricultural area into breeds illustrates that environmental factors also play an important role in breed formation.

Pigs

It is only natural that China has many breeds of pig because of the topographical complexity, marked climatic differences, the diversity of feeds in different parts of China, and different requirements for pork products (such as lard, pork, salted pork, and ham) in various parts of the country. On the basis of climatic and natural conditions, we may divide all the kinds of pig into several regional types, each of which consists of a number of breeds.

1. North China Type

The pigs can generally withstand cold weather and harsh feeding conditions. Their body size is relatively large, and they have a black hair coat and coarse, long bristles. They mature sexually comparatively late, but they are fairly prolific, with seven to eight pairs of teats and twelve or more pigs per litter.

2. Central China Type

These are found in the region between the Yangtze and Pearl rivers, where the climate is temperate (or warm) and moist and the feed supply is rich and varied--conditions that favored the development of some breeds characterized by early sexual maturity and high prolificacy. Sows of the Taihu pig, for instance, have eight to nine pairs of teats, with an average litter size of twelve for first litters and fifteen for subsequent litters.

The Qinghua pigs live in environmental conditions similar to those of the Taihu pig, and they are also prolific, with eight pairs of teats and an average litter size of twelve. The Qinghua pig is noted for its thin skin and fine bone. Selection has always been directed toward producing the Qinghua ham, a favorite for its taste, rosy color, and international reputation.

Most central subtropical belt breeds of pig are characterized by early sexual maturity, males maturing at 3 months and females at 4 months. The gilts can be bred and become pregnant at 5-6 months of age and are very prolific, with seven to eight pairs of teats and a litter size of about twelve.

3. South China Type

These pigs are found in the south subtropical belt and the north tropical belt. Because of the long-term effects of their environmental conditions, these pigs have low-set, short bodies, with concave backs and pouched, pendulous bellies extending to the ground. All these breeds are of the lard type. They are characterized by early sexual maturity but are less prolific.

In addition to the above regional types, there are other breeds in the cold highland belt.

The great number of Chinese breeds of livestock will surely provide valuable material for work in animal genetics and breeding. Also, these breeds may contribute much to our animal production in ways that we cannot now foresee. All these breeds are an important part not only of China's, but also of the world's, livestock gene pool.

III. NEW BREEDS IN THE PROCESS OF IMPROVEMENT

As mentioned above, the native breeds of Chinese farm animals have some outstanding genetic merits, such as high adaptability to unfavorable environments, the ability to withstand harsh feeding conditions, and disease resistance. But, generally speaking, their productivity is comparatively low, and they are not meeting the ever-increasing demand for animal products. So there is an urgent need to increase their productivity as rapidly as possible.

The following examples may illustrate some progress in our animal breeding projects:

Horses

In northeast China, we have crossed different exotic breeds of native Mongolian horses to produce new breeds of harness horse. The results are as follows:

Breed	Height at Withers (cm) Male	Female	Chest Index (%)
Heilongjiang harness horse	153	150	121
Jilin harness horse	156	152	122
Teiling harness horse	156	154	124

Cattle

1. Milking Cattle--Black-and-White Dairy Cattle

These are either progeny of Holstein cattle imported from overseas in the past or the upgraded progeny of native yellow cows sired by Holstein-Friesian bulls. Since they have been selectively bred and adapted to the Chinese environment for so many years, they are now called Chinese Black-and-White dairy cattle. Generally, these cows produce 3,000-3,500 kg of milk in one lactation period (300-day basis) with a fat content of approximately 3.4 percent. Registered cows in the northern area produce 5,804 kg of milk and in the southern area, 5,079 kg. The highest individual record is 15,945 kg of milk in one lactation period. The lifetime record is 91,300 kg.

2. Milk/Meat Dual-Purpose Cattle

This breed is the product of long-time selection and crossbreeding between native Mongolian cattle and a number of exotic breeds (e.g., Simmental) on the grasslands of the northeast. This breed is similar to Mongolian cattle and is well adapted to the local climate and year-round grazing. Generally, the milk production is 1,800-3,000 kg and the fat content is 4 percent.

3. Meat/Milk Dual-Purpose Cattle

These are F2 and F3 generations of Mongolian cows upgraded by Shorthorn bulls in Inner Mongolia. They are deep red in color, with a uniform appearance and a meat/milk dual-purpose conformation. This breed is also in the process of being improved.

Sheep

Improvement of sheep in our country has progressed rapidly with reasonably good results. The average fleece weight of the improved (crossbred) fine-wool and medium-fine-wool sheep is two to three times heavier than that of the original coarse-wool sheep. The quality of the wool has also improved. The Xinjiang Fine-Wool and the Northeast Fine-Wool sheep are the two established breeds resulting from years of cross-breeding between the local coarse-wool ewes and the imported fine-wool rams. The wool is of 60's-64's quality (average fiber diameter, 20.6-25.0 μm) with a fleece weight of about 5 kg.

Pigs

1. The Harbin White Pig

This pig of the northeast (a meat/lard dual-purpose type) resulted from crossbreeding, first of the Yorkshire and then of the Soviet Large White, with the white crossbred pigs of unknown origin owned by the peasants. Backcrossing among the crossbreds and selection were practiced for a long period. The pigs of this breed are characterized by rapid growth, large body size, and thick backfat.

2. The New-Huai Pig

This pig of the central area (a meat/lard dual-purpose type) is the product of selective breeding from the crossbred progeny of Yorkshire and native Huai pigs in the Huai River lower basin.

SUMMARY

In breeding and improving the farm animals in our country, we have taken into account the need for increased animal productivity along with improved feeding, management, and other environmental conditions. That is to say, we are trying to integrate the hereditary and environmental factors.

3

SOME ECONOMICS OF ANIMAL PRODUCTION

Roy N. Van Arsdall

Three basic factors largely determine the mix, amount, quality, and utilization of farm animals and animal products in China. They are the sociopolitical structure under which all economic activity takes place, the basic resources available for use in food production, and the infrastructure. All three pose both advantages and disadvantages for the advancement of animal production in the country. Changes that have occurred within the last 3 years generally favor strengthening animal production, but difficult problems remain.

The present population of China is estimated to be 975 million people. Eighty percent live in the countryside and work in agriculture or light industry. In 1978, rural people earned 47 percent of their income from light industry, 33 percent from production of crops, and 20 percent from livestock and fisheries. What this represents in terms of gross national product is unknown, but in 1977 the total GNP of China was an estimated $350 billion (U.S.), or about 19 percent of that of the United States.

THE STATE, STATE FARMS, AND COMMUNE SYSTEM

All crop and livestock production takes place either in state farms or in the commune system with certain control exercised by the state.* This combination of control and organization of production largely determines the type and direction of production in agriculture. Heavy emphasis is now being placed on expansion and modernization of agricultural production, especially livestock production.

The government permits considerable freedom in decision-making at the local level but exercises control over production of crops and livestock in many ways. All land is owned by the state. It is classified according to permissible uses, such as tillable land, pasture or range land, and forest land. People at the local level can decide which crops to plant on land designated as tillable, but they cannot cultivate land classed as pasture or range. The government maintains control over all supplies of grains and concentrate feeds. People at the local level

*State is the term used for the national government of China.

can choose the kinds of livestock they wish to produce, but production is limited by state allocations of concentrate feeds and other needed inputs, such as vitamins and veterinary supplies.

Economic incentives are used by the government to control and direct animal production. The state sets the price on all grains and concentrate feedstuffs. It also sets the price on other purchased inputs, such as semen, veterinary supplies, and machinery. Prices for all livestock and livestock products sold to the state are set by the state. Thus freedom of choice in production of livestock is largely conditioned by actions taken by the state.

State farms account for a small portion of agriculture in China, probably about 5 percent of the total cultivated land. State farms are totally government owned and operated. Many state farms in the advanced areas of the country are of a special-purpose nature devoted to extensive ranching, grain production, specialized dairies or poultry-production units near large cities, centers for production of semen or female breeding stock, and the like. Some have large land areas; others, such as drylot dairies or bull stud stations, have only a building site. Those with little land may be within the boundaries of a commune. Most state farms, however, remain diversified operations, as in the past.

State farms operate on a budget from the government, and the government disposes of the output. People who work on state farms are called agricultural workers and are paid a wage or salary plus incentives to encourage high performance. Workers have no share in the income of a state farm.

Communes usually have a substantial land base that is much like a small county in the United States. Communes that we visited in the intensive agricultural areas range to populations of nearly 100,000 people organized into production brigades and production teams. Production activities are greatly diversified and include crop and livestock production and light industry.

Communes in the arid range area of Inner Mongolia reflect the extensive extreme. Commune organization there includes only a few brigades of 100 or so people, each with no breakdown to the team level. Herding of grazing animals and production of a winter feed supply are the sole agricultural activities.

People engaged in livestock and crop production in communes are known as commune members or peasants rather than as agricultural workers as on state farms. Their basic source of income is a share of the commune income; thus they have a vested interest in successful operation of the commune. Additional income is derived from sale of produce from private plots that peasants are allowed to operate and from sale of privately owned livestock and livestock products, including manure.

This state/state farm/commune complex facilitates rapid change in livestock production in many respects. State farms, being under direct control of the government, can institute changes by direct edict without regard to profits or losses. Commune operations are directly influenced by government actions through "advice" from the state about desirable goals, kind and amount of production inputs made available, and prices assigned to inputs and outputs. The organization is tight and well established from state to production team. Rapid improvement is therefore possible if decisions are correct; massive and rapid deterioration, if decisions are wrong.

The diversity and complexity of economic and social activities in the communes is illustrated by the following partial statistics for the Xinfa commune near Harbin:

Area, 70 square km
Arable land, 3,334 hectares
Population, 30,000
Households, 5,600
Work force, 9,600
Production brigades, 11
Production teams, 53
Livestock farms, 5
Crop production, diversified, including grain, vegetables, and nursery stock

Partial list of sales to the state in 1978

Vegetables, 40 million kg	Milk, 450,000 kg
Pigs, 5,000 head	Spirits, 0.72 million kg
Eggs, 20,000 kg	

Partial list of manufacturing industries

Distilleries, 4	Brick yard, 1
Starch plants, 2	Can factory, 1
Noodle factory, 1	

Partial list of support facilities

Machine repair shops, 8	Medical clinic, 1
Irrigation wells, 143	Elementary schools, 11
Water drainage stations, 9	Middle schools, 3
Veterinary clinic, 1	Shops and stores, 6
Home for elderly, 1	

PRIVATE OWNERSHIP OF LIVESTOCK

In recent years private production of livestock was discouraged. Emphasis has now shifted toward expanded private production of livestock on a controlled basis, especially the finishing of hogs for slaughter. Encouragement is provided to peasant production through market price incentives, more-liberal allowances on maximum numbers of livestock that can be kept by a family, and provision of essential feedstuffs and other necessary inputs by the state. Control is exercised by limiting the numbers of animals that can be kept and the feed supply and by requiring a specified portion to be sold to the government at fixed prices.

The state policy on private production of livestock varies according to the agriculture of the area. Limits seem most strict in the intensive crop-producing areas and relatively liberal in the grazing areas. Sixty to eighty percent of all slaughter hogs, by far the most important species of animal in China, come from private production. Production is concentrated in the agricultural or crop-producing areas. No definitive limit could be determined for the number of hogs that a family can have. Two or three head was the limit most often mentioned, but one respondent at Harbin said that there is no limit except feed supply. It seems probable that allocations of feeds effectively limit all families to a few head of hogs, as private individuals control no grain. The Brick Bridge commune near Shanghai specified a limit of four or five pigs per year for family production.

Families most commonly purchase feeder pigs produced at team, brigade, or commune level. In some communes, individuals are not allowed to have sows; in others, private ownership of a sow is permitted, with the family entitled either to sell pigs or to finish them for slaughter. The Xinfa commune near Harbin reported that a family can keep a sow and raise pigs once the production goal of the commune has been met.

Private production of chickens, ducks, and geese is apparently unconstrained except by the supply of feed. Conversely, private ownership of large animals is apparently forbidden in the major crop-production areas. Most dairy cattle are held in state farms or suburban communes. Horses, mules, water buffalo, and other draft animals are collectively owned in the agricultural areas.

The policy on private production of livestock is much more liberal in the grazing areas. In a pasture area of Heilongjiang Province, a family was said to be allowed to own maximums of two sheep, three horses, two cows, and an unspecified amount of poultry. Production from these animals belongs to the family, but they cannot use the offspring of the animals to increase numbers beyond the specified limits. Private-property limits in the grassland area of Inner Mongolia were twenty sheep, two horses, and three cows, with limits on other species unspecified.

The most effective limit on private production of concentrate-consuming livestock is feed. It was repeatedly clear that the state makes certain amounts of concentrate feeds available when animals are sold in order to make continued production possible. (In China concentrates include all feedstuffs other than forages.) This applies primarily to hogs. One example was provided by the head of a family in the Xinfa commune near Harbin. The family purchased two feeder pigs and raised them to slaughter weights of 150 kg each, which is over twice the average slaughter weight. When the pigs were sold, the state awarded coupons for the purchase of 50 kg of feed grain for each hog sold and coupons for 0.5 kg of soybean meal and 0.5 kg of corn bran for each kilogram of pork sold. These feedstuffs were then purchased at the government-established price for each feedstuff. It is unclear how individuals, or even communes, obtain allocations of concentrate feeds with which to enter into or expand livestock production.

Regulations on slaughtering and disposition of livestock are also in force. People in the extensive grazing areas slaughter animals to meet their daily food requirements. Families in the cropping areas can slaughter their own chickens, ducks, and geese, but their privately owned hogs usually must be processed in a slaughterhouse or by the local butcher.

The state must provide food for people in urban areas and generate some foreign exchange through export of meat and other livestock products. Therefore a portion of privately produced livestock, now specified as 50 percent instead of the previous 60 percent, must be sold to the state. The remainder may be sold to the state, kept for home consumption, or sold on the open market. Payment is flexible in that one can accept money or meat coupons that can be exchanged for supplies of meat from the local store during the year. In the far north, natural freezing permits the keeping of meat at home during winter, but for most of China the lack of refrigeration makes meat coupons more practical.

Private ownership and sale of horses and other large animals seem quite common in the grazing areas. After orders are filled for the government, substantial numbers of horses are left for people to dispose of as they wish. These are both traded and sold at local fairs, although one respondent indicated that a state official must approve sales arranged among individuals.

LIVESTOCK AND COMMUNE FAMILY INCOME

Livestock, especially hogs, apparently are significant contributors to diets and cash incomes of rural commune families. The range in kinds and numbers of livestock kept by families is great, and there is no basis on which to portray an average situation for the country. One example can be presented, and it is doubtless nontypical in several respects. It does, however, illustrate the important of livestock, even in small numbers, to the income of a family.

The Xinfa commune is an important producer of hogs for breeding stock and for sale as feeder pigs to families within the commune. The commune hog manager provided data about prices of hogs and feeds. Several families within the commune then provided data about their incomes and livestock operations. One family provided the following information.

The family consists of six people: the husband, a disabled and retired veteran of the armed services; his wife, a working member of the commune; two adult children, working members of the commune; one son in the military service; and one son still of school age who is not working.

Annual income for the family averages 200 yuan per month.* Presumably, the family income total includes the husband's pension and the income of his wife and two working children, one of whom has a rather high paying job in one of the commune factories. Average field jobs in the commune are valued at 10 work points, which were worth 0.22 yuan per point in 1978. At this rate, a person working 300 days a year would have an annual income of 660 yuan.

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*All prices and costs in this chapter are given in terms of yuan. The exchange rate in mid-1979 when these data were collected was approximately 1.56 yuan per $1.00 (U.S.), or $0.64 per 1.00 yuan.

Contrast this income with that realized from the sale of livestock produced by this family. The family bought and finished two feeder pigs to market weights of 150 kg each. For each 100-kg liveweight sold, they took coupons for 30 kg of meat, accepting cash for the remainder. The example shown below illustrates maximum possible effect on each income by assuming that both hogs are sold outright to the government, one in a compulsory sale to the state at the base price and the other in a free-choice sale to the state at twice base price. When the hogs are sold, the state allows coupons for 50 kg of feed grain for each hog sold plus a 0.5 kg of soybean meal and 0.5 kg of bran for each kilogram of pork sold. The two hogs produced seven to eight carts of manure, which sold for 7.00 yuan per cart load.

Based on specified prices and cost rates and feedstuffs allowed, and assuming that both hogs are sold to the state, the return to the family would be over 500 yuan--nearly as much as the annual work point income for an average field worker in this commune and far above the annual per-capita incomes reported for most other communes.

Sales:	1	hog @ 150 kg × 90% dressing percentage × 1.50 yuan/kg	202.50
	1	hog @ 150 kg × 90% dressing percentage × 3.00 yuan/kg	405.00
	7	cart loads manure × 7.00 yuan/cart	49.00
		Gross income (yuan)	656.50
Costs:	2	feeder pigs × 18 kg/head × 1.20 yuan/kg	43.20
	50	kg grain × 2 head × 0.164 yuan/kg	16.40
	0.5	kg soybean meal × 2 head × 135 kg meat × 0.20 yuan/kg	27.00
	0.5	kg bran × 2 head × 135 kg meat × 0.07 yuan/kg	9.45
		medicines, marketing, other costs, unknown	--
		Total specified costs (yuan)	96.05
		Returns over specified costs (yuan)	560.45

Admittedly, the family income and the hog production of this family both reflect an extreme case. The annual incomes reported for commune work were usually less than 200 yuan. Liveweight at slaughter of the hogs used in the illustration was over twice the national average. In the example, 370 kg of concentrate feeds were purchased to produce 264-kg liveweight gain, indicating that much additional feed was obtained from other sources. Perhaps the family was able to harvest enough forage, salvage crop residues, and use garbage to make up the deficit. Possible additional costs of production are unknown. Regardless of the nontypical nature of this hog enterprise and allowing for possible errors in communication, it is obvious that owning even a few animals can be of great importance to a family.

In addition to the two hogs, the above family kept four hens and three geese. Both the eggs and the meat were consumed in the household.

DECISION MAKING AND COORDINATION

The decision making that guides animal production in China is two pronged. Government officials at the national level establish the basic framework within which production must occur. The national government specifies land use within general categories, controls all supplies of grain, sets allocations of grains and other concentrate feeds to producers, allocates other inputs necessary to livestock production, fixes the prices of both inputs and outputs, and specifies the proportion of production that must be sold to the state. The national government also has the responsibility for the infrastructure beyond the "farm gate."

Within the set of constraints established by the state, the lowest level of organization, the production team or production brigade, can now decide what and how much it will produce. Although there are "goals" set or suggested by the state, people may choose to use their tillable land for any crop they wish. Livestock may be produced or not, and the method of production is established by local choice. Other than specific constraints, the major incentive to move toward state goals is the premiums paid when production exceeds goals.

The merits of such a system of directing crop and animal production will not be debated here. Like any system, it has both strengths and weaknesses. It is based on the premise that a group of top-level decision makers has the wisdom, breadth of knowledge, data, and analytical capabilities to decide what is best for a nation in general terms and that individual producers can and will respond to those needs within the constraints imposed on them.

Knowledgeable, skillful, dedicated, and industrious persons were encountered throughout the country in all occupations related to agriculture. They ranged from veterinary surgeons to workers caring for sows in the farrowing house. All persons seemed to be performing their specialized tasks effectively insofar as could be determined by limited observations.

Individuals, work groups, factories--all the components of a system--seem to perform conscientiously and effectively, but each within the confines of its own specialty. The linkages necessary to form the parts into an effective system for food and fiber production and distribution are weak. It is evidently too complex a job for effective central direction, and incentives do not exist to cause the parts to link themselves effectively through individual initiative. Evidence of this problem surfaced on numerous occasions. It appears to be the root cause of a fundamental constraint on improved efficiency of crop and livestock production, and it will become more serious as China moves toward its stated goal of mechanization and modernization of agriculture.

Groups that we met were keenly interested in the technologies of production--the physiology of reproduction, artificial insemination techniques, disease control, trace-mineral deficiencies--but virtually no one expressed interest in or concern with systems management even at the enterprise level, much less throughout the entire supply and distribution chain. A few of the older scientists recognize the problems but note that corrective action could be taken only at the national level.

The lack of an effective infrastructure was succinctly portrayed by a comment by one of the leading Chinese animal scientists. He said, "Our poultry producers ask me why they cannot care for 50,000 laying hens per man as they do in the U.S. I tell them that when something goes wrong in a U.S. operation, the man picks up the telephone and it gets fixed. You pick up the phone in China and no one answers!"

Insofar as could be determined, neither management nor agricultural economics is taught in school. In the past, agricultural economists were not engaged in research. Their education was limited to courses in accounting. The statement was made by one official that managers come up through the ranks. "They do not have to go to school to learn management. By the time they get to a management position they know what they are supposed to do." This attitude is not surprising, as the country is just emerging from a long period during which peasants or workers had top decision-making roles and technicians the mid-level positions, while scientists and other highly trained persons were doing the most menial of tasks.

The level of technical development dictates the advances that can be made in animal production. What finally is accomplished will be determined by the effectiveness of management in forming the parts and linking them together to function as a system. Some of the leading animal scientists now recognize that there is need for a great deal more involvement of economists in research, planning, and the conduct of business. Infusions of technology in whatever form will only make the parts of the overall system more interdependent. The future is bright if emphasis is finally placed on increasing the effectiveness of system performance instead of concentrating solely on phase activities. If this is to be done, a priority problem is training of younger people. Most highly trained scientists are now at least 50 years old, and those giving verbal recognition to the needs for improved system coordination were the oldest among persons with whom we spoke.

DATA FOR PLANNING

Accurate data on resources, production, and performance are necessary in the effective management of any business in any economy. They are especially important in a centrally managed economy such as that of China, in which the government makes the basic decisions about the allocation of resources among production alternatives and rations the resulting output to the population.

The organization of agriculture in the commune and state farm systems is well suited to rapid and accurate collection of statistical information. The communication system is good. Calls for information can move immediately from central government to team level. The organization already exists to assemble and move the needed data through the leadership levels of work team, brigade, commune, county, prefecture, and province and to the national level. There is every reason to expect full and accurate accounting of livestock because reports are mandatory and receipt of production inputs or the right to purchase them--sires, frozen semen, veterinary supplies, feed grains, protein supplements--are based on kinds and numbers of animals on hand.

The Bureau of Statistics has the responsibility for collecting data on animal agriculture. Agricultural officials in Inner Mongolia reported that statisticians work at all levels down to that of the commune. A census count of animals is made twice a year, once in the spring and again at the end of the year. Inventories are recorded by species. That count is subdivided according to sex, age, size, and quality. Quality is listed in three categories: unimproved breeds, improving breeds, and improved breeds. A statistical book is said to be prepared for each kind of livestock, but these books are apparently available only to government officials.

Statistics on grain production in Inner Mongolia are collected twice annually, once at the end of June to quantify hectares planted and again at the end of the year to determine production. Some monitoring of growing conditions occurs during the growing season. Presumably, the same types of inventory are taken throughout the country, with schedules adjusted to conform to planting and harvesting periods.

Knowledge of inventories seems adequate. The data reportedly collected are quite detailed in a functionally descriptive way, and the system facilitates data collection. Managers at every livestock operation had and provided a detailed physical accounting of their businesses.

Adequate measures of performance seem largely lacking. The basic level of accounting was said to be at the team level at present. Additional charges are added to the team accounts as they move through brigade to commune level. According to one Chinese official, this system of accounting has some deficiencies, but specifics were not given. Many communes carry on a large number of economic activities, including crop, livestock, and industrial production. Thousands of people are employed. A rather sophisticated accounting system would be required to provide useful guidance to management. Such a system does not appear to be available.

The types of records kept and the uses to which they are put are more important than who keeps them. Artificial insemination stations and the state dairy farms reported keeping performance records on both bulls and milk cows. Performance records are kept on sows in the breed improvement units, in herd expansion centers, and in communes that sold breeding stock. These records, however, are usually limited to milk produced per cow or pigs farrowed per litter. Some managers said that they keep no records of feed use or feed conversion ratios. If records are kept on other costs of production or returns, they were not identified.

Closest determination of the enterprise cost-and-returns accounting procedure was provided by the manager of the commune-operated feeder-pig-production enterprise at the Brick Bridge commune near Shanghai. Pigs are sold at average weights of 17.5 kg per head for 1.80 yuan per kilogram to families, production teams, and production brigades. Presumably, culled breeding stock goes to the slaughter market at usual slaughter prices. No mention was made of value received for manure, but manure was generally reported to be sold for use in crop production in the same commune. These three products constitute the expected sources of income.

Costs of production were specified as feed, veterinary supplies, and labor. The concentrate portion of the ration is charged at market prices. Forages, which constitute a substantial portion of the feed supply and are produced in the commune, were said to be charged to the hog enterprise, but value was not specified. Veterinary supplies are charged at cost. Labor cost is computed on a work point basis. The residual income, after these three categories of costs were deducted, is called net income.

Charges are not made against this hog enterprise for investments in buildings, equipment, or other depreciable assets. Part of net income is set aside each year into what was called an accumulation fund. This is used to upgrade or expand the enterprise. There was no indication about how such costs as repairs, electric power, fuel, and several other common inputs are handled. Possibly these costs are assessed as overhead at the aggregate level of accounting for the commune.

Overall, information necessary to evaluate the economic performance of a livestock enterprise apparently is not being generated. Even though prices for both inputs and products are set by the government, such information seems essential for sound decisions both at the national level, where prices and cost rates must be determined, and at the production level, where producers may still choose among alternative enterprises and systems of production.

PRICING

Prices have been used to regulate both the quantity and the quality of animal production as well as the consumption of animal products in China. The system bears some similarities to the open-market system but differs in many important respects.

The state fixes prices for products that it buys and sells. Prices for basic commodities, such as food and feed grains and the associated consumer products, have been held relatively low and unchanged for many years. Retail prices for animal products have also been kept relatively stable, but prices paid to producers for animal products have been increased periodically to encourage greater production.

The state offers two cash prices for pork. One price applies to the amount, usually half of production, that is required to be sold to the state; the other applies to additional pork that producers may sell to the state if they choose to do so. The latter price is twice the former so that the government can obtain maximum amounts of meat under its control for distribution in urban areas and for export. The same dual-pricing system may also apply to other kinds of meats and animal products, but this relationship was not ascertained with certainty.

The state supplements cash prices with noncash incentives designed to influence long-term production, seasonality of marketings, and the proportion of production sold to the state. Some of these incentives have direct market value, such as additional feed given without cost when animals are sold to the government. Some regulate amount of production, such as coupons permitting the purchase of specified amounts of concentrate feeds that are under the control of the state.

Some incentives have consumption benefit to the producer, such as coupons permitting extra purchase of rationed commodities (e.g., cloth and light industrial products). Timing of sales is influenced largely by the level of these noncash incentives. Also, these noncash incentives, coupled with cash prices offered by the state, determine whether products under the control of the producer are consumed, sold to the state, or taken to the open market where the cash price is the only return.

Prices for animals have some bearing on quality. First, and most important, all slaughter animals are priced according to their estimated yield of meat. This is done by visual inspection by a skilled evaluator. A hog weighing 100 kg, for example, might be estimated to dress 85 percent (dressed weight includes all but the hair, blood, and contents of the digestive tract). The applicable price is then paid for 85 kg of meat. The liveweight becomes irrelevant.

Grades, and price differentials pertaining to them, apply to hogs but apparently not to other species of livestock. Two examples noted were different, and the potential influence on quality seems minor compared with that of meat yield. The Xinfa commune reported the following grade and price schedule for hogs:

Grade	Yuan per Kilogram of Pork
Prime	1.50
Grade 1	1.50
Grade 2	1.48
Grade 3	1.39

Grade is based on weight. The heavier the hog, the higher the grade.

The slaughterhouse at the Huashan commune near Guangzhou used only two grades for slaughter hogs. The standard state price was paid for hogs yielding less than 70 kg of meat. Those yielding 70 kg of meat or more per carcass brought a 6-percent price premium.

A complete price schedule is not available for all species of meat animals and poultry, but evidence indicates that meats are considered of nearly equal value regardless of source. From Heilongjiang and Inner Mongolia in the north to Guangdong in the south, base prices to producers for meat were quoted in the range of 1.10 to 1.30 yuan per kilogram. The base price for pork was commonly 1.20 to 1.30 yuan throughout the country.

A large state farm in Inner Mongolia reported prices of "about 1.20 yuan" per kilogram for "meat." Production included both cattle and sheep. The price for meat from 4-year-old culled ewes was reported to be the same as that for meat from yearling lambs. Culled laying hens were priced at 1.24 yuan per kilogram of meat at a production site near Harbin; rabbit meat brought 1.10 yuan per kilogram for producers around Shanghai.

Such uniform pricing of meats carries over into the retail sector, where neither kinds of meat nor parts of the carcass differ greatly in price except in urban markets. This may serve distribution adequately so long as the total supply of meat is quite short, but equal pricing on the production side ignores differences in costs of production among species of livestock. Balancing production between grazing and concentrate-consuming species of animals seems ill served by this method of pricing. Questions also arise about multiple-purpose animals, such as sheep, cows, and fowl.

Prices paid to producers for wool ranged from 4.28 to 4.36 yuan per kilogram of first class semifine clean wool to 3.36 yuan per kilogram of fourth-class clean wool. Whether this is a sufficient economic incentive to cause producers to shift emphasis from meat-producing to high-quality wool-producing sheep, which was stated as the present order of priorities, is not known.

Communes and state farms that produce horses and other draft animals in the grassland areas sell most of their output to the government, which then makes distribution to users, typically communes in the crop-producing areas where the animals are used for draft and transportation. After state orders have been filled, individual producers and brigades often have surplus horses that they can sell to individuals by private treaty, but the sale is subject to approval by a state official. These horses remain in the grassland area where their major use is for livestock herding and transportation.

The price of horses has been weakening steadily for several years because of increased mechanization and a shift in emphasis to production of sheep and cattle on the grasslands. Improved crossbred horses were said to bring 700 yuan each a few years ago. Now the price is around 400 yuan, and producers report difficulty in marketing their supply. Horses were the only agricultural commodity for which demand and supply had seemingly been allowed to operate rather freely in the determination of price, and horses are also the only agricultural commodity whose price has changed significantly since 1949.

The people in the grassland areas exhibited both sadness and concern about the future of the horse. Yet it is probable that allowing more freedom for demand and supply to establish prices for horses and other draft animals will result in practical shifts in the utilization of grazing lands for sheep and cattle.

The state uses a combination of prices and rationing to control consumption of meat. Retail prices are kept relatively low and stable for meat purchased under the ration or coupon allocation provided by the state. Rationing is adjusted periodically to conform to supply. Purchases in addition to the amounts covered by coupons can be made. Here demand and supply rule, and the open-market price is often several times the price in the controlled market. A commune member noted, for example, that in late June of 1979 the open-market price of pork was 20 percent above the price of coupon-covered pork; rice was nearly three times as high on the open market.

Examination of retail pricing of animal products was made only on a cursory basis. Pork was the only product checked in any detail. In some cases, it appeared that carcasses were being cut into portions and sold to customers with little if any regard to the basic cut of meat, especially in the small meat markets. Where meat was quite scarce, apparently pork was pork, whether ham or side meat.

Retailing practices obviously differ from place to place. Consumption of meat varies largely according to local production, as shipment among provinces appears to be minimal. Evidence suggests that where meat is relatively more plentiful, conventional cuts of meat are made from carcasses, and the cuts are differentially priced.

Data from a meat market in Harbin illustrate the situation in an area with a relatively substantial supply of meat. At the time of our visit, consumers had coupons for 2.5 kg of meat per person for the month. If this allowance is extended to an annual basis at the same monthly rate, the resulting per capita allowance is far above the national average.

The Harbin meat market sold sides of pork at the following prices per kilogram of product:

Grade	Whole Side without Skin or Bone	Whole Side with Skin on but Boneless (Yuan/kg)	Whole Side with Skin and Bone
First class	2.14	2.08	1.90
Second class	1.94	1.88	1.70
Third class	1.74	1.68	1.50

The classes refer to carcass weights with head on. First-class carcasses weigh over 50 kg; second-class carcasses weigh 40 to 50 kg, and third-class carcasses weigh less than 40 kg. Backfat drops from 2.5 cm for first-class carcasses to less than 1.5 cm for third-class carcasses.

The Harbin meat market also prepared and retailed cuts of pork at the following prices per kilogram of product:

Parts of Pork Carcass and Yuan/kg	
Loin, 2.50	Ground pork, 2.14
Bacon, 2.24	Jowl, 1.78
Ham, 2.24	Fat, 1.78
Leaf fat, 2.20	Spareribs, 0.90
Shoulder, 2.18	Shank, 0.86
Backfat, 2.14	Backbones, 0.60
Flank, 2.14	Bones, 0.20

This retail price schedule reflects differences in the quality of the product. It also reflects the high value placed on fat relative to lean meat. Consumers were said to prefer lean pork in summer, fat pork in winter. The prices above were obtained in mid-summer, so wintertime prices for fat may be higher than prices for the best quality of lean meat if prices are adjusted seasonally to reflect consumer demand.

A comparison of these retail prices for pork with prices paid to producers by the state is further evidence of the level of subsidization by the state. In the same area at the same time, producers were receiving 1.39 to 1.50 yuan per kilogram of meat in live hogs sold to the state under quota. This leaves some margin for expenses of transportation, processing, and retailing, but there is a sizable negative price margin for hogs sold to the state above quota requirements at twice the base price.

INCENTIVES IN LIVESTOCK PRODUCTION

Multiple economic incentives are in effect to promote and expand livestock production. State farms can encourage performance only through the wage and bonus system, but they account for a minor part of total production except in dairying. In communes and in household production, the income motive is strong.

Overall, livestock producers are said to have fared better economically in the past than have crop producers because state-controlled prices have favored livestock over crops. The Xinfa commune, Harbin, reported paying 0.162 yuan per kilogram for first-grade corn and sorghum grain, 0.20 yuan for soybean meal, and 0.07 yuan for wheat bran. The price received for pork meat is 1.50 yuan for prime and No. 1 grade hogs, which account for 75 percent of total production. These grades would likely dress 80 percent or better on their measuring system, so the liveweight price would be at least 1.20 yuan per kilogram. That converts to a corn/hog ratio of only 13:1 on base price, which is not particularly favorable to hog production. Sales to the state above quota, however, bring twice base price, or a ratio of 26:1. This results in a strong economic incentive for producers to sell maximum amounts to the state.

Soybean meal is cheap relative to grain. Also, nonfeed inputs are much lower in both amount and cost in China than in typical U.S. operations. Considerable low-cost forage is used in the ration. An individual hog producer can fare better than indicated by the corn/hog ratio to the extent that he can get salvage feedstuffs at no cost. Also, livestock manures are sold for much higher prices than the values typically assigned to manures in the United States.

Commune members have a dual incentive to achieve success in livestock and all other production activities. First, they have a vested interest in the commune, as its earnings are distributed among the members on the basis of the amount of work that they contribute to it. Second, the work point system by which all work is measured and earnings allocated is structured to reflect both type of work and level of performance. In earlier years, members might be paid on a time basis, a piece basis, or a combination of the two systems. Typically, commune managers did not announce the basis of payment before the work was done. Now the work point system is moving toward a combination of standardized work points by jobs plus an incentive payment (or penalty) based on performance.

Peasants who work in crop and livestock production in the Xinfa commune get 9.0 to 12.0 work points for an 8-hour day. The standard for work in the farrowing house caring for 20 sows and litters is 9.5 work points per 8-hour day. Litters from the 20 sows are expected to weigh an average of 120 kg at 60 days of age. For each 5 kg that a sow is above the standard weight, the worker is awarded a bonus of 1.5 work points per day; for each 5 kg below, a penalty of 0.5 work points is assessed.

A good litter average in terms of number of pigs saved and good performance in terms of weight gained could conceivably result in double earnings for a conscientious worker. Such a bonus system also holds the potential for inefficient use of resources, especially feed, unless practices are carefully monitored and controlled.

The system of pricing of production inputs for use in livestock production, the pricing of livestock and livestock products for sale to the state and on the open market, and related bonuses added to cash payments by the state have a great effect on the level of interest in livestock production. All these forces are now directed toward encouraging expansion of livestock production.

SUBSIDIES FOR ANIMAL PRODUCTION

The state heavily subsidizes animal agriculture in several ways from basic production through the marketplace. There are multiple goals of increasing the quantity and quality of animal products, providing a better income level for producers, and keeping prices to consumers low.

A substantial and increasing program of research and education in animal production is maintained with state funds. The state also attempts to keep the cost of production inputs low. Specifically mentioned were veterinary supplies and semen from quality sires made available at cost of production. The charge for each insemination with bull semen from the Beijing artificial insemination station, for example, is only about one twentieth of the average cost in the United States. The most significant and obvious subsidies, however, are in the combination of prices paid for livestock and prices charged to consumers for animal products.

Whole sides of pork, including skin and bones, are being retailed in a Harbin meat market for 1.90 yuan per kilogram for first-class carcasses; 1.50 yuan per kilogram for third-class carcasses. At the same time, producers are being paid a base price of 1.20 to 1.30 yuan per kilogram of meat required to be sold to the state and twice as much for meat sold to the state above quota level. In addition, the state gives variable amounts in the form of bonuses and incentives. Further, the state bears the cost of transportation and slaughtering and sells meat to retail markets at prices low enough to allow the markets to cover costs of operation and earn a fair return.

Two specific examples of subsidized pricing were provided by agricultural officials in Shanghai. One dealt with duck eggs; the other with duck meat. Details are as follows:

<u>Duck Eggs (kg)</u>

Price paid to producer	1.70 yuan
Transportation and storage	0.22 yuan
Breakage loss during shipment	5 to 7 percent
Price to retailer	1.44 yuan
Price to consumer	1.64 yuan

<u>Duck Meat (kg)</u>

Price paid to producer	1.70 yuan
Transportation and storage (frozen)	0.50 to 0.60 yuan
Slaughtering by state	(unspecified cost)
Price to retailer	(unspecified)
Price to consumer	1.60 yuan

In both of these examples, the government was paying more to the producer for the product than consumers were being charged at the retail level. In between, the state was absorbing the cost of all losses in shipment and of transportation, processing, and storage and was providing the products to markets at prices sufficiently below retail prices so that markets could cover costs and have competitive return for themselves. Questioning of officials revealed that this pattern of subsidization holds for all animal products except milk. Since milk is in short supply and a portion of total production goes to hotels for consumption by foreigners, the retail price of milk was said to be higher than the prices paid to producers. Specifics on prices were not obtained.

The Shanghai officials reported that the National People's Congress of China established new policies for subsidizing agriculture in late June 1979. These policies include (1) increasing base prices paid for agricultural products, (2) reducing the purchase prices charged for production inputs, (3) reducing taxes, (4) liberalizing the requirement of sales to the state, and (5) keeping retail prices low.

The new marketing policies are intended to increase the incomes and standard of living of peasants engaged in agriculture while placing modest additional financial burdens on consumers. Increases in annual income are expected to average 10 yuan or more for every peasant in China.

LAND, POPULATION, AND ANIMAL RESOURCES

Current aggregate national statistics for China were difficult to acquire. Chinese scientists and government officials provided estimates for many things but emphasized that it had been impossible to make full and accurate accounting in the short time since the reorganization of the government in 1976. The following picture of the people and of the land and animal resources of the country can therefore be considered only general approximations. Data come from a variety of secondary sources and from estimates made by officials in China.

China has 960 million hectares of land, which makes it slightly larger than the United States. Cropland consists of only 100 million hectares, which is roughly two thirds of the size of the 156 million hectares of cropland in the United States. Multiple cropping in China, however, increases cropland area planted annually to about 160 percent of measured cropland. The amount of forest land is a little greater than the cropland area in China; permanent pasture land is about twice the cropland base. More than half of the total land area of the country is classed as other land not included in any of the agricultural, grazing, or forest categories. Most of this other land is either too arid or too high in altitude to be of significance in either crop or animal production.

The population of China was estimated to be about 975 million persons in 1979, or 200 million more than the 774 million estimated by the Food and Agriculture Organization of the United Nations (FAO) for 1970. The rural population accounts for about 80 percent of the total. The farm labor force was estimated to be 315 million in 1977. That same year the farm population in the United States was only 3.6 percent of the total population; the farm labor force was 4.1 million people. A great difference is that five or six people work in support of each person directly employed in U.S. agriculture, whereas support workers in China undoubtedly number far less than one person for each one directly employed in agriculture.

The inventories of animals in China seem even more tentative than were statistics on some of the other resources. Best estimates of inventories for 1978 are:

Kind of Animal	Million Head
Hogs	301
Sheep	100
Goats	70
Cattle	70
Water buffalo	(30)
Dairy cattle	(0.4)
Beef cattle	(6.0)
Other cattle	(33.6)
Horses	12
Asses	12
Mules	3
Poultry	1,400
Layers	
Broilers	
Beijing ducks	
Other ducks	
Turkeys	
Geese	

Although these inventories may lack accuracy in absolute terms, their general magnitude seems acceptable. On that basis, several points are worth noting. These are inventories and not measures of production. Current literature, for example, frequently sets the annual inventory of hogs in China around 300 million head. In reality, the annual slaughter rate is about 50 percent of inventory, or about 150 million head. This figure naturally creates some confusion because annual hog slaughter in the United States is about 170 percent of inventory.

Additional information provided by Chinese scientists and government officials gives a general description of where animals are produced. Location or production of selected species of animals according to the productivity of land was reported as follows:

Animal	Range or Pasture Areas (%)	Agricultural Areas (%)
Horses	50	50
Donkeys and mules	20-30	70-80
Cattle	28	72
Sheep	75	25
Hogs	5	95
Total	25	75

The general mix of animal species changes with climate and productivity of the land. This is illustrated by partial animal inventory data for two provinces and one autonomous region: (1) Inner Mongolia--northern, semi-arid pasture and range land; (2) Heilongjiang--northern, moderate precipitation, crop and pasture land; and (3) Guangdong--southern, tropical, high precipitation.

Kind of Livestock	Inner Mongolia	Heilongjiang	Guangdong
Hogs	2,300	8,400	27,500
Beef cattle	1,300	985	1,100
Dairy cattle	[a]	130	[a]
Water buffalo	0	0	2,600
Sheep	10,500	2,020[b]	--
Goats	6,000	--	400[b]
All poultry	[a]	40,000	[a]
Horses	920	1,500	[c]
Asses and mules	475	[a]	[c]
Camels	120	0	0
Deer	[a]	60	[c]

[a] No estimate.
[b] One inventory number given for two species of livestock.
[c] No estimate provided, but the count is considered to be quite small.

Careful readers may wonder about the 60,000 head of deer in Heilongjiang inventory. Deer are produced in enclosed drylot operations, but they are not used for meat. Only their antlers are harvested. These are dried, ground into a powder, and sold as an aphrodisiac. One person said the price was around 2,000 yuan per kilogram of powdered antler.

LIVESTOCK FEED PRODUCTION

Supplies and quality of feedstuffs and policies on animal production and use of grains are the most important determinants of livestock production in China. Past official policies were directed chiefly at increasing numbers of livestock, especially hogs, without regard to the availability of feed. Numbers of hogs were dutifully increased, but rations were grossly inadequate, with the result that most feed was used for maintenance, little for gain or production. This error is well understood by Chinese animal scientists and the present leadership and is in the process of being corrected.

Capacity to produce feeds for animals and the quality of feedstuffs remain severe limitations. Total cropland in China is 100 million hectares, which is the equivalent of 64 percent of the cropland in the United States, or 14 percent of U.S. cropland on a per capita basis. Grain production has risen steadily in recent years in China and stood officially at 305 million metric tons of grain equivalent in 1978. U.S. production of food and feed grains totaled 273 million metric tons in 1978.

Much of the grain produced in China is food grain. Rice production alone accounted for 137 million metric tons in 1978; wheat, 45 million metric tons. Coarse grain production amounted to 80.5 million metric tons, and the remainder--some 42.5 million metric tons--was in grain equivalents, including such crops as soybeans, peas, and potatoes.

According to Vice Minister of Agriculture He Kang, only 7 percent of the total production of grain equivalents is fed to livestock in China. Also, much of what is termed concentrate feeds for livestock is milling by-products, such as bran, which generally lowers the quality of rations. Chinese exports of grain are less than 1 percent of production. In the United States, approximately 50 percent of all grain produced is fed to livestock; 36 percent of total grain production is exported.

Scientific investigations are under way to improve production of both cereal and coarse grains, but several limitations on production are obvious. First, and most basic, is the limited amount of cropland. Second, the lack of an adequate infrastructure requires localized production of many crops for consumption in the immediate area even though climate and soils may be better suited for other crops.

Some grain is reported to be produced in large plantations under mechanization, but most operations observed appeared to be performed by manual methods from tillage through harvest. This results in problems of timely planting, effective weed control, and harvest of the crop at maturity with minimum loss. Drying and storage also appear potentially wasteful, especially if much rainfall occurs during the harvest season. Grain is commonly dried to storable moisture content by spreading it over a threshing yard or road each day until dry. Disastrous results could occur during an excessively rainy season. Repetitive handling also causes losses.

Even the most mechanized of grain-producing operations have rather low production per worker. The *Beijing Review* reported that mechanized state farms had achieved annual production of 10 metric tons of grain per worker. This productivity amounts to somewhere between 1.5 and 3.5 hectares per worker, depending upon yields and kind of crop.

The present system of double and even triple cropping poses a problem for mechanical planting and harvesting of grain. Consecutively planted crops, such as rice after rice, would permit use of conventional machinery, although more field drying before harvest would be necessary. The interplanting of crops, such as planting of corn in growing wheat, would require either the development of special-purpose machines or a shift in cropping patterns. Whether increased efficiencies from mechanization would offset losses in production from less intensive land use remains a question now being debated by Chinese scientists and leaders.

Grazing lands, which essentially support all forage-consuming animals except the developed dairy herds, are reported to be generally unproductive. Range areas are unfenced. Nomadic herdsmen have made unconstrained use of them in years past and have severely damaged the stands of forages. Improvements are only now beginning, but the potential for improvement is considered great.

LIVESTOCK-PRODUCTION FACILITIES

Cropland is too scarce in China to be used for pasture or extensive animal-production sites. Only in the nontillable grasslands and range areas are livestock produced by grazing methods. All livestock in the agricultural areas are kept in drylot or totally housed situations. Only ducks and geese were observed in the fields, and they were gleaning grain after harvest.

Extensive use is made of brick, stone, concrete, and adobe in the construction of livestock-production facilities. Some steel is used, but virtually no wood, because it is in short supply.

Large layer enterprises on state farms or communes usually employ conventional litter houses with open runs to the outside. Caged layer houses were observed in two locations. Ducks are produced in either a drylot system with housing or in housing connected with water. Chickens, ducks, and geese kept in small numbers by peasants have no particular kind of housing.

All dairies that we observed, most of which are operated by the state, employ drylot systems, including exercise yards, open-sided shades, and stanchion-type milking barns. Bunker- or trench-type silos are used, but only a few upright silos were seen. Dairy farms do not have the extensive milk-handling and refrigeration facilities found in U.S. dairies. One state dairy was considering installation of a milking parlor, but none were seen in use.

Production facilities for hogs range from none where peasant-owned hogs have free range of the village area to large environmentally controlled central housing units. Typically, the 60-80 percent of the hogs that are owned and finished for slaughter by the peasants either run free or are kept in small adobe, brick, or concrete pig sties, partially roofed, holding one to three hogs and measuring 5 by 10 feet, more or less. Commune and state farm finishing units are usually low rectangular or quonset-type totally enclosed buildings with hog access doors to paved lots. Pen capacity ranges from 20 to 50 head each. Feeding is done manually in outside pens. The most advanced finishing units are both one- and two-story totally enclosed housing units with partially slotted floors, mechanical distribution of feed, nipple-type waterers, and electrically powered fan ventilation. Only one set of this type of finishing building was observed.

Farrowing at the state farm and commune levels is commonly done in pen-type central farrowing houses. In some cases, sows have access to outside paved-floor pens; in others they are totally confined. Farrowing crates were not seen in use. Brigade- and team-level farrowing units, which produce most of the feeder pigs for sale to peasants for finishing, are low open-front, shed-type buildings with small outside pen areas for individual housing of 10 to 20 sows and their litters.

State farms construct livestock-production facilities from budgets provided by the state. Communes withhold a portion of net income (10 percent was given as typical) for capital improvements, including the construction of livestock housing. Loans may be obtained from the State Bank of Agriculture or from savings accounts held by members of the commune.

LABOR PRODUCTIVITY IN LIVESTOCK PRODUCTION

The general level of labor productivity in animal production is quite low, even in the rare cases in which mechanization of materials handling is sufficient to achieve a relatively high output per unit of labor. Any attempt to measure the productivity of labor in livestock production at this time would be rather meaningless because there is a surplus of labor relative to other productive resources. Several workers were often observed at tasks that a fraction of the number could have handled.

Several examples are sufficient to relate present labor use to output in animal production. A layer unit in a commune near Harbin employs 64 people to handle a hatchery, 15,000 layers, and 11,000 pullets with annual production of 120,000 kg of eggs in litter-type housing with outside pen runs. Another egg-production unit on a state farm near Beijing utilizes fully mechanized caged layer houses and was said to be operated with one person per 17,000-bird house, but there were several times as many workers in evidence as were necessary for this rate of employment. A drylot Beijing duck enterprise in a commune near Beijing utilizes 60 people for an annual production of 60,000 ducks.

Sixty to eighty percent of all hogs are finished to slaughter weight in lots of one to three head by peasants. Labor is a relevant consideration here only as it applies to time to salvage feedstuffs, and no estimate is available for that requirement. Nearly all farrowing and raising of feeder pigs, however, is done in collective units or on state farms. The only evidence of labor use in these operations is that workers have time to give much individual attention to each sow and litter.

Artificial insemination is practical because there is adequate labor to observe sows for the presence of heat or estrus. On the Harbin municipal hog farm, the workers massage udders to calm sows and stimulate milk flow, move pigs among sows to save the maximum number, work with the pigs during nursing to assure that even the weakest pig is placed on a teat, and then teach the baby pigs to eat individually. Marginal saving of animals and the associated feed input is obviously considered more important than the large labor input required.

Workers in the farrowing houses at the Xinfa commune near Harbin have responsibility for only 20 sows each. The state experimental hog farm within the boundaries of a commune near Beijing has 10 boars and 60 sows and employs 25 people in the operation. The Brick Bridge commune near Shanghai uses 16 people--11 herdsmen, 4 technicians, and 1 leader--for the care of 132 sows producing feeder pigs.

The ratio of labor use relative to production of livestock is also high in the grazing areas. A 3,730-km^2 state livestock ranch in Inner Mongolia near Xilinhaote has 4,500 staff members to look after and produce feed for an inventory of 61,900 animals--50,000 sheep, 3,000 cattle, and 8,900 horses. Annual production amounts to 33,000 young animals. A brigade of a livestock herding commune in the same province utilizes 131 workers out of a population of 321 persons to care for 7,000 head of grazing livestock, half of which are sheep.

Mechanization of operations in livestock production might be economically justifiable if it increases efficiency of production through processing of a more effective ration or creates an environment more suited to animal performance. Certainly, more mechanization is important to the extent that it can be used to produce more and higher-quality animal feeds. Mechanization simply as a substitute for labor, however, must rank low in the priorities set for ways to increase and improve animal production in China.

Overall, the labor situation in agriculture presents somewhat of a paradox. Many Chinese throughout the country said that there is a shortage of labor, especially in periods critical for crop production, such as planting and harvesting seasons. Yet observation indicated that there frequently were many more people working than necessary to accomplish a given task, even with manual methods.

GOALS FOR THE FUTURE

People engaged in animal production in China are glowing with enthusiasm. From scientist to worker, they finally feel free to apply knowledge to production. They firmly believe that they recognize the basic problems and can make rapid advances in adapting science and technology to fit the circumstances existing in the country. The hope is that much of the 10 lost years can be recovered through their own efforts, with help in science and technology from other countries.

Modernization and mechanization are key terms used to identify the new policy in crop and livestock production. They have many meanings, sometimes apparently not fully thought out by the people who use them, but there is also a considerable degree of specificity attached to them. In broad terms, grain production is to be increased to 400 million metric tons by 1985, compared with the 305 million metric tons produced in 1978. The goal for the red meat supply is 16 kg per capita in 1985, compared with the present 8 kg per capita. The hope is that exports of animal products can also be expanded.

The most important methods that will be employed to expand grain production are the use of improved varieties, fertilization, and more-intensive land use. Mechanization of tillage, planting, and harvesting operations is intended to increase yields through more-timely operations and is expected to make the work easier and to free people for employment in industry. Irrigation is being intensified. The project designed to move water from the Yangtze River area 1,200 km north to the Beijing area is a major example. The effectiveness of double versus triple cropping is still a matter of study and debate. Imports of grains and high-protein feeds are expected to be increased, but the success of the program for expanded meat production depends largely on the extent to which domestic grain production can be expanded.

The "people first" philosophy that has been applied to the use of grain is now being questioned by some in scientific circles. One scientist commented that the people get more and more grain as production increases, but their diets simply get worse and worse (Figure 1). He believes that average human diets would improve if more grain, both absolutely and proportionally, were diverted to use as animal feeds

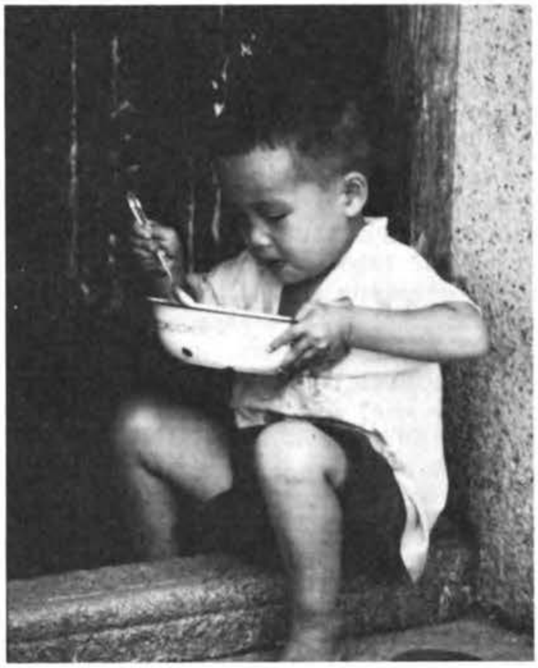

FIGURE 1 Food for thought: Illustration of the goal to improve human nutrition in China.

rather than being used directly for human consumption. The transition phase while grains are being changed in kind and diverted for animal use, but before more animal products become available, if such a policy is accepted, will be the critical period.

The goal to increase the production of the animal products, chiefly meat, is being approached on several fronts. Most important, the former policy of placing sole emphasis on increasing numbers has been abandoned. That resulted in large inventories, especially of hogs, but little increase in production. Feed supplies were going largely for maintenance rather than gain. Pasture and range lands became overstocked, resulting in severe damage to grasslands and a high-risk situation, as evidenced by a drought in the late 1960's that forced reduction of animal numbers in Inner Mongolia from 26 million to only 6 million head; the stock has now recovered to 20 million head.

A program for improving the productivity of livestock through genetic improvement is under discussion. Plans for use of specific germ plasm or organized mating are not yet complete, but a delivery system for rapid dissemination of superior germ plasm through artificial insemination is well developed. In addition, state centers for the multiplication and distribution of improved female breeding stock have been established. If exotic breeds are crossed with native livestock, the native livestock may become extinct. Chinese scientists are attempting to preserve gene pools of native livestock and capture their desirable traits, such as high prolificacy of some native breeds of hogs, in future breeding programs.

Full recognition is given to the need for adequate rations, both in terms of energy content, especially for hogs, and protein content. Effort will be made to provide adequate rations even if it becomes necessary to stabilize or even reduce numbers of animals. Mention was made of the need to reverse the declining acreage of soybean production with the view that more soybeans could help to alleviate the shortage of both high-protein feeds and oil for human consumption. Some interest was also noted in establishing manufacturing plants for the production of synthetic amino acids.

A rigorous program for the control of diseases and parasites of animals is under way. One major drawback is lack of any comprehensive monitoring or control of the health of imported animals. Risk is great because China seemingly is now free of some important animal diseases, notably African swine fever, which now devastates production in some other areas of the world. There will be increasing pressure for more-effective controls on the health of imported livestock in the future.

Hogs dominate animal production in China and will probably continue to do so in the foreseeable future. Chinese scientists recognize, however, that forage-producing pastures and range lands represent a large and relatively untapped feed resource for animal production. Uncontrolled nomadic grazing severely damaged grasslands in the past through overgrazing. Deterioration continues at present, but plans are under way to reverse the trend. Many areas remain virtually unused and will be brought into production.

The inherent capabilities of land in the grassland areas are being inventoried. Cultivation of lands suited only for forage production is being stopped. Nomadic herders of livestock are being allocated certain areas of land as their home ranges. They are being helped with the construction of permanent winter living quarters, housing and sheds for livestock, and development of sites for production of winter feed supplies. Fencing is being built in the grasslands. By these means, livestock herders are being given an incentive to protect and improve their home areas of grassland.

Additional measures to increase the productivity of grasslands are either in use or under study. Major objectives are to attempt to improve native pastures, seed with improved varieties of forage plants, develop irrigation where feasible, control grazing through rotational grazing, and use fencing to assist both controlled grazing and production of forages for harvest. Control of damaging rodents through both chemical and biological means is under study. Also, serious consideration is being given to the mix of animal species now on the grasslands.

Emphasis is shifting toward beef cattle and fine-wool-producing sheep and away from horses, for which the need is lessening because of mechanization. Chinese scientists estimate that the productivity of some grasslands can be increased as much as tenfold from the present level. Perhaps the most important clue pointing toward a high probability of success is that persons at the decision-making level place system coordination and economics in a priority position with respect to the animal-breeding/forage-production complex.

Recognition is being given both to economies of size and to the productive powers of individual ownership. Egg-laying flocks and broiler production are being concentrated in larger operations for increased efficiency in the use of concentrate feeds and for more stable year-round production. Dairying is carried on in larger operations, probably because of the difficulty of maintaining sanitation and problems of transport from small, scattered operations. Some hog production has been moved into large-sized units, but this improvement has been made primarily in the pig-production enterprises that control the genetic quality of the animals and assure proper treatment for diseases.

Individuals do most of the finishing of hogs for slaughter and are being encouraged to expand through allocations of concentrate feeds, reduced costs of inputs, and increased prices for hogs. Otherwise, the animal productivity embodied in feedstuffs salvaged by the peasants might not be recoverable; this possibility seems fully recognized. Any undesirable connotation that was formerly applied to private initiative is apparently no longer going to hinder expansion of animal production.

A strong factor in the movement toward future goals in crop and livestock production is the rapid resurgence of higher education, research, and extension. Although some university staffs are only partially reassembled, some do not yet have physical facilities, and students commonly number only a fraction of enrollments in earlier years, the general climate is encouraging. Work is under way, people are positive and enthusiastic, and the present leadership evidently looks favorably toward increased application of science and education.

Realization of goals established for animal production cannot be accomplished by enthusiasm alone. Basic resources are in extremely short supply. The level of technological development is rather low in most economic activities, both within and outside agriculture. A suitable infrastructure does not exist, even for the present level of development.

As new technologies are superimposed on the present system, the problems and interdependencies will become infinitely more complex. A major question is whether the necessary experience exists in the present hierarchy of managers to recognize the problems, set priorities for development, and tie the parts together into an effective overall system once changes have been made. If these problems are met and resolved, progress in animal agriculture could well be phenomenal.

4

SWINE PRODUCTION

Virgil W. Hays

Pigs provide China with 80 to 90 percent of the red meat consumed per capita per year. They represent an important source of farm income and are a major contributor to the food supply.

There are an estimated 290 million to 300 million pigs in China, and, on the average, 8 to 10 months beyond weaning, or a total of 10 to 12 months, are required for pigs to reach market weight. The Ministry of Agriculture estimates that the average slaughter weight is about 75 kg. With the Chinese methods of dressing pork, approximately 68 kg of meat are obtained per pig; this is sufficient meat for seven people per year. To provide the estimated amounts of pork consumed by a population of 1 billion people would require the slaughtering of 140-150 million pigs per year. This figure is in relatively close agreement with the Chinese estimate of 150 million to 160 million pigs slaughtered per year.

The figures on total inventory and time-to-market weight do not agree with data for pork consumption and total number of pigs slaughtered, and they suggest major errors in estimates in the following: number of pigs on hand, time to slaughter, average slaughter weight, annual pork consumption, mortality of pigs, or a combination of some or all of these.

Such discrepancies are understandable when one considers that there have been relatively large fluctuations in recent years in the numbers of pigs produced, depending on the governmental policies toward family or communal rearing of pigs. Furthermore, in China pork consumption in any one year depends on pork produced, so relating the average consumption over several years to the inventory in a given year can certainly result in confusing numbers.

SWINE BREEDING

Numerous breeds or lines within breeds of pig have resulted from the long history of swine production and from the relative degree of geographical isolation. Epstein discusses in considerable detail the breeds of pig as he found them and states that there are more than 100 breeds and varieties of pig in China, with about 40 breeds being of economic significance.[1] Our limited observation would confirm that many breeds are found and that many variations can result from centuries of crossing or mixing.

At present, swine breeding represents a major part of the total swine research effort. Hybridization, crossing, line breeding, and development of new breeds are some of the areas being pursued. In general, these programs involve the native breeds of the area and considerable infusion of genetic material from imported breeds, primarily variations of the European Large White breed, including Soviet White and Landrace.

In the Beijing area, we visited a state farm within a commune that was breeding the Beijing Black pig and producing approximately 30,000 pigs per year. One production team provided the foundation breeding stock for the other 61 teams in the commune. This breed of pig is the result of crossing Soviet White, Berkshire, Yorkshire, and a native breed. It is a strong, rugged breed and apparently has good production traits.

Based on averages for 200 litters, the production results were 10.5 live pigs farrowed per litter, 0.6 pigs born dead per litter, 9.1 pigs weaned per litter, and weanling weights of 14 to 18 kg at 45 to 60 days. Estimates listed 1.85 litters per sow per year in a herd of 300 sows and 17 boars. Sows are kept in the herd for an average of 5 to 6 years, which would suggest that this production team keeps its sows as long as they remain productive.

The basic breeding program of the state farm involves selection within lines and crossing the lines for breeding animals to be used by the other production teams. Selection of breeding animals is based on an index including litter size at birth and weaning, weight at weaning (which receives major emphasis), and weight and backfat thickness at 6 months of age. Feed required per unit of gain is not considered in the selection index because of the great variation in feed resources available from one test to another.

In the Harbin area, Heilongjiang Province, emphasis is evidently concentrated on four breeds: Sanjiang White, a new breed being developed; Harbin White; White and Black Spot of the area; and Damin (Min Zhu), a native black pig.

The climatic conditions in Heilongjiang Province are quite severe; thus the goal is a hardy breed that can tolerate the severe winters and be strong in the productive traits of litter size, growth rate, and efficiency of converting high-fiber feeds to pork.

We visited a municipal multiplier hog farm that provides breeding stock to communes or other state farms in the area. That farm is producing Harbin White pigs, a locally developed breed developed from a cross of the Soviet White and local native breeds. The Harbin White is a strong-backed pig without the pendulous udder common to many of the native breeds. The sows produce 10 to 12 live pigs per litter, and the pigs weigh 14 to 16 kg at 60-day weaning. Most of the pigs are sold at weaning for breeding stock.

The gilts reserved for the multiplier herd and the cull pigs (those not satisfactory as breeding animals) attain body weights of 120 kg at 8 months after weaning and require approximately 3.6 kg of feed per kilogram of weight gain. These pigs appear to be a rugged breed of large mature size. Although the meat of the Harbin White is too fat by U.S. standards, pork fat is in high demand in most parts of China. Thus the Harbin White seems to be a satisfactory breed with great potential.

Professor Xu Zhenying (Tseng-Ying Hsu) described in some detail the development of a new and the first bacon breed (the Sanjiang White) for the northeast provinces. The development of this breed represents a joint effort among the Northeast College of Agriculture, the Experiment Station of the Provincial State Farm Administration, and six state farm production brigades. The breeding is based on Landrace, imported about 15 years ago but found to be intolerant of the harsh climatic conditions, and the indigenous Min Zhu.

The foundation Min Zhu pigs came from 27 different farms, and the Landrace from 41 different farms. The breeds differ in average litter size (12.3 versus 11.4 pigs), birth weight (1.0 versus 1.3 kg), carcass length (90.0 versus 97.6 cm), backfat thickness (3.18 versus 2.57 cm), and loin eye area (23.2 versus 31.3 cm^2) for the Min Zhu and Landrace, respectively. Average growth rate and dressing percentage are similar for the two breeds.

The researchers are in the sixth year of the breed development program and are of the opinion that an improved breed will result that will possess good combining ability with the Harbin White and the Soviet Large White breeds. More details of the status of the new improved breed (Sanjiang) will be published soon by Xu Zhenying and Gen Resheng, professor and lecturer, respectively, Animal Sciences Department, Northeast College of Agriculture.

The Animal Sciences Institute of the Shanghai Academy of Agricultural Sciences is concentrating on the Shanghai White breed, which has been established for several years. This breed is the result of crossing the Soviet White with the native Meishan of the area. This white breed is similar to the Harbin White but is adapted to the warmer climatic conditions of the Shanghai area. Growth rate is good, and the breed does quite well on high-roughage and by-product feeds.

The institute emphasizes high muscle percentage in its selection program because of the local demand, particularly among the urban populations, for less fat on the pork than that preferred in the northern areas of China. The Animal Sciences Institute has collaborated with communes in the Shanghai area to establish the Shanghai White breed.

The institute is also involved in selection programs with the native Taihu breeds (Fung-Cheng and Meishan). These native pigs produce larger litters than the newer breeds; they are docile; and there is the general understanding that people prefer the meat of the native pigs. These pigs are considered to be more disease resistant, probably because of the many years of natural selection, and have good combining ability with the other breeds, particularly in imparting the desirable traits of larger litter size and higher level of disease resistance.

In reported comparisons with the Shanghai White, the Meishan sows gave birth to and weaned about three pigs more per litter (15 versus 12 farrowed and 14 versus 11.5 weaned) than the Shanghai White. Litter size for crosses was intermediate, 13.5 and 12.5, respectively, farrowed and weaned. The early growth rate of the Shanghai White pigs was superior to that of the cross, 19 versus 15 kg of body weight at 60-day weaning.

The smaller mature size, slower growth rate, weak back, pendulous belly, and the wrinkled skin of the native pig seem to be undesirable traits. The sway backs and pendulous bellies, common traits of many of the native pigs throughout China, appear to be the result of a combination of factors, both genetic and environmental. It is visually obvious in the very early life of the pig that both the back and belly will sway as the pig ages; thus the marked condition of the older pig is at least partially inherited. However, the composition of the diet, high in fiber and usually high in the ratio of water to dry matter, most likely exaggerates the genetic condition.

Many of these pigs are fed diets that are deficient in one or more of the nutrients critical for strong skeletal development. The combination of these dietary and genetic factors results in a very pendulous underline that approaches or does touch the floor, particularly during the stages of late pregnancy or heavy lactation.

In addition to the breed development and/or improvement work under way at research institutes, some communes have breeding units to provide improved breeding stock to the brigades, teams, and families within their communes. The activities of one such commune breeding the Beijing Black pig were previously described. Near Shanghai we visited another pig-breeding farm on the Brick Bridge commune. Families in this commune do not keep sows for breeding purposes but purchase the weanling pigs and finish them to market weight.

Efforts of this farm are concentrated on the Fung-Cheng (or Fong-Jin) breed, a local native breed that is the result of inbreeding or linebreeding. At present, the farm has 132 sows and 8 boars, all originating from 2 sows and 1 boar selected on the basis of performance from an original group of 80. The breed itself has a history of several hundred years. The farm staff is not overly concerned about the high degree of inbreeding but indicated that earlier a substantial number of pigs were culled because of poor performance and high mortality. Litter size was reported as averaging 15.1 pigs born and 12.3 pigs weaned per litter for the past 2 years. The pigs averaged 16.5 to 18.25 kg at weaning.

Shortly after weaning, the pigs are sold as breeding animals to the teams or brigades. Some culls and most of the males are sold to families to be finished to market weight. At the brigade and team level, the sows are crossed with Soviet White boars to produce market pigs. The breeding farm also keeps four Soviet White boars to produce crossbred pigs.

At the Animal Husbandry and Veterinary Medicine Institute of the Jiangsu Provincial Academy of Agricultural Sciences, we saw native pigs of Taihu breeding that are similar to the Fung-Cheng (Fong-Jin) pigs just discussed (Figure 1). These are called the Erhualian (Huai) breed. The institute is using this breed of native pig in a crossing program to develop a new breed called Xinhua. The Xinhua is a black pig resulting from crossing the Erhualian and the Yorkshire.

These native pigs are relatively small at maturity and grow slowly, weighing about 60 kg at 10 months of age. Their main advantage is superior reproductive potential (large number of pigs farrowed and early sexual maturity). It is not uncommon for gilts to have 8 to 10 pairs of teats and well-developed udder sections. Xinhua appears to be intermediate between the two parent breeds in reproductive performance

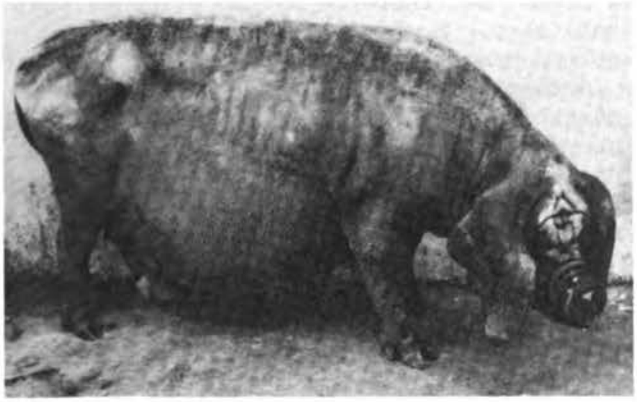

FIGURE 1 A Fung-Cheng (Fong-Jin) sow resulting from the inbreeding program of the Brick Bridge People's Commune.

but superior to both in terms of growth rate. The black color comes from the dominant black of the Erhualian (Figure 2).

Our only other opportunity to view swine-breeding research was at the Institute of Animal Sciences in the Guangdong Agricultural Academy near Guangzhou. No apparent effort is being made there to develop a new breed of pig, but, through selection programs and application of artificial insemination, the academy has been instrumental in distributing about 3,000 improved boars among the communes in the province. These boars are being used by the brigades and teams to provide fresh semen for artificially inseminating sows and upgrading the pigs produced in the province.

Pigs of the Danish Landrace and native White and Black Spot breeds are being maintained for artificial insemination research and for testing the performance of the crossbred pigs.

There are no national or provincial registries of swine breeds in China. Any records kept are done so by the individual units, that is, by the institute, state farm, or commune breeding center, so the maintenance of a pure breed or line of pigs over many years is solely dependent on the geographical limitations for crossing. At this time there is a great deal of emphasis on, and probably prestige associated

FIGURE 2 Some native swine breeds are highly prolific and have the capacity to nurse large litters. Note the nine pairs of well-spaced teats on the Xinhua gilt.

with, the development of a new breed, but there is little evidence that definitive goals have been established. Much of the effort involves the crossing of native and imported breeds. The predominant imported breeds are the Yorkshire type (European or Soviet Large White), with lesser emphasis on Landrace, Berkshire, and other breeds.

There are some traits of interest in the native breeds that need to be evaluated and possibly maintained. There is a general belief that the native breeds are more adapted to the local conditions (including tolerance to the colder climate of the north or the warmer climate of the south), more efficient in utilizing high-fiber and by-product feeds, and more resistant to the local diseases and parasites and that they produce a meat of superior quality.

A more definitive trait that can be measured easily is the apparent higher rate of reproductive performance. Chinese geneticists see the need to evaluate each of these traits before the tide of new breed development results in the loss of this genetic material. The pig population is so large and transportation so limited that there is little danger of this happening very soon, but, on the other hand, the resources for extensive breed evaluation are essentially nonexistent. Effective breed evaluation is complicated by the complete lack of breed registries.

The traits of litter size and roughage utilization are of definite interest to the U.S. swine industry. We should cooperate in research programs to determine whether significant improvements could be expected from an exchange of genetic material between the two countries. Once it is definitely decided that significant gains could be made through exchange, we could then assess the methods of conducting an exchange with minimum disease risks.

It appears from the limited data that we were able to collect that average litter size for some of the native breeds is at least two to three pigs greater than for the Yorkshire-type pigs (European or Soviet Large White). Since Yorkshire and Landrace are our most prolific breeds, there may be opportunities to improve reproductive efficiencies in the United States markedly. One must not overlook the fact that the pigs are smaller at birth; possibly a reduced survival rate might largely offset the advantages of more pigs farrowed per litter.

The opinion of some people in China is that the exceptionally large litters are of no particular benefit because of the high subsequent mortality, although logically the more pigs that are farrowed, the more that will be weaned. Although we have long been aware of this trait of larger litter size, we have not made a concerted effort to incorporate it into our breeding stock through importation.

The evidence for increased ability to utilize high-fiber or by-product feeds by the China pigs is much less tangible than the evidence for larger litter size, but this trait could certainly be important to the world's swine industry. U.S. researchers have conducted very little research to determine whether improvements, through selection, can be made in the pigs' ability to utilize fibrous feeds. China has genetic material resulting from many generations of natural and planned selection that should provide definitive answers within a short period of time.

SWINE NUTRITION AND MANAGEMENT

Planned feeding and nutritional programs for pigs are nearly nonexistent in China, and we saw little swine nutrition research in progress. This lack of visible nutrition research was explained on the basis that the research stations and institutes are just now getting reestablished following the Cultural Revolution. Of the research in progress, most is being conducted on state or commune farms.

The major limitation on swine production is limited feed supply. About 7 percent of the 300 million tons of grain produced in China may be allocated to animal production; the rest is reserved for human food. Should all the 7 percent be allocated to pork production, it would amount to only about 70 kg of grain per pig, much less than that needed to finish a pig to market weight.

Concentrate feeds now being used in swine production are mostly by-products of rice or wheat milling, and these are sufficient to provide only a portion of the total feed necessary to finish pigs to market weight. In most areas, we found that the families are provided 1-2 kg of concentrate feed for each kilogram of pig marketed. It was obvious that silages, water plants, vegetable and crop residues, and feedstuffs originating from household garbage and the family garden plots play a major role in meeting the total feed needs.

Some farms grow water plants and other forage crops specifically for swine feed. The longer growing seasons of southern China allow for a nearly year-round green feed supply, and that, coupled with the greater production of wheat and rice, accounts for the larger populations of pigs in those areas. In the Nanjing area, three kinds of water plants are cultivated as pig feed. These include one genus (*Altenanthera*) that roots in soil and two genera (*Pistia* and *Eichornia*) that root in water. The optimum growing temperatures for the three genera differ sufficiently for them jointly to provide a nearly year-round feed supply. The plants are high in moisture content; hence the animal must consume great quantities if these plants are to make significant contributions to the daily nutrient requirements. In the northern areas, more silages and root crops are used.

It is difficult to suggest what a typical diet might be. However, at one swine-breeding station, gestating sows are fed 1 kg of concentrate and 8 to 10 kg of aquatic plants. The level of concentrate feed is increased to 1.5 kg in late gestation and 3.5 kg during lactation. At this time of our visit, the concentrate feed consisted of 65 percent barley, 30 percent rice bran and middlings, and 5 percent cottonseed meal. For lactating sows, fish meal (4.0 percent) and minerals (1.0 percent) replaced an equal portion of the barley. This mix would be a quite satisfactory sow feed if the allowances could be nearly doubled and the mix were amply fortified with vitamins and minerals.

The condition of the sows and pigs at research stations and other communes suggests that the above allowance is certainly not less and is probably greater than the average. Sufficient quantities of barley are not being produced to permit all sows to be fed at this rate. Both researchers and people in charge of Chinese swine production are aware of the U.S. swine feeding standards and indicated that theirs are similar when and if the feed supply permits.

Vitamin, mineral, trace-mineral, and feed additive supplementation of swine feeds is restricted because of the limited supply and relatively high cost of these items. At one commune, we found that the residue from antibiotic fermentations is being utilized as pig feed. This, no doubt, would provide substantial quantities of B vitamins as well as some antibiotics to the diets. The general conditions of the family-reared pigs in that commune were substantially better than the conditions of many we observed at other farms. The fermentation residue being fed may have contributed to the apparent improved condition. A diet consisting totally of vegetable products would certainly be limited in vitamin B12, particularly since most of the pigs are confined and the practice of conserving manure minimizes the pigs' access to the manure.

Obvious nutritional deficiencies, other than that of total quantity of food, were not apparent. The young pigs usually were healthy and appeared to be growing well up to time of weaning, but postweaning growth rate appeared to be slow. This would be expected with diets low in concentrate feeds, limited in total quantity, and not adequately fortified with vitamins and minerals.

We were told that individual families are able to get their pigs to market weight more quickly than communally reared pigs. The difference was attributed to more abundant food supply and better care at the family level, but the generalization could not be substantiated by the general appearance of the communal and family-reared pigs that we observed.

It was apparent that early postweaning growth rate is slow, and this is primarily a result of inadequate total feed and of nutrient imbalances in the feed that is provided. The breeding farms do not bother to keep feed conversion records because the diets vary so much from time to time. However, the breeders still mention feed conversion as being of prime importance as a selection trait.

Most of the research interest in nutrition is related to alternative feed supplies and availability of nutrients. Protein from fermentation products, locust tree leaves, and other legumes and production, evaluation, and utilization of aquatic plants are examples of subjects of research in progress.

There are some cooperative efforts in swine nutrition research. For example, researchers in the Inner Mongolia and Heilongjiang provinces are collaborating to define protein requirement and feeding standards for the pig from weaning to 20-kg body weight. The early postweaning stage is a most critical one in view of the limitations of feed supply.

There appears to be a lag period following weaning, but, once the pig reaches 40 to 50 kg of body weight, it is evidently better able to cope with the type of diet being provided. At present most of the feeding trials in progress are being conducted at the communes because there are limited research facilities or experimental animals available at the institutes.

HOUSING AND MANAGEMENT

Swine housing needs and types used vary greatly because of the environmental extremes from north to south in China. There are a few slatted-floor-type finishing units with mechanical ventilation and feeding and gravity-flow waste removal, and their use is probably unjustified in view of the present abundant labor and limited capital situations. At most communal swine units, enclosed or partially enclosed and naturally ventilated shelters for the pigs are combined with outside feeding or exercise floors. In the warmer climate, the shelter is usually the open-front type.

Manure is saved to be returned to the land as fertilizer and represents a source of income to the family or communal unit rearing the pigs. In fact, the returns from the manure are considered a primary incentive to encourage families to keep pigs. Sows and litters are most frequently kept in a farrowing-pen arrangement. Only a few of these are equipped with protective guards to prevent overlay. The sows usually have access to an outside pen or are moved from the pen for feeding. The animals are almost constantly attended, and, for the sows, this means 24 hours a day during the farrowing period.

The amounts of labor provided vary from place to place, but a few examples should illustrate that labor supply is abundant. At one municipal multiplier swine-breeding unit, there were 45 people in the pig-production unit with a total herd size of 350 sows (250 sows and 100 replacement gilts). This farm produces about 5,000 pigs per year. The pigs are sold at time of weaning to communes for breeding purposes. In the sow units, there are 5 attendants for every 60 sows with litters.

Another pig-breeding unit, again one that sells the pigs shortly after weaning, had 132 sows and a labor force of 16 to care for them, including 11 laborers, 4 technicians, and 1 leader (Figure 3).

Obviously, the individual attention provided by such a small ratio of pigs to workers should greatly enhance productivity, whether this is measured by efficacy of heat detection, breeding efficiency, or pig survival or in some other way. However, it should be recognized that essentially no services, such as feed delivery, are available. We tend

FIGURE 3 An abundant labor supply allows careful attention to sows and litters throughout the farrowing and suckling period. A Harbin White sow and litter.

to underestimate the total labor going into production of pigs in the United States because we have backup services and a high degree of mechanization that substitute for on-site laborers.

After the pigs are weaned, a high percentage (up to 80 percent) is sold to or distributed among families to be finished to market weight. Performance and survival of these family-owned pigs are reported to be superior to those of the pigs kept in the collective units. This superior performance is attributed to the individual care, protection from cold, and the more adequate food supply that can be provided. Often the pig is housed in a small sty attached to or near the family home.

The potential income and food to be realized by sale of the pig encourages provision of extra labor to care for the pig and probably, if necessary, a sharing of the food supply (Figure 4). Certainly,

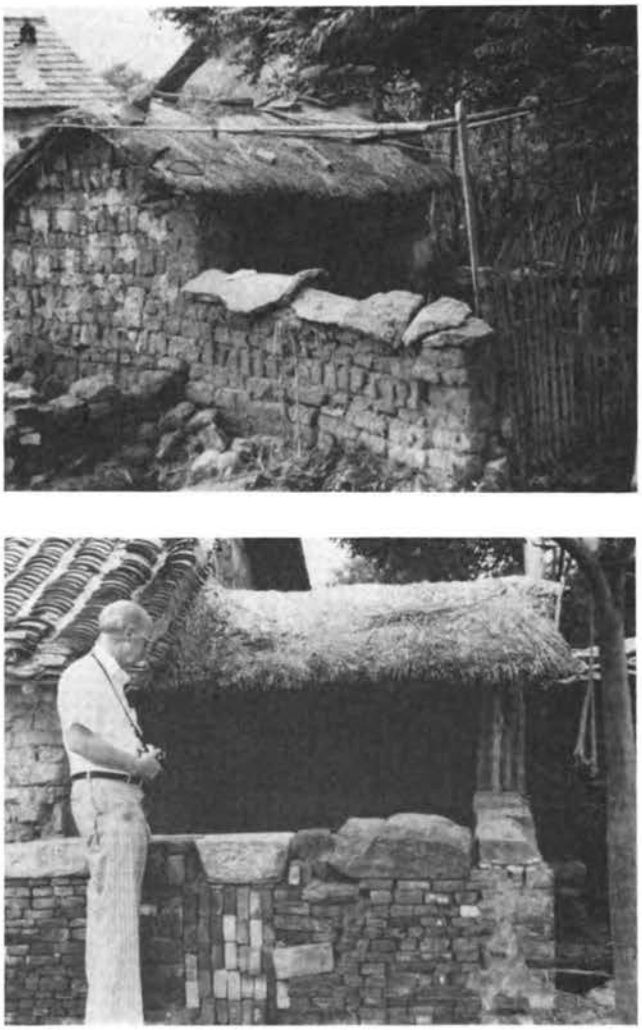

FIGURE 4 Sixty to eighty percent of pigs are finished individually or in small groups to market weight by families. These pigs are housed in styes near or attached to the homes as illustrated in these photographs.

the household wastes, and plants that can be collected by the family members, can contribute substantially to the pig's food intake. It is really questionable whether a major shift from family rearing of one or a few pigs per family to rearing large groups of pigs collectively could be accomplished without far more feed grains being available for swine feeding.

Pigs are weaned at 50 to 60 days of age, and the sows are rebred to produce approximately two farrowings per year. Artificial insemination is used extensively, and details of its research and application are presented elsewhere in this report.

When male pigs are castrated, this is done before they are weaned; and it is also rather common to spay gilts that are to be finished for meat. With the delayed marketing of pigs in China, this would be desirable; otherwise all gilts would exhibit estrus several times before reaching slaughter weight.

We were informed that all pigs are immunized against hog cholera using a modified live virus vaccine, and, in some areas, at least, they are immunized for swine erysipelas using an attenuated bacterin. Chemicals are used to control internal parasites. The vaccines and chemicals are made available through the communes, but, in view of the wide distribution of pigs, it is probably unlikely that all pigs are immunized or adequately protected from intestinal parasites. Atrophic rhinitis, transmissable gastroenteritis, and other enteric diseases are also considered common health problems. Diseases and their control are discussed in more detail elsewhere in this report.

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5

POULTRY PRODUCTION

William F. Dean

Poultry (chickens, ducks, and geese) are second to swine in importance as food animals in China. Collectively produced poultry, as well as those raised by individual households, contribute significantly to the supply of meat and eggs. Concentrate feedstuffs are required for their production, but poultry also convert foodstuffs not readily utilizable by humans, such as grain left in fields after harvest, grain by-products, household garbage, and insects in rice paddies, into a high-quality protein human food. Poultry provide manure for fertilizer and feathers and down for winter garments. The world-famous Beijing (Peking) duck is a major attraction to foreigners at restaurants in the large cities. Broilers, Beijing ducks, and feathers and down are important export items and, therefore, sources of foreign exchange.

As in the case of other food animals, feed supply is the major limitation to the expansion of poultry production in China, and a solution to this problem precludes any major increase in production. There are, however, definite signs of efforts to modernize the industry in other areas, such as poultry breeding and mechanization of production. These efforts will undoubtedly, in time, bring about progress if the necessary feed supplies can be made available through increased production, imports, or other means.

CURRENT STATUS OF PRODUCTION

Reliable statistics on national production of poultry in China appear to be unavailable. A Chinese poultry specialist responded with laughter to questions on this subject. One can appreciate the difficulty of obtaining reliable head counts in a country in which large numbers of poultry are raised by individual households. Recent rough estimates of the total poultry population in China range from 1.4 billion to 1.6 billion head.[1,2] Smil,[3] who constructed food balance sheets for China in 1976, estimated that production of poultry and eggs was 3.5 million and 3.6 million metric tons, respectively, for the year. Using these statistics and a population of 950 million persons, Smil calculated a per capita consumption of approximately 3.0 kg for each of these products.

Beijing poultry authorities did estimate national production of Beijing ducks to be approximately 10 million head annually. In spite of their popularity, Beijing ducks represent only about 5 percent of the ducks produced in China. The remainder of production is accounted for by the Ma duck, which is particularly common in the rice-growing areas of southeast China. No estimate of the total production of Ma ducks was available. Conversations with poultry specialists at Shanghai, Nanjing, Yangzhou, and Guangzhou and observation of ducks in these areas suggest that large numbers are produced.

Collective production of broilers and Beijing ducks appeared to be concentrated near the larger cities, such as Beijing, Shanghai, and Guangzhou. Interestingly, a large portion of both of these fowl is exported. For example, out of approximately 20 million broilers produced in Shanghai, 15 million are exported. One third of the Beijing ducks raised in the Beijing area (which includes about 60 farms that raise 30,000 to 200,000 ducks per year) are exported to Hong Kong and Japan. Most of the remainder are sold to restaurants in Beijing that cater largely to a foreign clientele.

The Beijing Duck restaurant in Beijing serves as many as 5,000 duck dinners in an evening. The Chinese do not particularly care to eat broilers or Beijing ducks but prefer older chickens, such as spent layers and Ma ducks, which are smaller and have less fat than the Beijing breed. In addition to broilers and Beijing ducks, China also exports a significant quantity of feathers and down. In 1977, 6,668,000 pounds of feathers and down were exported to the United States alone.[4]

According to authorities at Harbin, the province of Heilongjiang produces 40 million head of poultry per year. No breakdown according to species was given, but chickens appear to be the predominant fowl around Harbin (Figure 1). There are about 30 layer operations in the area. One, at the Xinfa commune, keeps 16,000 layers that produce 120,000 kg of eggs per year. Eggs from these farms are purchased from the communes by the state and sold in Harbin for local consumption.

There was no evidence of any appreciable poultry production in the Inner Mongolia Autonomous Region, except for small flocks of chickens and ducks kept by individual households. However, we were informed that efforts are under way to introduce poultry production into the region.

The largest poultry-producing commune visited by our delegation was

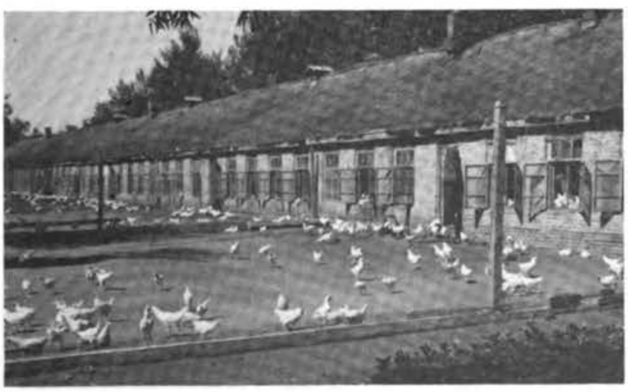

FIGURE 1 Replacement White Leghorn pullets at Xinfa commune, Harbin, Heilongjiang province. Housing for layers in production was of the same design and construction.

FIGURE 2 Newly hatched chicks at Renhe commune, Guangzhou.

the Renhe commune near Guangzhou, which claimed to produce 500,000 poultry (chickens, ducks, and geese) per year (Figures 2 and 3). This production is apparently spread over a number of small farms, since the production units that we saw were not exceptionally large. The second-largest and most modern poultry operation visited was the Red Star chicken farm, south of Beijing. This farm maintains 200,000 layers, which produce about 7,000 kg of eggs daily. This state-supported commune is discussed further in the section of this chapter on management.

Although it was not possible to obtain data on the proportion of poultry produced on communes compared with those raised by individual households on a national basis, we did learn that, near the larger cities, the percentage of communally grown poultry is very high. At Shanghai, for example, it was estimated that 90 percent of the ducks are produced collectively.

BREEDING

Among the poultry research projects being pursued by Chinese scientists, poultry breeding appears to be receiving the most attention. Two

FIGURE 3 Lion's Head geese and Beijing ducks at Renhe commune, Guangzhou.

FIGURE 4 Neoputung breeders (developed from the local Putung breed and exogenous Cornish and New Hampshire stock) at the Xinyang Poultry Breeding Institute, Shanghai.

poultry-breeding institutes in southeast China, one at Shanghai and the other near Yangzhou, are putting forth significant effort to develop improved breeding stock that will perform well under Chinese conditions. Most of the projects now under way were not initiated until after 1976. Both institutes have rather good breeding facilities. There are 360 breeding pens at the Shanghai center and 1,400 at Yangzhou. Each pen is equipped with trapnests and accommodates 12-15 hens.

One approach being used at these breeding centers to improve chickens for meat production is to carry out a series of crosses involving a native breed that performs well under local conditions and one or more exogenous breeds with desirable traits. At the Shanghai institute, for example, a breed called Neoputung was developed from a local breed (Putung), White Cornish, and New Hampshire (Figure 4). Field studies were being carried out in the Shanghai area with chicks from 10,000 Neoputung breeders. Broilers of this breed weight 1.5 kg at 9 or 10 weeks of age, we were told.

At the Yangzhou breeding station, the Luhua cross, a cross between Red Cornish and a local Red, reportedly weighed 2.1 kg at 8 weeks of age. Three strains were said to have been developed from this cross. A number of other crosses were being investigated that involved crossing a local breed with an exogenous breed, such as Red or White Cornish, White Plymouth Rock, and New Hampshire (Figure 5). Broilers seen at

FIGURE 5 White Plymouth Rock breeding stock at Renhe commune, Guangzhou.

communal poultry farms around Shanghai and Guangzhou appeared to have originated from some of these crosses. White Plymouth Rock breeders were frequently seen at these farms, suggesting their use as one of the lines in these crosses.

Other breeds of chickens being utilized in research at Yangzhou included Shenchu, a buff-colored breed; Taihu, a crested, white-feathered, black-skinned breed; and black-feathered Langshans. The predominant egg-laying breed of chicken seen in China was the White Leghorn. In Beijing, White Leghorns kept in cages at the Red Star commune averaged 236 eggs/hen/year. Floor-managed White Leghorns at Harbin averaged about 60 percent egg production on a hen-housed basis. Egg size was said to be 56 g.

The Beijing duck in China today and the "White Pekin" duck of the United States, which share a common ancestry (the U.S. White Pekin was introduced from China in 1873), are almost identical in appearance and, based on early descriptions of the Pekin duck,[5] the breed has changed very little over the past 100 years.

As previously stated, the predominant breed of duck in China is the Ma Ya (Ya means duck in Chinese), or Ma duck. It is sometimes referred to as the sparrow duck because its color is mottled brown, resembling the coloration of the house sparrow. Actually its coloring is similar to that of the Mallard, particularly in females and immature males. We did not have an opportunity to see mature males at close range, but were told that they have a green head, similar to that of the Mallard.

There are two major subclassifications of the Ma duck, the Gao You, a dual-purpose variety, and the Sao, which is noted for its egg-laying ability (Figure 6). The Gao You appeared to be the most common variety in the areas that we visited. It is considerably larger than the Mallard but not so large as the Beijing breed. The Sao variety reportedly lays about 250 eggs per year (Figure 7).

In contrast with the work on chickens, little breeding research is being done on ducks in China. Work just getting under way deals with the Ma × Muscovy and Beijing × Muscovy crosses. Work on artificial insemination of ducks and the use of frozen semen is also in its early

FIGURE 6 Ma ducks of the Gao You variety at the Jiaodu Poultry Research Institute near Yangzhou.

FIGURE 7 Sao ducks, a high egg-producing breed seen at the Jiaodu Poultry Research Institute near Yangzhou.

stages. At Yangzhou, a small number of Shiao ducks, which resemble Indian Runners and lay over 300 eggs per year, are under investigation. We did not see any of these ducks in the field.

Between Nanjing and Yangzhou, we observed numerous flocks of white geese, which the Chinese have given the name Taihu after a nearby lake (Figure 8). The breed resembles the White Chinese goose listed in *The American Standard of Perfection*[6] but does not have the prominent knob and is smaller in size than the goose listed in the Standard. This goose appears to be about the same size as the Beijing duck.

NUTRITION

The limited supply of grain and feed protein sources available for use in poultry feeds in China is obviously a major obstacle to modernization of poultry production, if modernization is to include appreciable expansion of production. Efforts to modernize the poultry industry by developing improved breeding stock and mechanizing production will be of limited value unless an adequate supply of the required feedstuffs

FIGURE 8 Taihu geese (named after a nearby lake) observed in route from Nanjing to Yangzhou.

is available. Regardless of how the necessary feed supply is made available--through increased domestic production allocations or importation from other countries--a commitment by the policy makers to provide a regular year-round supply of good-quality feed ingredients is essential for modernization to be successful.

Perhaps the second most important challenge facing the Chinese in their effort to modernize poultry production is improving the quality of poultry feeds so that the feedstuffs that are available are used efficiently. The composition of poultry rations in the different areas visited by our delegation varies from complete rations, comparable with U.S. poultry feeds, to rations composed of whatever happens to be available. At the state-supported Red Star poultry farm at Beijing, caged layers are fed complete rations formulated to meet nutrient specifications, which, according to our host, follow mainly the U.S. National Research Council[7] requirements.

The major ingredients used include soybean meal, corn, milo, barley, fishmeal, wheat bran, locust leaf meal (comparable with alfalfa meal), methionine, and mineral and vitamin supplements. Performance of Leghorn hens fed such a ration was reported to be 236 eggs per hen and 2.86-kg feed per kilogram of eggs. Visits to some communal poultry farms, such as Xinfa commune at Harbin, revealed that less-complete rations are being fed. Vitamin supplements in particular are not regularly available. Supplemental green feeds are fed daily in an effort to supply vitamins. Shortages of vitamins presumably become more severe during the long cold winters in the northern provinces.

Although details regarding the precise trace-mineral supplements being added to poultry feeds in China were not obtained, comments by Chinese scientists during our discussions indicated that complete mixes are not always available. One specific trace-mineral deficiency that was acknowledged to occur in chickens is selenium deficiency. Broilers fed rations composed of ingredients grown in northeastern China, where soils are known to be selenium deficient, develop typical manifestations of selenium deficiency, including exudative diathesis. This is reportedly corrected by giving 1 ppm selenium in drinking water (this level seems unnecessarily high based on U.S. studies).

In many instances, the composition of poultry rations appears to be determined by the availability of feedstuffs in a particular area. This is most evident in the makeup of rations for ducks. At Shuang Qiao (Double Bridge) commune duck farm near Beijing, Beijing ducks are fed rations containing soybean meal, corn, sorghum grains, wheat meal by-product, wheat bran, rice bran, and bone meal (specifics regarding trace-mineral and vitamin supplements were not given) (Figure 9). Feed conversion of Beijing ducks fed such a ration is 3.50 units of feed per unit of live weight at 60 days of age. In contrast with this formula, Beijing ducks at Renhe commune at Guangzhou are fed a ration that consists mainly of rice and fish meal.

At Yangzhou, we were told that adult Ma ducks fend for themselves, and growing ducks are fed a daily ration of eel, rice, barley, rice bran, and whatever else they can find. It should be explained that the Ma ducks, which are raised in small flocks, are taken out to the rice fields daily, usually by a young member of a family, to feed on whatever

FIGURE 9 Beijing ducklings at different stages of growth at the Double Bridge commune near Beijing.

they can find. They apparently do not disturb the developing rice plants. After rice and other grains are harvested, ducks are allowed to glean grain remaining in the fields.

One unusual feature of feeding Beijing ducks is the force feeding that is carried out during the last 10-14 days before slaughter (Figure 10). This is done to provide the thick skin-fat layer that is a desirable feature of the Beijing duck prepared in restaurants in Beijing and other large cities. To facilitate force feeding, an electric-powered pump intermittently delivers a predetermined amount of wet mash from a reservoir tank to a discharge tube located so that the ducks can be manipulated, one by one, into position to receive an injection of the gruel from the tube into the esophagus. From day of hatching until the initiation of force feeding at about 7 weeks of age, ducklings are fed a wet mash, which they voluntarily consume, four to six times daily.

Chinese duck farm personnel described a problem that is apparently associated with wet mash and/or force feeding and the development of molds in the mash. Gas is formed in the esophagus (a duck does not have a true crop), which causes massive distension of the esophagus. Farmers puncture the esophagus to relieve pressure.

FIGURE 10 Beijing ducks being force-fed at the Double Bridge commune duck farm near Beijing.

In spite of the practice of force feeding, body weights at market age are not exceptional; in fact weights are slightly less at 60 days than those obtained in the United States in White Pekin ducks at 49 days of age. Although many factors may be responsible for this difference in performance, the use of pelleted feeds by U.S. duck growers is a major advantage. If good-quality pelleted feeds were available to Chinese duck producers, the daily wet mash feeding and most likely the force feeding could be eliminated with results as good as or better than are now obtained.

Aflatoxin poisoning in ducks resulting from feeding contaminated grain was acknowledged to be a problem in China. In view of the high sensitivity of the duckling to this toxin, contaminated grains, if they must be fed, would best be used for feeding less sensitive species. In addition to taking all possible measures to improve harvest and storage conditions, the Chinese might consider investigating some of the methods of detoxification of contaminated grain that have shown promise recently.[8]

There was little evidence of research on poultry nutrition being carried out, except for work that was just getting started. One of the projects recently initiated is on determining the metabolizable energy content of feedstuffs for chickens and ducks. This work would seem to be appropriate in view of the necessity for using various by-products of wheat and rice milling and leaf meals from various native plants in poultry feeds.

MANAGEMENT

Management features observed by our delegation during visits to communally operated Chinese poultry farms that were of particular interest included the following:

1. Poultry buildings, particularly in the north, are generally well constructed, usually of brick. Cement tile roofs are common. Although there was little opportunity for close inspection, it appeared that most buildings are not well insulated.
2. Natural ventilation systems are the most common. The only mechanical ventilation was seen at the state-operated Red Star chicken farm at Beijing.
3. Provision for access to outdoor runs is common, even in the north. In the south, partially enclosed buildings are more common, and, in the case of ducks, only minimal shelter is provided.
4. Replacement pullets are usually kept on the same farm with layers. Keeping breeders and market birds on the same farm is common with both broilers and ducks.
5. Most poultry farms are labor intensive, with few labor-saving design features. At Shanghai, an estimate of output per poultry worker was one man per 2,000 birds. (This applies to both broilers and ducks.)
6. At one farm at Shanghai, broilers were being grown out in multiple deck batteries.

7. No refrigeration is available for storage of market or hatching eggs on the farm.

8. Ma ducks and geese are managed in small flocks, as described in the section of this chapter on nutrition. In order to distinguish ownership of flocks of Taihu geese, the heads of this white-feathered breed are sometimes dyed a particular color.

In keeping with present policy to mechanize agriculture, some effort is being made, at least on a trial basis, to mechanize poultry production. We observed two facilities set up to evaluate mechanized caged layer-production units. One test building located at the Yangzhou Poultry Breeding Center houses 4,000 layers. It is equipped for mechanical feeding, waste removal, and egg collection. The unit was relatively new, and no results were given. This system represents a high capital investment and seemed out of place in a country in which saving labor would appear to be less important than increasing productivity.

The other facility that was apparently set up to evaluate mechanization on a larger scale is the Red Star commune at Beijing. This facility, which began operation in 1977, is a 200,000-caged layer farm operated under the direction of the Bureau of Animal Husbandry. The farm consists of 18 total confinement buildings: 2 for starting, 4 for growing, and 12 for laying. Buildings, which are of brick construction with cement tile roofs, are equipped for mechanical feeding and manure removal.

Feed, which is formulated to meet U.S. National Research Council requirements, is prepared at a mill in Beijing. The daily output of eggs at the time of our visit was 7,000 kg. Strict control of traffic seemed to be enforced. Visitors were not allowed to enter any of the buildings. A major shortcoming in terms of disease control was the keeping of replacement birds on the same farm with layers. The fact that some disease problems had been experienced was acknowledged, but few details were given.

When asked about the advantages of this modern, mechanized layer farm, leaders of the project replied that it provides a constant supply of eggs and saves labor. Again, one could question the advantages of saving labor, but the more predictable supply of eggs, which probably reflects improved performance resulting from better housing, good nutrition, and possibly the use of their better genetic lines, would appear to represent real progress.

The Chinese need to get the greatest yield of poultry products out of each ton of feed allotted to poultry and to get the most out of capital invested in housing and equipment. Therefore it would seem advisable for them to place less emphasis on equipment designed mainly to save labor and more emphasis on measures that will improve efficiency of production. Such measures should include health related design features in poultry farm layouts, such as isolation of age groups. Greater use of insulation could moderate the effects of high and low temperatures and improve growth, egg production, and feed utilization. With Beijing ducks, mechanization would be applied most advantageously to the pelleting of duck feeds.

DISEASES

For a complete discussion of diseases of poultry, the reader is referred to Chapter 13. Comments here will be confined to observations regarding the occurrence of duck diseases in China.

During the visit of the U.S. delegation, there were few indications of research, diagnostic services, or biologic production relating to duck diseases. This was surprising in view of China's large duck population. There appeared to be no real duck disease specialist at any of the institutes visited. Authorities on ducks in many cases were either uncertain about what diseases were present or reluctant to discuss them.

However, all the common duck diseases present in the United States and in other duck-producing countries were acknowledged to be present in China. These included fowl cholera, duck virus hepatitis, duck virus enteritis, *Pasteurella anatipestifer* infection, salmonellosis, and colibacillosis. Fowl cholera appeared to be the most serious duck disease. Duck plague (duck virus enteritis) was reported to be present only in the Guangzhou area. Little information regarding measures being taken to control these diseases was available.

SUMMARY AND CONCLUSIONS

During a 28-day tour of selected areas in eastern China, poultry production was observed at state farms and communes near the cities of Beijing, Harbin, Shanghai, and Guangzhou. During our travel, we observed that the keeping of small numbers of poultry by individual households was common throughout the countryside. In addition, numerous small flocks of ducks and geese were seen throughout the rice-growing areas of southeastern China.

All attempts to survey the poultry industry in China to date, including this one, have been handicapped by the unavailability of national statistics on poultry numbers. In isolated instances, statistics on provincial or municipal production were obtained.

In general, poultry production is much less intensive than, and technologically far behind, that of countries with advanced poultry industries. At communes visited by the U.S. delegation, flocks of laying hens ranged in size from a few hundred to 16,000. Only small flocks of fewer than 1,000 broilers were observed. Beijing duck farms near Beijing produce 30,000 to 200,000 ducks per year. Ma ducks (the predominant breed) are raised in small flocks of a few hundred.

Most of the poultry observed, even in the north, are grown in semi-confinement with access to outdoor runs. Ducks and geese in the south are provided minimal shelter. In one instance, broilers at Guangzhou were seen in multiple deck batteries. Buildings are usually of durable construction, and in the north, brick walls and cement tile roofs are common. Little mechanical ventilation or evidence of the use of insulation was seen at communal poultry farms. Keeping replacement pullets on the same farms with layers and market birds with breeders is common.

Refrigeration is not available for storage of market or hatching eggs on the farms. At Shanghai, an estimate of output per worker was one person per 2,000 birds (broilers and ducks). Beijing ducks are fed wet mash several times daily for the first 7 weeks and then force fed the last 2 weeks before marketing. These labor intensive practices could be eliminated and performance improved if pelleted feeds were made available.

An attempt to apply modern technology to producing table eggs was seen at an experimental mechanized caged layer project at a state farm near Beijing. Aside from some disease problems, reported performance approached that of a modern laying hen operation. One major improvement over conventional systems noted by the operators was a predictable year-round supply of eggs.

Poultry research is just getting under way following the 10-year period (1966-1976) during which most research was at a standstill. However, signs of significant progress since 1976 are evident. The major emphasis of poultry research appears to be on breeding. Institutes at Shanghai and Yangzhou have a combined total of 1,760 breeding pens equipped with trapnests, which appeared to be fully utilized. Research on chickens seems to emphasize the development of new breeds utilizing local and exogenous breeds, such as New Hampshire, Cornish, and White Plymouth Rock. Little evidence of poultry nutrition research was seen at the institutes visited.

The only indication of research pertaining to housing, equipment, and management was seen at the mechanized caged layer project at Beijing (mentioned above) and at a smaller similar project at the Yangzhou Poultry Institute. Although these projects are innovative and will provide much useful information, the emphasis being placed on mechanized feeding, egg collection, and manure removal seems misplaced. There is a relative abundance of labor, and the more immediate needs of the poultry industry in China include better-quality feeds and improved disease control programs, including diagnostic services, insulation of housing to conserve feed energy, and better ventilation systems.

As is true in the case of all food animals, the feed supply is the major factor limiting production of poultry. Not only is there an insufficient supply of grain, but part of the grain that is available is of low quality and may contain mycotoxins. Protein feedstuffs are in short supply. Apparently more soybeans could be grown, but because of low prices received for soybeans, farmers prefer to grow other crops. Much of the soybean meal that is produced is not heated sufficiently to inactivate the trypsin inhibitor and therefore is not suitable for feeding poultry.

Supplies of vitamin and mineral supplements needed to balance poultry rations properly are inadequate. The future of the poultry industry in China is largely dependent on what the policy makers decide about making the above-mentioned feedstuffs available. Consideration should be given to increased allocations, greater incentives for production of soybeans, and importation of grains, soybean meal, and vitamin and mineral supplements.

Although there are many obstacles to modernization of poultry production in China, the resourcefulness, pride, and determination of the Chinese, as well as the abundant supply of reliable inexpensive labor, should not be underestimated. If the needs of the poultry industry are recognized and dealt with, the potential for poultry raising's playing a greater role in China's agriculture would appear to be great.

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6

CATTLE AND BUFFALO PRODUCTION

James E. Oldfield

BACKGROUND

The history of cattle in China, like that of several other domestic animal species, is a long one. Epstein[1] has recorded that the first domesticated cattle appeared in northern China toward the end of the Neolithic period, or about the middle of the third millennium B.C. Over the centuries since their introduction, the number of cattle has increased slowly, probably at least partly influenced by the great growth of the human population and the intensification of cropland agriculture to provide food for it.

The huge land mass of China may be roughly divided into two areas for purposes of agricultural classification. These are the so-called agricultural area and the pastoral area. The agricultural area includes the northeast and the eastern seaboard, the middle and lower regions of the Yangtze basin, and the subtropical plains and valleys of southeast China. The pastoral area (Figure 1) includes the Inner Mongolian plateau in the north and the Xinjiang and Tibetan plateaus of the far west and southeast China. Animal agriculture is not the same in both of these two broad areas, as one might expect. In the former, it tends to be intensified to varying degrees; in the latter, it is an extensive, rangelandlike husbandry. The distribution of cattle reflects these management differences. Although the total land area of the pastoral zone is much greater, the majority of cattle (about 72 percent) are found in the agricultural zone.[2]

The role of the pig as a waste-products scavenger as well as its efficiency as a producer of fat for the diet of working people no doubt led to the present prominence of that species in Chinese animal husbandry and had a negative effect on increases in the number of cattle. Present government policy, as explained to our delegation, recognizes the potential use for grazing animals, particularly cattle, and this suggests that the cattle population may increase more rapidly in the future.

The Chinese agricultural planners realize that, although pigs can and do convert a wide range of plant and animal wastes for human food use, pigs do require some grain for finishing, and grain continues to be short in supply. Cattle, it is reasoned, can subsist and grow on diets restricted completely to native forages and lesser-known plant

FIGURE 1 The pastoral zone of China; a scene near Xilinhaote, in Inner Mongolia.

types, including water weeds. Official emphasis, then, in the development of Chinese animal agriculture, is placed on increasing the efficiency of production of species such as pigs and poultry, while holding their numbers relatively constant, but allows for an increase in the number of cattle. Since feed supply would be a limiting factor in any such development, rangeland resource management and improvement of the livestock-carrying capacity of native grasslands would be an integral part of any such development.

Some scattered news reports indicate that success in these efforts is already being achieved. To cite two examples from Chinese newspaper sources, the Ikochao League in Inner Mongolia has increased the number of livestock by 187,000 (these are not all cattle, however) during the past year, while the province of Heilongjiang has raised its number of beef cattle by 110,000 head over the 3-year period 1974-1977.

Increasing cattle production in the arable agricultural area is also possible, if it can be accomplished without interruption of supplies of materials that are now used for direct consumption by the human population or maintaining the fertility of the croplands. It was suggested to us by Chinese scientists that cropland fertility might be maintained by diverting certain photosynthetic products through animals. For example, various oil meals and green-manure crops now used as soil amendments could be fed to livestock, such as cattle, and their manures then used for maintaining soil fertility.

STATISTICS ON CATTLE AND BUFFALO POPULATIONS

Comparison of some of the cattle statistics from China with those from other countries can be interesting and instructive. The total population of cattle, including buffalo, has been estimated at 70 million head, or about one animal for every 13 persons in the country. In contrast, the U.S. cattle population in 1978 was 111 million, or approximately one animal for every 2 humans. Using other criteria, annual meat consumption by the Chinese was estimated at 8 kg per capita, mostly supplied as pork.

There is obviously great variation about this average figure, however. In Inner Mongolia, we were told, a much higher meat diet is common, totaling about 50 kg per capita annually, made up of beef and mutton. In comparison, recent annual consumption figures for beef alone in the United States were about 53 kg per capita. Stated goals were to double supplies of meat for the human diet in China by *1985*, and the production of more beef figures importantly in these aims.

In the past, cattle in China were bred largely as multipurpose animals. In various areas, depending on local needs, dual- or even triple-purpose types of cattle have emerged, with the purposes including, roughly in order of priority, work, milk, and meat production. There is some evidence that selection among cattle is becoming more specific--particularly as far as dairy animals are concerned.

Dairy Cattle

Dairying is concentrated largely around the major cities, and there crossing of high-milk-producing local animals with imported Holstein-Friesians has led to establishment of some excellent dairy herds. Still, the total number of dairy cows in the country, 400,000 head, falls far short of meeting milk needs. In Heilongjiang province, in the country's far northeast (which, incidentally, is a center of dairy production), such crosses have involved the local Pinchow and Sanho breeds.

Pinchow cattle developed along the Pinchow railway line in the northeastern provinces. The Pinchow ancestry, in turn, was formed by crosses of local stock on Simmentals brought in largely from the Soviet Union. These were tall, leggy animals with a variety of coat colors, including black and white, yellow and white, and red and white.

The Sanho ancestry included Mongolian cows and Holstein bulls imported from Europe, and the breed, also called Three River cattle, became established in the northeastern corner of Inner Mongolia. These are large black and white animals with good milk-producing ability. Other high-quality dairy cattle are being developed, from somewhat similar ancestry, in the Beijing area. These are called Beijing Black and White cattle and were produced by crossing Pinchow cows with Holstein bulls obtained from the United States, Canada, and Japan. These are large, high-milk-producing cattle, frequently producing 5,000 kg of 4 percent fat milk during first lactation.

We visited two communes where these cattle were maintained. The first, in the Beijing area, had 400 head of milking cows, with an average annual production of 6,700 kg per head. The second, No. 7 Dairy Farm, is part of the Shanghai Dairy Corporation and had 1,050 milking cows (Figure 2). This farm was established in 1958, at which time average milk production, measured over a 300-day lactation, was 4,142 kg. This has been increased; 1978 average production was listed at 5,933 kg per head.

In assessing these figures, it should be remembered that the diet contains a smaller amount of concentrate feeds than those commonly fed in the United States. At the Shanghai dairy unit, the diet fed the milk

FIGURE 2 An example of the high-quality dairy animals produced at the No. 7 Dairy Farm, Shanghai.

cows is most varied, including green weeds from the grain fields; water weeds, such as lotus; and surplus vegetables, such as cabbage, cucumber, and tomatoes, in addition to conventional hays and silages. The cattle appeared to relish these various feeds, and, surprisingly, there were no indications of off flavors in the milk served to us. Since beet sugar is produced in a number of areas in China, beet pulp is frequently available and is often incorporated into dairy rations, either fresh (wet) or ensiled.

Milking difficulties must be listed prominently among dairy management problems. On farms visited, cows were milked either in in-line stanchion units or by hand, even in some large-scale operations. The difficulties apparently lie in obtaining replacement parts for existing equipment, much of which came from the Soviet Union. Plans for building modern milking facilities were described to us on several occasions. These planned facilities are quite modern, in contrast, including some turntable or carousel units.

Most dairy operations raise their own replacement heifers (Figure 3). Breeding is almost entirely by artificial insemination, as it is in this

FIGURE 3 Vigorous young replacement heifers at a Beijing dairy farm.

country. Semen from selected bulls, many of which are imports, is processed at state farm insemination stations and made available in the form of frozen pellets. Conception rates of 85 percent from an average of 1.9 inseminations per cow at first breeding are reported from some of the better farms. These statistics apparently relate to native yellow cattle. The figure is somewhat lower (65 percent) for Friesian-type animals. Heifers are usually bred first at about 17-18 months. Calves are separated from the cows shortly after birth, and the bull calves are immediately shipped out to specialized feeding units, where they are raised for veal.

The heifer calves at the farm of the Shanghai Dairy Corporation are kept in bamboo crates for 3 days, during which they are fed colostrum at the rate of 2 kg per feeding, twice daily. (The crates are roomy and can be completely disassembled for cleaning and sanitation.) Following this, they are raised in group pens and fed largely on milk for a variable period of 30 to 90 days. Development of milk-replacer formulas would seem to be potentially productive for Chinese dairy scientists. Identification of satisfactory protein sources could free appreciable quantities of milk now used in calf rearing. Labor is plentiful, and the calves receive considerable individual attention, which doubtless contributes to their high survival rate.

Individual milk records are kept on the cows, and feeding is adjusted to production by manipulating either the total ration or the grain portion of it. The grain ration is composed almost entirely of by-products rather than whole grains. Such items as corn gluten meal, rice bran, brewers' grains, and soybean curd residue were encountered from place to place, depending on the nature of local crop production. Health of the dairy animals that we viewed was generally good and was better than that of beef cattle.

Some difficulties with milk fever were reported; this disease is apparently treated with parenteral calcium gluconate. There is no organized program for prevention of milk fever by manipulation of dietary calcium and phosphorus levels or of vitamin D levels during the dry period and just before calving: perhaps the relatively low incidence of the disease does not justify it. The incidence of mastitis is quite low also, perhaps because of the udder care practiced and the considerable amount of hand milking. Even in some of the larger dairy operations, cows may be milked by hand for 15-20 days after freshening.

An organized dairy industry has existed in China only since about 1949. Hailar, in Heilongjiang, is currently the major dairy center for the country, but signficant numbers of milk cows and milk processing plants occur around the major cities. Fresh milk is produced, largely to be consumed by urban children; dried milk, butter, and cheese are produced for use in the hotel trade and for sale in outlying areas of the country.

Beef Cattle

It is more difficult to get accurate estimates of numbers of beef cattle in China than of other domestic species, partly because of the custom of Chinese agricultural statisticians of lumping cattle numbers into a group they call large animals and partly because of problems of definition, since China really does not have a beef industry as we know it. Instead, over the years, beef has been more of a by-product than a primary one, coming principally from cull dairy stock and from overage draft animals. Paradoxically, even though their numbers are relatively small, beef cattle are the most widely distributed domestic animals in China. There are significant numbers in every province, with the major population centers located in Inner Mongolia and the northeast (Figure 4).[1]

Although there is considerable local variation, all native cattle in China are referred to as yellow cattle, a term that has no precise meaning even as far as coat color is concerned but serves generally to differentiate them from buffalo. Within this very broad definition, Cheng[2] has subclassified cattle according to habitat: the habitat groupings include cattle found in the pastoral grassland areas, such as Inner Mongolia, and those inhabiting the agricultural cultivated areas--mostly in the east and south.

Again, in general terms, the yellow cattle of the north tend to be larger and bigger boned than those in the south, and it was our impression that Mongolian breeds were considerably larger than those found in Guangdong, in the vicinity of Guangzhou, some of which were fine boned, almost deerlike, in appearance (Figure 5). Also, most northern cattle seen were humpless, and many in the south were humped.

There are obvious differences in the feed base for the pastoral and agricultural region cattle. The former depend on locally grown forage for virtually their complete diet, and they graze year round, often under severe and unfavorable feeding conditions. Some hay is put up for winter feeding. It is made from the same native forage--largely grass--that is grazed in the other seasons and is generally handled and stacked loose. We saw only one extensive storage site for baled forage (actually straw), and this was in Heilongjiang and was said to be destined for industrial use in the manufacture of paper.

The pastoral area cattle are actually triple-purpose--draft, milk,

FIGURE 4 Cattle of mixed ancestry in Inner Mongolia.

FIGURE 5 Small, southern native cattle grazing on the roadside in Guang-dong.

and meat. In contrast, the southern cattle are more strictly dual-purpose--draft and meat--since the milk-production function is satisfied by the specialized dairy stock already described. Agricultural by-products, including sugar beet pulp, usually fed either wet or ensiled in the proximity of sugar refineries, figure prominently in the diet of these cattle.

One of the obvious shortcomings in developing a specific beef cattle industry in China is a general lack of feed resources. The government intention to increase numbers of cattle in the grassland or pastoral areas places emphasis on what we would call the cow-calf or cow-yearling type of operation. The range areas in Inner Mongolia that we visited were not critically overgrazed but were described to us by natives of the area as considerably less productive than they had been a couple of decades earlier. Where water could be obtained by drilling or from surface sources, the range area appeared to have great potential as a forage-production site, and there was evidence that the government is taking positive steps toward improving it.

The Grassland Research Institute, on the outskirst of Xilinhaote, Inner Mongolia, is a center for forage improvement located on a tract of some 34 hectares of land representing four local conditions: improved, semi-arid, arid, and desert. In addition, the institute staff maintains active liaison with nearby communes, which permits field testing of some of their plant selections. The basis for their studies was provided by plants selected from the native range, on the basis of yield, nutrient content, winter hardiness, or other desirable traits. Among the plots viewed, there were strains of Chinese wild rye, wild barley grass and wheat grass, which appeared promising, and a wild, yellow-flowered alfalfa, which should prove useful as a nitrogen-accumulating range legume.

The identification and development of range legumes capable of surviving the severe Mongolian winters is a priority item in the institute's program. Fertilization studies have demonstrated that seed treatment with certain trace elements, such as boron and molybdenum, would produce a stand in 1 year that would otherwise take 3 or more years to establish.

Additional grassland studies included identification of poisonous and harmful plants, such as *Oxytropis*, which is small, yellow flowered, and leafy but excessively spiny and dangerous to grazing livestock.

Such plants use scarce water and soil nutrients that might be used by improved forage species and therefore should be removed (Figure 6). A listing of some of the plants studied at the Grassland Research Institute is given in Table 1.

Most of the range cattle that we saw in Inner Mongolia appeared healthy and well fleshed, but it should be remembered that they were at probably the most productive part of the grazing season, in early June. One possible avenue of production improvement is mineral supplementation, especially with phosphorous and probably with some of the trace elements in specific localities. There were some scattered reports of cattle losses from botulism occasioned by the animals' chewing on bones of dead carcasses on the range, and this strongly suggests phosphorus deficiency.

There are also apparently recognized zones of selenium deficiency in China. Selenium deficiency results in calf losses from so-called white muscle disease. When range mineral supplementation was observed, it involved simply provision of rock salt, and the explanation was offered that the animals drink from alkaline ponds and get other needed minerals that way. Supplementation studies with bone meal or dicalcium phosphate and some form of trace-mineralized salt would seem worthwhile.

Another approach to increased beef production is genetic improvement of the animals themselves. There was much less evidence of involvement of imported stock among the beef herds of the grasslands than there had been in the generally high-quality dairy cattle of the agricultural areas. One state breeding farm we visited did have a varied group of breed sires, including Hereford, Angus, Charolais, Limousin, Simmental, and Murray Grey (Figure 7). Neither Hereford nor Angus cattle appeared popular, and the belief was expressed that Hereford were not considered

FIGURE 6 Removal of undesirable range weeds, such as *Oxytropis*, is necessary to increase range carrying capacity.

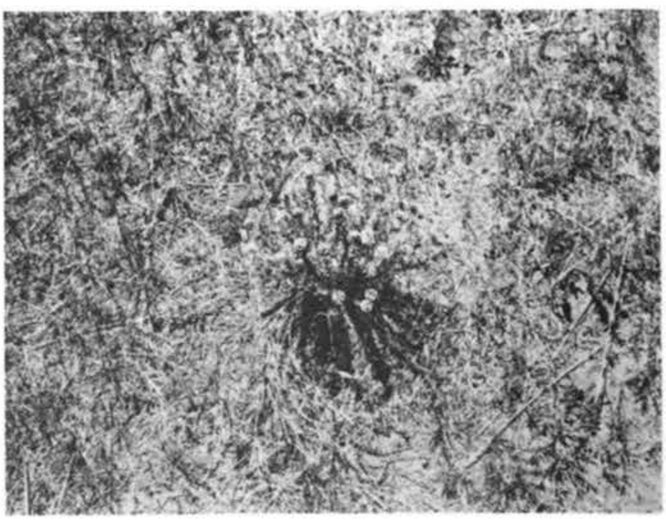

TABLE 1 Names of Grasses and Legumes

Common Name	Scientific Name	Chinese Name
Wheat Grass	*Agropyron*	冰草属
Crested	*desertorum*	沙生冰草
Siberian	*sibiricum*	西伯利亚冰草
Tall	*elongatum*	高長冰草
Wild Rye	*Elymus*	披碱草属
	dahuricus	披碱草
	sibiricus	老芒草
Wheat Grass	*Agropyron chinense* *(Aneurolepidium chinense)*	羊草
	Achnatherum splendens	芨芨草
Bluegrass	*Poa*	早熟禾属
Kentucky	*pratensis*	草地早熟禾
Bromegrass	*Bromus L.*	雀麦草属
Smooth	*inermis*	无芒雀麦
Sweet Clover	*Melilotus*	草木栖属
White	*alba*	白花草木栖
Yellow	*officinalis*	黄花草木栖
Alfalfa, Lucerne	*Medicago*	苜蓿
Purple	*sativa*	紫花苜蓿
Yellow	*falcata*	黄花苜蓿
Loco	*Astragalus*	黄蓍属
Sagebrush	*Artemesia*	蒿属
Fringed sagebrush	*frigida*	冷蒿
Point Vetch	*Oxytropis*	棘豆属

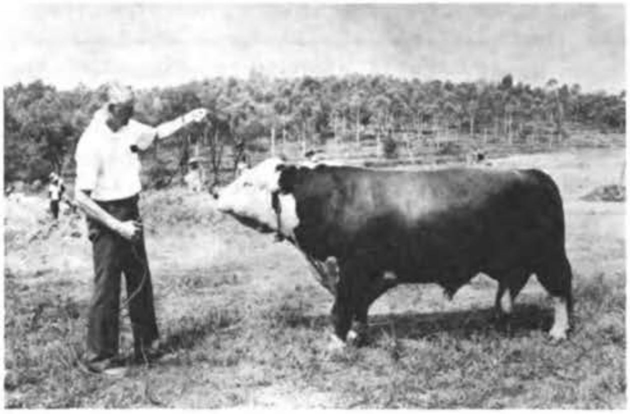

FIGURE 7 Beef sires at a state artificial insemination stud farm.

hardy in the long, cold winters, an opinion that is contrary to experience with this popular breed on the northwestern American ranges.

It would seem that progress could be accelerated by setting some basic selection criteria--reproductive efficiency, hardiness, freedom from defects, and good growth and feed conversion qualities--and then purchasing top sires exhibiting these traits for the state-supported artificial insemination programs. Once obtained, the animals should be managed to enhance their contributions. Most of the animals viewed as artifical insemination studs appeared too fat.

Artificial insemination, although used almost always in dairy operations, is practiced sparingly with beef cattle; its use for production of beef cattle is almost entirely on state farms. Intensification of this technology would be useful in speeding genetic progress in Chinese beef production. Performance record keeping, although quite detailed on individual farms, seems to be only loosely organized nationally. One has the impression that development of performance-testing associations and perhaps breed associations on a national basis would speed improvement of China's cattle herds.

The extent and speed of expansion of the numbers of beef cattle in China will depend largely on government policy. The direction of such expansion, if achieved, will be influenced by the uses the cattle are expected to fill. The indications to our delegation were that meat production, for improvement of the domestic diet, will be given top priority. On the other hand, we heard some suggestions that, in the past at least, beef has not generally been liked by the Chinese, and this leads to speculation that enhanced beef production might also serve as a cash generator on world markets. It will be interesting to see how this issue will be resolved. At any rate, the development of numbers of cattle, both beef and dairy types, appears to offer great production potential to the Chinese.

Buffalo

As with beef cattle, the estimation of buffalo numbers in China was difficult and was likely to include wide margins of error. The FAO, in its *Production Year Book* (1975) set the total of buffalo in China at 29.8 million, whereas Cockrill's recent book, *The Buffaloes of China*,[3] also published by FAO, set the total population of buffalo, country wide, at 29.6 million in 1973. If this figure is accurate, China would be home for about one fifth of the world's total buffalo. With few authoritative data to draw from, we are inclined to extrapolate a current population of between 30 million and 31 million. The buffalo frequent the warmer areas in south-central and southeast China and were abundantly in evidence around Guangzhou.

The native buffalo of China (analogous to the yellow cattle) are generally known as the Shui niu, or Swamp breed. Within this breed there are a number of distinctive types with various local names, but all enjoy a common ancestry. Swamp buffalo are heavy horned, and the horns are characteristically set on almost a horizontal plane with the head, as contrasted with the more upstanding horns of cattle. The hair coat is often sparse, and its color is a slate gray, frequently with two lighter-colored chevrons, one below the jaw and one on the chest above the brisket.[3]

Some attention is being given to improving buffalo by selective breeding, with emphasis placed largely on increasing size. There is no evidence that buffalo will cross with cattle or any other species. Swamp buffalo are used primarily as draft animals and perform a number of agricultural tasks, including plowing, land leveling, harrowing, hauling, and operation of various kinds of machinery (Figure 8). Only after their most productive draft life is past are they finally used for meat. The meat-producing capacity of the buffalo in China has therefore scarcely been tapped.

A distinctly different type of buffalo, not native to China but introduced from India about 1965, is the Murrah, which is useful for milk production. Pure Murrahs are darker in color than the Swamp and have more upward-curving horns. Murrah and Swamp buffalo will cross, and the milk-producing ability of the latter is improved thereby, reaching up to 630 kg per lactation. Buffalo milk is notable mainly for its high fat content--around 10 percent, with 5 percent protein, 4.8 percent lactose, and 0.8 percent ash.

FIGURE 8 Buffalo continue to be used primarily as sources of farm power. Increased mechanization could free them for other purposes.

Since a premium is no longer paid for high-fat milk, the popularity of these milking crosses has declined.

Buffalo breeding, like that of beef cattle, is largely natural but with a growing interest in artificial insemination. Age of puberty for buffalo averages 12-18 months, and earliest calving is at about 21 months. The gestation length is reported variably between 330 and 340 days. The estrus cycle is 21-29 days, and the cows return to heat 90-143 days after calving, or earlier if they are well nourished.

The staple feed for buffalo is rice straw, and an adult will eat 50-60 *jin* (25-30 kg) of straw a day, in three separate feedings. Buffalo crave salt, and rice straw consumption drops off sharply if salt is withheld. The state supplies salt to communes for feeding purposes, and salt is either offered for consumption at will in rock or ground form, or dissolved and sprinkled over the straw. Experimentation is continuing at the South China Agricultural College at Guangzhou on supplementation procedures to improve buffalo performance on the basic straw diet.

Feeding green crop residues and weeds has been shown to increase digestibility of the straw, as has supplementary urea mixed with rice bran or potato starch. In normal farm practice, buffalo are frequently grazed, under control, along road verges and river or canal banks.

When buffalo are slaughtered for meat, the carcasses dress out at about 48 percent edible meat, which is indicative of their general leanness and lack of finish. Buffalo meat tends to be tough and stringy.

Like that for beef cattle, the potential use for water buffalo in China is considerable. Research on selection and crossbreeding among types, already under way, shows great promise. The ability of buffalo to digest fibrous feeds is said to be superior to that of cattle, and it can be improved still more by judicious supplementation, established through feed research. Buffalo should thus fit well into an agricultural scheme favoring the increase of forage-consuming animals and preservation of grain resources for the human diet.

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7

SHEEP AND GOAT PRODUCTION

Warren C. Foote

INTRODUCTION

The goat in present-day China--although found practically everywhere--is largely unrecognized as a provider of food and fiber. But this is not true historically. There is a legend in China that five goats came to the area of Canton in south China carrying stalks of wheat and grain in their mouths and thus sowed the first wheat in what is now a major wheat-producing area. This legend is recognized by statues of such goats in Canton, and the old name for the city of Canton, Yang-Cheng, means goattown in Chinese.

Sheep and goats in China are considered under the single classification of *yang*, which refers to both species. The number of goats in China, 70 million, is the same as that estimated for India and is several times larger than for any other country. China, with an estimated 100 million sheep, ranks third, after the Soviet Union and Australia. These 170 million small ruminants represent the second-largest population of farm mammals in China and are highly important sources of food and wool considering their adaptability, production potential, and utilization of available renewable resources.

The information obtained about sheep and goat production during our delegation's visit to China was sketchy. This report is an attempt to synthesize the information obtained to provide an overall view as well as some detail describing production systems and levels of production. Some useful information was not available. Also, undoubtedly, there are errors because information was incomplete or misunderstood, resulting in incorrect assumptions.

The information that was obtained came from a variety of sources. These included our own personal observations; formal presentations; general or specific discussions, including interviews; and correspondence following our visit. The people providing the information usually had specific information dealing primarily with their own communes, state farms, or research institutes. This made it difficult to obtain an overview of production for China as a country, or even for an individual province.

The only area we visited in which sheep and perhaps goats were considered a major species for production was Inner Mongolia. Information obtained about these species in other areas was most often incidental to that obtained about other species of animals or agricultural enterprises.

The government in China has a great influence on sheep and goat production. Its objective of being self-sufficient in all aspects of production has encouraged a major emphasis on wool production. Selection for sheep capable of producing fine and semifine apparel wool has received additional encouragement as China attempts to increase its foreign exchange and recognizes that woolen goods are significant export items.

The government has set a goal of doubling its per capita consumption of red meat from 8 to 16 kg by 1985. This is to be accomplished through an increase in efficiency of production without an appreciable increase in numbers of animals, except for ruminants in the pastoral regions. China looks to cattle and small ruminants as important sources of increased meat production through the use of range and pasture areas rather than feed that can be used directly as food for man. According to information released by the State Statistical Bureau, the number of sheep and goats increased 5.1 percent from 1977 to 1978, compared with an increase of 3.3 percent of pigs. China allots only 7 percent of its annual production of approximately 300 million tons of grain for use as livestock feed.

Goats are recognized as significant contributors to food and fiber production because of their ability to utilize range areas not suitable for sheep or cattle. Emphasis is also placed on goats for milk production, primarily for family use. Differences in emphasis on improvement of sheep compared with improvement of goats can be seen by the use of artificial insemination, which is a prime tool for genetic improvement. Approximately 60 percent of all ewes are artificially inseminated, including approximately 85 percent of range sheep, in which improved wool production has primarily occurred. There is practically no artificial insemination of goats.

Many of the pastoral regions are included in the autonomous regions of Inner Mongolia, Xinjiang, Ningxia, and Xizang (Tibet). The people in these regions are not Han Chinese and exercise certain aspects of independence, which influences sheep and goat production. We observed this in the management of communes and brigades, particularly in establishing production goals and using products produced for private consumption and in ownership of animals. For example, the average annual per capita consumption of meat for China is estimated at 8 kg, but in the pastoral regions of Inner Mongolia it is 70-100 kg, and these requirements are satisfied as part of the cost of production before the surplus is sold to the state.

We were told that neighboring provinces, such as Shānxi and Shǎnxi, which also have large numbers of small ruminants but are not autonomous regions, do not enjoy these privileges. Also, in Inner Mongolia, households are allowed to own as many as 20 sheep and goats and occasionally even more, in addition to two to three cattle and also horses required for managing livestock (Figure 1). The privately owned animals are grazed without any apparent remuneration to the state. This comparatively high ownership allowance was interrupted by the Cultural Revolution and only recently reestablished.

This arrangement can be compared with private ownership of usually only one to three small ruminants or pigs and a similar number of

FIGURE 1 A pastoral view of extensive sheep production near Xilinhaote in Inner Mongolia. The breed of sheep is the Inner Mongolian Semifine wool.

poultry in the nonpastoral, agricultural communes. Population density, regardless of degree of autonomy, must also play a role in private ownership. No data-based estimates were found for the proportion of sheep and goats privately owned, and estimates by Chinese animal scientists varied considerably, but conservatively over 50 percent of sheep and goats in the rural (nonpastoral) areas and approximately 25 percent in all China are privately owned.

The sheep and goat producers, like all Chinese, are industrious and take great pride in production from their animals. However, it appears that a significant incentive to improve level and efficiency of production is provided through private ownership. The income from private ownership provides a direct means for improving the owners' standard of living.

CLIMATE AND PHYSICAL ENVIRONMENT AND RESOURCES FOR SHEEP AND GOAT PRODUCTION

Eleven percent of the total land area of China is listed as cultivated land. The remaining area is divided into forest (10 percent), pasture (28 percent), and wasteland (51 percent). According to this information, nearly 90 percent of the land is used or available for grazing of livestock. The wasteland, which makes up one half of the total land area, cannot be used in any significant way except by sheep, goats, and camels. The better pastoral regions are grazed by cattle, horses (which are decreasing in importance), and improved genotypes or breeds of sheep. Sheep and goats are used on less productive or accessible areas, and goats and camels on the least productive, desert areas.

Physically, western China is divided into high ranges with plateaus and basins between. The Tarim desert is located in the northwest in Xinjiang, and the Gobi desert and plateau is located farther north and east, extending into Mongolia. The major pastoral areas are located in the north, west, and southwest and include Inner Mongolia, Xinjiang, Ningxia, and Xizang and the provinces of Gansu and Qinghai. These areas receive from 25 to 50 cm (10-20 in.) of precipitation annually, mostly in the summer months. Summers are hot and dry or cool, depending primarily on elevation, and winters are cold except in the south. In areas such as Inner Mongolia the growing season is short.

The Chinese government has undertaken a program to identify and preserve indigenous breeds or genetic types of livestock and evaluate them for their usefulness in production. To date they have identified 67 breeds of sheep and goats that represent adaptation to the major climatic-physical environments in China and the various production traits. These breeds include the Hu or Lake sheep and native goats, which are kept in pens year round in the hot humid areas in Jiangsu and Zhejiang provinces.

Breeds raised in significant numbers include the Mongolian Fat-Tail and the Fine-Wool and Semifine-Wool breeds of Inner Mongolia, the native hair goat and the Kuche and Hotien breeds of sheep in the deserts and semiarid areas of the northwest, and the Tibetan dwarf goats and thin-tailed Tibetan sheep on the high plateaus of Xizang.[1] In addition to meat, many of these breeds also produce a specialty fiber or skin.

The Cultural Revolution seriously interrupted research and the processes of higher education during the period 1966-1976. China is just now recovering from the events of that period. Because of this there are inadequate numbers of properly trained and experienced people to carry out improvement programs with sheep and goats. The scientists in nearly every educational or research institution we visited were familiar with the current literature dealing especially with technology. Almost without exception, they knew about the latest research techniques and were particularly conversant with subjects dealing with endocrinology and physiology of reproduction.

A major part of these scientists' research efforts deal with technique development, such as embryo transfer, semen processing and freezing, and artificial insemination. The Chinese scientists are successful in their work in these areas. Insemination with fresh semen from selected rams has long been used in China as a part of selection programs and has made a major contribution in improvement of wool.

MAJOR PRODUCTS FROM SHEEP AND GOATS

The major products from small ruminants in China are meat, wool, milk, and skins. The Inner Mongolian Fine-Wool, Inner Mongolian Semifine Wool, and the Northeast China Fine-Wool sheep are used for production of apparel wool. Native breeds, such as the Inner Mongolian Fat-Tail, are still used, as they have been for centuries, to produce wool for carpets, which are hand woven.

There is no evidence that a particular breed or type of sheep or goat has been developed specifically for meat. Genetic types of native goat that are particularly well adapted to harsh environments and do not produce other products, such as milk or fiber, serve a primary function as meat producers. All sheep, except those slaughtered for their skins when they are young, are used for meat. The Hu breed of sheep and a small native breed of goat are kept entirely or mostly confined, and the young are sacrificed at 1-3 days of age for skin production. There are no native dairy breeds of sheep or goats, although some breeds of goat have increased milk production. Native goats crossed with exotic dairy breeds are used for milk production, primarily for family use.

PRODUCTION SYSTEMS

Inner Mongolia Autonomous Region

Our greatest opportunity to observe and discuss sheep and goat production directly was in Inner Mongolia. We visited flocks of improved wool breeds of sheep in the vicinity of the capital city of Huhehaote and also in Xilinhaote. The areas we visited were prairie-type ranges containing grasses, brush, and forbs. Improved wool breeds of sheep are kept mainly for wool production, but more attention is now being given to meat production with the increased emphasis placed on production of meat by the government. Meat is the main product from coarse-wool or unimproved-wool sheep. No milk is produced from sheep in Inner Mongolia. Some milk is produced from goats for family use. The main product from goats is meat. A cashmere-type down fiber is produced in Inner Mongolia, where there are approximately 10 million sheep and 6 million goats.

In Inner Mongolia, the sheep and goats are managed all year under range conditions. There is little supplemental feeding. The sheep are managed in flocks of 200-400 to 600-700, depending on the type of sheep. The improved-wool breeds usually receive better care and therefore have smaller flock size than the native breeds, such as the Mongolian Fat-Tail.

Flocks of sheep are assigned to families within the brigades as management units (Figure 2). Sometimes two families care for one or more flocks, more or less working in shifts. A family in Inner Mongolia usually includes parents and children and perhaps grandparents but not other relatives. The assigned families are responsible for the flock or flocks throughout the year. Sheep are usually moved from 50 to 150 km to obtain feed during years when the feed supply is good and as much as 150-200 km during years with poor feed supply. A government policy of assigning confining areas to the communes has reduced the traditional transhumant nature of sheep production (Figure 3).

The ewes are bred artificially with fresh diluted semen from September to December, depending on the feed supply. The ewes are checked for estrus each morning and sometimes again in the evening with aproned rams. Those ewes in heat are retained for insemination. Semen is collected with an artificial vagina, and the semen is processed at the site of insemination in portable field laboratories. The ewes are inseminated in the morning and usually again in the evening.

FIGURE 2 Portion of a flock of privately owned sheep in Inner Mongolia. Animals in this flock apparently owned by several different families and managed together.

FIGURE 3 Houses such as the one in the center of this photo are sometimes used for sheep kept in confinement. This picture was taken in a rural area around Beijing.

Ewes that fail to settle are inseminated for a maximum of three estrous periods. The ewes are often exposed subsequently for natural breeding. The fertility measured as the proportion of ewes lambing was reported at 80-90 percent. Lambing rate varies from 100 to 120 percent, depending on the breed. At lambing time, each ewe with her lamb(s) is placed in a stationary adobe or portable wooden individual pen for 1-3 days. Following this period, these ewes are placed with other ewes with lambs of similar age and returned to pasture. Tails are removed, primarily from the improved-wool breeds. Rams not saved for breeding are castrated.

Both docking and castration are done with rubber bands at about 3 days of age. The lambs are weaned at about 4 months of age. Sheep are sold for slaughter directly from the range, usually when they are 1.5-3.5 years old. A few are marketed at 1 year of age or less. This type of management obviously represents a high maintenance/production ratio cost. The preferred slaughter weight is 30-40 kg, but older animals may be as heavy as 60-70 kg. The animals are probably driven distances of 50-100 km or more to slaughter.

We were told that goats are assigned to families or households within the brigades in flocks of about the same size and are managed similarly to sheep except that they are bred naturally and less care is provided at kidding.

Cattle, sheep, and goats may all be grazed on the same area but not at the same time. Cattle are usually grazed first, and then sheep and goats. Goats and camels utilize the poorest areas but again usually graze separately. These types of grazing, together with other aspects of management, indicate that the animals are carefully controlled; therefore grazing periods and intensities can and may be well regulated.

The sheep are shorn once or twice a year, depending on the type of wool. Native sheep with unimproved wool are shorn twice a year, in June and again in September. The improved-wool breeds are shorn once a year in June. Sheep are shorn both by hand and with powered equipment. In Inner Mongolia, we were told, shearing is done mostly by hand.

Fine wool is classified into four categories or classes. The price for clean wool is established for each by the state. The price for first-class wool is 2.14-2.18 yuan per 0.5 kg and for fourth-class wool is 1.68 yuan per 0.5 kg. The price for Mongolian Fat-Tail wool is approximately 1.59 yuan per 0.5 kg. A classification referred to as super semifine wool has a price of 2.50, which is higher than for first-class fine wool. The wool produced by both the fine- and semifine-wool breeds has good uniformity and grades 62's-64's and 58's-60's, respectively. The staple length is relatively short, but the goal is a length of 7 cm or more.

A ratio of approximately 3:1 in price of wool to meat is usually maintained. We were given prices of 0.70, 0.50, and 0.76 yuan per 0.5 kg, respectively, for sheep, goats, and cattle. Another price quoted for sheep was 0.66 yuan.

The price for meat is based on the estimated carcass yield made from the live animals. These estimates are made by specially trained state personnel, usually without weighing the animal.

The graded wool is baled and sent to textile factories in Xilinhaote. This wool, together with wool imported form Australia, is used to make gabardinelike cloth for export, principally to Hong Kong.

There is little fencing of ranges or pastures, but more is planned for the future. There is some predation by wolves and possibly by a larger-type fox. A smaller-type fox does not prey on livestock. A person killing a wolf is rewarded with two sheep and in addition is allowed to sell the wolf pelt.

Dogs were reported to be involved in management of sheep and goats. We were told that the same dog is used for both herding and guarding. We observed a few dogs, and they appeared to be used primarily as watch dogs around the sheep and living quarters to alert people when other persons or animals are approaching.

In the areas visited by the delegation, the people caring for the sheep live in *yurts* (portable tentlike dwellings), which in most cases appeared quite adequate. The families are with the herders. Only those persons needed to care for the sheep travel with the sheep when they leave the central or main location. Particularly in Inner Mongolia, it seems apparent that those communes working with livestock have all the necessities to make them comfortable under rural conditions.

We visited a brigade approximately 60 km from Xilinhaote, which included 420 km^2 and some additional range in separate areas. The brigade was composed of 106 families consisting of 321 people. The farm contained approximately 7,000 livestock: 420 horses, including

130 females; 320 cattle, including 120 dairy cattle; 3,600 sheep, including 2,300 females; 1,600 goats, including 1,100 females; and 42 camels. They had seven herding groups.

The people producing sheep are vitally concerned with improving production--more in terms of efficiency than increased numbers, although both are part of their plans for increased production. The Animal Science Research Institute of Inner Mongolia in Huhehaote has a major responsibility for increasing production. Its major efforts are to extend the use of superior rams for improving wool production by use of frozen semen and to initiate crossbreeding programs to improve meat production.

We were told that nonreturn rates for five trials in 1977 involving approximately 442 ewes were 55 percent using egg yolk citrate diluent containing 3 percent glucose, 11 percent lactose, and a final glycerol concentration of 3.7 percent. Information received from institute personnel since our visit to China reports on research also conducted in seven other provinces during 1978. The conception rate from Inner Mongolia was 38 percent (42 of 110 ewes inseminated lambed). These results, which come from research programs initiated in about 1974, are comparable with those reported from other parts of the world. Initially the semen was frozen as pellets, but straws are now used.

Conception rate to first service using fresh semen is approximately 70 percent. The Chinese inseminate with 0.05-0.10 ml of diluted semen. The main purpose of artificial insemination has been to facilitate genetic improvement of wool production. However, artificial insemination also avoids the problems of naturally breeding fat-tailed ewes. In their breeding programs, the Chinese recognize the need to retain a genetic complement of the native breed to maintain adaptation.

Scientists at the institute are also doing some research in using pregnant-mare's-serum-gonadotropin (PMSG) to increase the proportion of ewes producing twins. At the beginning they obtained only minimal success. They reported some ewes failing to respond and others producing litters of four to five young. They also measured genotype differences in response. The improved-wool breeds are the most responsive, the native breeds the least responsive, and crossbred ewes intermediate in their response. The source of PMSG is unextracted serum from local mares. The activity was measured by using a mouse uterine response assay.

Research at the institute to increase meat production through crossbreeding is just being initiated. They have two Hampshire rams and one crossbred primarily Suffolk ram. These rams reportedly came from New Zealand and do not represent the quality that is available in the world, especially in the United States. However, use of these rams indicates the access that the Chinese probably have to this type of breeding stock at this time. Additional rams are to be obtained to broaden the base for this genetic improvement program.

Scientists at the Animal Science Research Institute plan to cross these rams with the Wuzhumuqin and Inner Mongolian Fat-Tail. They have made no decision about whether this crossbreeding program would result in development of a new breed specifically for meat production or whether the objectives would best be achieved through some type of permanent crossbreeding program. The scientists also discussed the introduction for crossbreeding of rams from other breeds, such as Southdown and Polled Dorset. It was suggested that a careful analysis of meat-producing potential and adaptation be made before selecting additional breeds for crossbreeding.

Scientists at the institute also plan to use the Hampshire rams for crossing with fine- and semifine-wool breeds for lamb production. This would be done as a terminal cross in which all offspring, including females, would be sold for meat. This would keep the ewe lambs from being used as replacements and therefore would protect the genetic integrity of these two new wool breeds. Of the estimated 10 million sheep in Inner Mongolia, there are 100,000 fine-wool, 2.8 million crossbred (containing some improved wool breeding), 5.0 million Inner Mongolian, and 1.4 million Wuzhumuqin.

Although we saw several flocks of sheep in Inner Mongolia, we saw no flocks of goats. We were told that this is because the goats are kept on poorer ranges greater distances away. A significant number of goats in Inner Mongolia, as well as in other regions, produce down fiber or cashmere. Cashmere production, in at least some cases, has been improved through introduction of the Kashmir breed from India. Some information on cashmere production was obtained for three breeds--Mongolian, Erlangsham, and Aerbasi. The approximate population of each in Inner Mongolia is 4.9 million, 0.90 million, and 0.16 million, respectively. A total population of 6.0 million goats is estimated for Inner Mongolia.

The Inner Mongolian people in the commune we visited were concerned about the management of their ranges. Extreme weather conditions in 1977 had reduced the number of livestock, and the number had not been reestablished. An improvement in the range plant production had been recognized. Some members of the commune believe that the present stocking rate should be maintained, with increases being made only as increased feed production is achieved. Other methods for achieving increases in range feed production include improving the stocking rate and grazing system and fertilization with or without reseeding.

The Grassland Research Institute at Xilinhaote is conducting research on species of plants and their management for range improvement. Some areas are cultivated primarily for feed production. However, lack of moisture and the short growing season limit the usefulness of the grasslands, and restrictions on cultivation are being imposed. Geological surveys indicate that groundwater is available at depths ranging from 8 to 100 m in the areas that we visited. The use of water from this source, although probably not feasible for irrigation, could facilitate range management practices by providing increased sources and supplies to supplement the surface water and scattered shallow wells now used for stock watering. Planned spacing and location of wells for stock watering could greatly increase control of range utilization. Windmills are not being used to pump water in Inner Mongolia but seem a logical alternative to the hand- or animal-powered methods currently being used.

Northeast China

We were not able to visit any sheep- or goat-production units in this part of China. The information obtained came from scientists and producers we visited with during seminars and related discussions sponsored by the Heilongjiang Provincial Research Institute of Animal Science.

A major effort in sheep production in northeast China is to develop wool breeds. This has resulted in a new breed, the Northeast China Fine-Wool, developed from fine-wool sheep from Inner Mongolia and fine-wool breeds from the Soviet Union. These wool breeds or types were crossed with the native northeast China sheep. This is a thin-tailed sheep, which is a mixture from earlier crossing with native breeds, including the Mongolian Fat-Tail. The Northeast China Fine-Wool breed has been quite well established, and apparently the wool is finer and the fleece weight is heavier than those of the Inner Mongolian Fine-Wool breed. We were given estimates of fleece weights as high as 13.4 kg for rams and averages of 6.0 kg for ewes.

Breeding programs are now under way to develop a semifine- or medium-fine-wool breed. This is being accomplished by crossing the native sheep with the Corriedale, imported from Australia and New Zealand in 1967-1968. The goal is to develop a breed or type with 56-58 counts and 10-12 cm staple. First-grade wool sheep must produce a fleece that grades 56-58 and exceeds 10 cm in length. Approximately 40 percent of the offspring from their flocks meet these criteria.

The management of the range flocks in northeast China is similar to that described for Inner Mongolia. Physiological saline is commonly used to dilute semen in Inner Mongolia; whole milk is commonly used in Heilongjiang. The breeding season in the northeast is during September and October, at which time an effort is made to increase the level of feed for both the ewes and the rams to prepare them for breeding. Practically all the ewes are artificially inseminated and are bred to lamb first at 2 years of age. The lambing rate (based on ewes lambing) is 110-130 percent. The lambs are placed in close confinement with their mothers at birth and kept there for 1-3 days before being placed with other ewes and lambs. Weaning is at 3-4 months of age.

Apparently a higher proportion of lambs is docked in Heilongjiang than in Inner Mongolia. Sheep are sold for meat at 1.5-3.5 years of age. This is done in the fall, following summer grazing without harvested feed. The price received is 0.70 yuan per 0.5 kg of estimated carcass weight. This is comparable with the price received in Inner Mongolia. The price received for first-class semifine wool is 2.15 to 2.25 yuan per 0.5 kg. Animals from the improved-wool breeds or genetic types are shorn annually by using both hand and power shears.

There are only a few goats in northeast China, and these are kept mostly in groups of one to three by households to provide milk and meat. The few goats we observed were tethered or herded along the roadsides and edges of the fields and appeared to be typical of other goats observed in China kept under similar conditions. They appeared to be Saanen or Alpine crossed with the native goats.

INTENSIVE HOUSEHOLD PRODUCTION

We found no evidence of intensive sheep or goat production by state farms or communes, with the exception of a few goat dairies and one flock of approximately 40 Hu sheep. Apparently there is no growing/finishing of small ruminants of any consequence under intensive systems by communes or state farms, but only under private ownership.

It is estimated that more than 50 percent of the sheep and goats in nonpastoral China are privately owned. Only a few animals are allowed per household, and these animals are usually kept in some type of confinement--in small pens or tethered or herded along the sides of the roads and edges of the fields. The majority of the privately owned goats are kept for milk and meat. Varying degrees of dairy goat breeding are privately practiced. These dairy goats are concentrated in the agricultural communes around the larger cities, such as Shanghai, Beijing, Guangzhou, and Harbin, where much of the rural population lives (Figures 4 and 5).

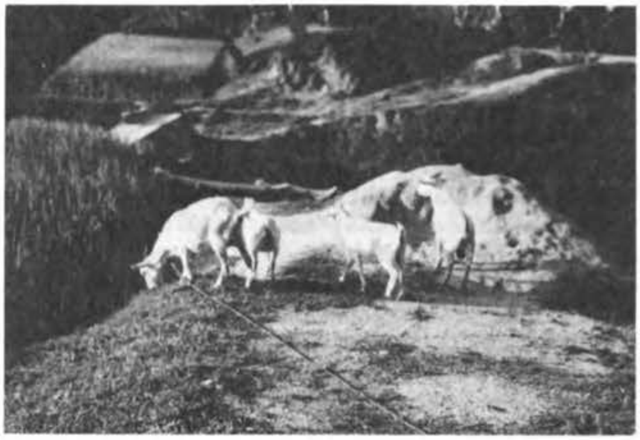
Privately owned goats are also raised for skin production from the young. The names of these breeds were not obtained, except for the Chung Wei breed, which is located primarily in Ningxia and Gansu provinces and sometimes in Inner Mongolia. The skins of these animals are taken when they are approximately 1 month of age. The young from a breed of goat located in Jiangsu Province are slaughtered for both meat and skins at 7-8 months of age.

Another type of goat used for production of skins is also located in the Jiangsu. These animals are small, with mature females weighing approximately 20 kg. They are generally white or black, with a grayish, off-white color preferred. The skins are taken at 2-3 days of age. Goats of this breed are usually kept in pens, and the manure is sold to communes. They usually kid once a year because of the imposed management, but some kid both fall and spring and produce 2 or 3 young per parturition. They have some potential to breed throughout the year. They are early maturing, and the males are bred as kids and then slaughtered, presumably to conserve feed. Mature males are seldom seen.

There are at least two breeds of sheep that are managed primarily for skin production. One of these, the Tan sheep, was described to us in Inner Mongolia but is mainly located in Ningxia and Gansu. These animals are slaughtered at 1 month of age or younger for skin production.

FIGURE 4 A small herd of privately owned goats being herded near Shanghai. These goats are of mixed breeding and are generally used for milk and meat.

FIGURE 5 Goats are often tethered for grazing as shown in this picture taken near Shanghai. It is of a doe and three kids of the Southeast China breed.



The second breed of sheep in which the skin is an important product is the Hu (also called the Wusin or Lake sheep), which was developed from the Mongolian Fat-Tailed breed centuries ago. This breed also is well known for its prolificacy. These animals are kept in pens year round and are hand fed. They are located mainly in the Jiangsu and Zhejiang provinces. Their level of prolificacy is from 2.2 to 2.4, with reports of litters of as high as eight kids.

The Hu breed also is reported to lamb regularly twice a year if managed properly. The skins are taken from birth to 2-3 days of age. We observed a flock of approximately 40 Hu sheep on the Malu commune near Shanghai. Management of the Hu sheep is related to silkworm production. Their manure is harvested as fertilizer for mulberry trees, which are grown as feed for silkworm larvae. In turn, excess mulberry leaves are used as feed for the sheep. An interesting aspect of adaptation of this breed is its capability to produce in total confinement in warm, humid, and often dark quarters. Hu sheep are also useful for meat and wool production. The wool is used for making carpets.

There is another highly prolific breed of sheep, the Han, located mainly in Henan, Shandung, and Hebei provinces.

The Southeast China goat is used for meat (Figure 5). It is small with disproportionately short legs. It is white or black in color. We observed a few of these goats in a commune near Canton; there was a total of approximately 20 animals, all privately owned.

We obtained information on only one goat dairy. It was a part of the Guangzhou Dairy Farm, a state farm belonging to the municipal government of Guangzhou. The goat dairy was managed in connection with a 1,000-cow dairy. There are 400-500 dairy goats; approximately 300 are milked at any one time. The goats are milked for 9 months; average milk production is 500 kg per goat. The highest production is approximately 800 kg per lactation.

The goats in this dairy originated more than 20 years ago when Indian dairy goats, Jamunapari or Beetal, were crossed with the South China native goats. More than 10 years ago (before the Cultural Revolution), a new breeding program was started using the Saanen goat. These dairy goats are now primarily Saanen. They tend to breed throughout the year, and at least some of them are artificially inseminated. Frozen semen has been used experimentally but with poor success to date. There are purebred flocks of Saanen and other dairy goats in Shǎnxi Province.

BREEDS OF SHEEP AND GOATS INTRODUCED INTO CHINA

Breeds of small ruminants introduced into China can generally be placed into three categories: breeds of goats to increase milk production, breeds of goats to increase fiber production, and breeds of sheep to increase wool production.

Direct information on the dates of importation or numbers of dairy goats imported were not obtained. Dairy goats from India, probably both the Beetal and Jamunapari breeds, were imported at least 20 years ago and served as a foundation for increasing milk production in Jiangsu Province. Saanen goats were also introduced later (but before the Cultural Revolution) into the same area and also into the Shaansi Province. Small flocks of purebred Saanens are maintained in this area. A significant proportion of the goats in the nonpastoral regions of China has dairy breeding derived from crosses with these exotic breeds and also with the Alpine and possibly the Toggenburg.

We were told that some Angora goats have been imported into China to improve fiber production, but we found no specific information and saw no goats to confirm this. We were also told of plans to import Angora goats from Angola for additional development of mohair production. Presumably Angora-type goats are kept in Xinjiang and/or parts of Xizang. Kashmir goats were reportedly imported from India into China and crossed with native goats in Inner Mongolia, Xinjiang, and Xizang. Their influence is seen in the down- or cashmere-producing goats.

Several different breeds of sheep have been imported to improve wool production through development of medium- to fine-wool breeds. Such breeds have been developed in Xinjiang, Inner Mongolia, and Heilongjiang. A major contribution came from breeds imported from the Soviet Union beginning in the early 1950's. These include the Caucasian Merino, the Stavropol Merino, the Askania Merino, and the Tsigai. Merinos have also been imported from Australia.

Corriedales and Lincolns were imported from New Zealand and Australia in 1967-1968 and are being used to develop the Northeast Medium-Fine-Wool breed. The Romney Marsh and the Corriedale were also imported during the same period into Jiangsu from New Zealand and Australia and are being crossed with the Hu sheep for increased wool production.

In addition, a small number of meat-type rams (primarily Hampshire) have been imported, presumably from New Zealand, for use in Inner Mongolia for improving meat production.

It is of interest to note that, while visiting in the Soviet Union in 1975 as a member of a U.S. sheep delegation, I found records showing that sheep of the Rambouillet breed were imported into the Soviet Union in the late 1920's and early 1930's from the southwestern and western United States and were used in developing several of the Soviet wool breeds used to develop wool breeds in China. At least indirectly, the sheep industry in the United States has contributed to the development of the sheep industry in China.

PRODUCTION CONSTRAINTS AND POTENTIALS

Sheep and goats in China, as in many parts of the world, represent a significant resource in producing food and fiber from renewable natural resources, such as range and pasture land, that are largely unutilizable by other means. The viability of these two species is indicated by a 5.1 percent increase in their numbers from 1977 to 1978. This is the largest increase of any of the farm mammals in China.

Many of the range areas used by sheep, and especially by goats, are classified as wasteland. There is little possibility of significantly increasing the productivity of these areas in terms of feed produced. However, the efficiency of utilization of the feed produced on these and all range areas could be greatly increased if the animals were managed to increase the ratio of production to maintenance. Under current management conditions on the rangelands of China, and in many other countries of the world, animals are kept on the range until they are marketed. In China this is usually from 1.5 to 3.5 years. Much less feed would be required for maintenance if the growing/finishing period were reduced and the animals marketed at earlier ages. However, this would require greater use of concentrate or other harvested feed, which is one of the greatest constraints on improved livestock production in China.

It appeared to us that the productivity of much of the range or pasture land that we visited in Inner Mongolia could be increased through such practices as reseeding and fertilization. The development of additional water sources through wells could also improve feed utilization from these areas.

There is a great potential for genetic improvement of sheep and goats in China. The native sheep and goats are especially well adapted to the varied environments and management systems in which they are placed. Their present levels of production are low in most cases. Genetic improvement, in terms of both crossbreeding with subsequent selection programs and the use of vigorous selection within existing genotypes without crossbreeding, could greatly increase the producing ability of sheep and goats under existing as well as improved conditions.

Genetic improvement of production has been developed in only two areas--improved wool production in sheep and milk production in goats. These two areas have not been fully exploited. For example, less than 25 percent of the total number of sheep in China have been bred for improved wool production. A relatively high proportion of the goats in China are milked, but not much has been done to improve their dairy breeding potential.

Capabilities exist for greatly increased reproductive performance, such as reduced age at first lambing, higher prolificacy, and shortened lambing intervals; for increased level and efficiency of production of products; and for adaptation to required environments and production systems. Plans to improve production genetically include continued work with wool and meat production in sheep. In some parts of China, efforts are being made to improve dairy goat production. Programs are being developed to measure reproduction and production capabilities of the native breeds of genetic types and to preserve them. Flocks of some imported breeds of sheep and goats are also being maintained.

Chinese animal scientists have shown great ability to adapt procedures and methods to increase production. This is illustrated particularly in their use of artificial insemination to bring about genetic improvement in wool production.

Scientists in China must give careful consideration to research dealing with fundamental questions about genetics, physiology, nutrition, and animal health and management that will provide applied technology for improving sheep and goat production.

China plans to increase the standard of living of all its people and also to strengthen its foreign exchange. Both of these goals require increased food and fiber production. Wool is an especially important item in terms of foreign exchange. China is expecting a significant proportion of this increased production to come from improved efficiency of sheep and goats under range conditions. Grazing animals, particularly small ruminants, and most of the land areas on which they graze represent major undeveloped resources for food and fiber production in China.

SUMMARY

China, with its estimated 70 million goats and 100 million sheep, has the largest number of small ruminants of any country in the world. An estimated 25 percent of them are owned and managed in very small flocks by families. The major range areas are in the north, west, and southwest. The major products are meat from all sheep and goats, fiber (wool, cashmere, and mohair) produced primarily in the pastoral regions, milk produced from privately owned goats for household use, and skins produced from sheep and goats at all ages when animals are slaughtered but particularly as specialty products from birth to 7 or 8 months.

Government plans to double per capita meat consumption by 1985 (from 8 to 16 kg) emphasize increases from sheep and goats as well as cattle in the pastoral areas. In pastoral areas, families of herders closely manage the small ruminants, managing the artificial insemination procedure and giving individual attention to sheep and goats beginning at parturition. Young are weaned at 3-4 months of age, and the animals are slaughtered at 1.5-3.5 years of age directly from the range.

Approximately 60 percent of all sheep and 85 percent of those under pastoral conditions are artificially inseminated, compared with practically none of the goats.

Intensive production is practiced only under private ownership, in which flock size is extremely small (generally one to three animals). These include goats for milk and goats and sheep for meat, fiber (almost entirely from sheep), and skins.

Small ruminants have been imported for improvement of milk production and cashmere and mohair production in goats and for apparel wool production in sheep.

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8

THE USE OF HORSES IN CHINA

Neal L. First

ORIGIN AND HISTORY

Horses have played a prominent role in shaping the history of China. One of the two ancestors of domesticated horses, the Przewolski horse, originated in the vicinity of the Gobi Desert.[1] This horse, the Tarpin of Turkestan, and their cross were the ancestors of most domesticated horses.[1] A few wild Przewolski horses still exist in the Gobi Desert, and a large number of crossbred cart horses still have the heavy head, prominent nose, and short ear of the Przewolski. Brood mares with this appearance were seen also in Inner Mongolia.

Mongolian saddle ponies appear to have the smaller, slimmer heads and thinner necks characteristic of the original Tarpin. Indeed, there is evidence that the original Mongolian pony came from the Turkestan area and through Russia.[1] It is likely, therefore, that they are of Western and Tarpin origin. Present-day Mongolian ponies are undoubtedly a mixture of Przewolski and Tarpin (Figure 1). According to Linton,[2] these Western domesticated horses were introduced through Russia into northeast China slightly after 2000 B.C. during the period of the Neolithic culture.

Since that time, most of the invasions of China and subsequent rule by people of Mongolian or Manchurian origin have been successful because the horses moved archers swiftly or moved supplies and war chariots to battle. These mounted invasions started with Mongolian invaders and establishment of the Shang dynasty in 1523 B.C. and ended with the Qing dynasty in 1912. Whereas the saddle horses of the past were primarily fleet-footed Mongolian ponies, the chariot and cart horses were the large-headed Przewolski. These also were used first by the Shang rulers.[3]

Throughout history, a large number of Western breeds of horse have been introduced into China and crossed with the Mongolian breed or other native horses. Both saddle- and draft-type horses have been introduced; however, the appearance of most cart horses is that of a light horse rather than heavy draft type.

FIGURE 1 Present-day Mongolian ponies, which are a mixture of Przewolski and Tarpin.

NUMBER OF HORSES IN CHINA

In all China, there are approximately 12 million horses, 3 million mules, and 12 million donkeys. The donkeys are located mostly in south and south-central China. The greatest number of horses is in Inner Mongolia and Heilongjiang provinces, with approximately 1 million in Inner Mongolia and 1.5 million in Heilongjiang. The adjacent autonomous regions of Xinjiang and Ningxia are principal breeding areas of horses to be used as cart horses in other provinces.

HOW HORSES ARE USED IN CHINA

The horses of China today have one principal use--that of being draft animals. In northern, central, and western China, the main short-distance transportation of goods is by horse cart. In northern China and part of central China where cereal grains are predominant crops, the horse is also the principal power for tilling soil. In south and south-central China, the horse has been replaced in the fields by water buffalo. It has been replaced on the road by mechanized vehicles (Figure 2) or oxen and in the mountains by donkeys.

In the pastoral areas, such as Inner Mongolia, horses are used for riding in herding livestock and for travel. There they are also used for milk, sports, and sometimes meat. A Mongolian mare will produce about 200 kg of milk and nurse a foal in a 3-month lactation.[4] This milk is often fermented to make a drink called koumiss.

Inner Mongolia, with 7.5 percent of the horses in China, uses horsepower almost exclusively for hauling and for field work in the agricultural areas. Here, and throughout China, the usual harness and hitching for hauling is a single wheel horse between the shafts of a cart. This horse is usually guided by reins. The harness is light with wooden hames over a light collar pad (Figure 3). The tugs pull directly from a 2-point hitch on the harness, thereby pulling from the middle of the shoulder. This wheel horse supports huge loads of 1 to 2 tons on a two-wheeled cart.

The pulling power of the wheel horse is usually supplemented by either a tandem lead horse hitched to the cart by a pair of long ropes and usually without reins or by two lead horses hitched only by ropes to the cart. These extra horses are often without full bridle or bit. The shaft horse is often controlled by a light leather noseband attached to reins. With heavy loads, the driver usually walks beside the horse using a short rein. The shafts are supported by straps from a padded backpad looking something like a pack saddle.

In central and northern China, the extra horses are often mules or donkeys, and in more southern provinces, small single donkey carts are found in use for short-distance hauling (Figure 4).

THE HORSES ARE SHOD

Cart horses are usually shod, and blacksmith stations are common throughout the agricultural areas of China where horses are in heavy use. These stations are easily identified by the presence of two upright poles and a cross pole used to restrain the horse and to tie up the foot being trimmed or shod, as shown in Figure 5.

HORSE-BREEDING AND HUSBANDRY IN INNER MONGOLIA

Most of the cart horses are without recorded ancestry and are the result of crossbreeding or are crosses of parents who are of mixed ancestry. The breeds of horse in China have been well described by

FIGURE 2 A typical mechanized vehicle prevalent on Chinese rural roads.

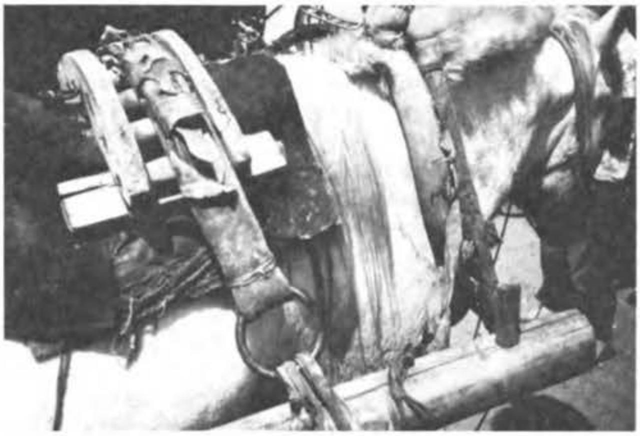

FIGURE 3 A typical harness.

FIGURE 4 Small single donkey cart used for short-distance hauling.

FIGURE 5 A blacksmith station.

Epstein,[5] Ensminger and Ensminger,[4] and by Cheng in this publication (Chapter 2). The ancestry of the present-day cart horses is part Mongolian pony with considerable Przewolski appearance and a part from various larger breeds. The present breeding effort is to increase the size of native horses by crossing them with larger breeds or with larger horses selected from existing stocks.

The objectives of breeding stations that we visited in Inner Mongolia are similar to those in the other horse-producing provinces. In Inner Mongolia, large bands of mares (Figure 6) are maintained on state farms for the production of stallions to be used by communes. These breeding grounds are in the pastoral areas, where nearly 100 percent of the state farms use artificial insemination to mate a selected large-type stallion to 100 or more mares per year.

In Inner Mongolia, the stallion is most commonly of the Russian Kobajinski or Danski breed. These nearly purebred stallions are produced in China. The mares are a cross of a native Mongolian pony or Przewolski type with one of the Russian horses. Mares developed after four or five generations of upgrading to the large-type horses are

FIGURE 6 Mongolian mares.

primarily of the large type, with little evidence of ancestry from the Mongolian pony.

Most mares on state farms are of the large types. The stallions produced are culled and gelded to become cart horses, or the best are distributed to communes to upgrade their mares. The mares belonging to brigades of communes show more Mongolian pony or Przewolski ancestry. The offspring from these mares are primarily distributed to be used as cart horses. These are usually unbroken to cart or saddle, as are the brood mares. In fact, I saw numerous Mongolian ponies under saddle but never any of the large thoroughbred-type horses. At the brigade level, there are still many Mongolian pony mares being bred to pure Mongolian stallions to maintain this breed for saddle stock.

In general, as one moves from east to west in Inner Mongolia, or toward the desert, the rain is less, grass is poorer, and horses are smaller. In some areas, the upgrading of local Mongolian- or Przewolski-type horses to large-type stallions has resulted in distinct breeds. Some of the more common are the Sanho horse of northeast Inner Mongolia and Heilongjiang provinces, the Sanpeitze from Xilinhaote, Inner Mongolia, and the Ili horse of Xinjiang. The Sanho, Sanpeitze, Hailer, and Ili were developed by crossing Mongolian ponies with thoroughbred or Arabian-type saddle horses from the Soviet Union. These were breeds such as the Kobajinski, Danski, Baltic Ardennes Orlov, and Anglo-Arab stallions. The Wuzhumuqin resembles the wild Przewolski, but it has been selected for size. It is not reported to result from crosses with other breeds.

The bands of brood mares are cared for by Mongolian horsemen living in *yurts* (Figure 7). In Mongolia, the lowest level of collective organization is the brigade. Often a family is devoted to caring for a band of mares. There have been attempts to settle the people in permanent homes during the winter, but the ever-changing need to graze new grasslands dictates a nomadic or seminomadic existence.

The Mongolian horsemen are a proud, rugged people with an erect posture in the saddle. Much of this saddle posture is the result of a small saddle hung well forward on the horse such that the rider stands in the stirrups when riding (Figure 8).

FIGURE 7 A *yurt*, or portable home made of felt, for the Mongolian horsemen.

FIGURE 8 Mongolian horsemen.

The Mongolian ponies at work carry their noses out and are not trained to move with a collected gait. They neck-rein and turn in response to leg pressure. They have three gaits: a walk, which is seldom used; a fast run or sometimes a pace; and a full-speed gallop. They are trained to stop when the rider sits down and to move out when the rider stands in the stirrups, taking weight off the seat.

Mongolian ponies are fast, quick, and of strong endurance. Three riders can easily contain and drive a herd of cattle or band of mares. The Mongolian horseman uses a loop on the end of a long pole to catch horses or cattle. Because the rider holds the pole and has no saddle horn to dolly a rope around, the mount must stay with the restrained beast until it is turned and stopped. This requires considerable coordination of rider and horse (Figure 9). The saddle has a wooden tree that elevates the seat high off the horse, a short seat, bars without horn, and a high cantle. The horse is protected from the saddle by a sheepskin or sometimes a blanket, and the seat of the saddle is often made more comfortable by a short, thick blanket that lies across it. The fenders are separate from the stirrups and are of various sizes

FIGURE 9 Mongolian horseman with long pole used to catch horses and cattle.

and shapes. The stirrups are made of iron, and the stirrup leathers are usually rawhide strips tied and cut to the length appropriate for the rider.

A Mongolian horseman is proud of his horse, and usually no one else rides it. Hobbles and a bedroll are common accessories.

REPRODUCTION OF HORSES IN INNER MONGOLIA

Whereas the breeding of mares on state farms is accomplished almost entirely by artificial insemination, most mares in communes are bred by natural service. About 20 percent of the mares in Inner Mongolia are artificially inseminated. The usual breeding system is to allow a stallion to select and protect a band of 20 to 30 mares. The band size is regulated by the stallion, who rejects daughters from the band and seeks replacements from other bands. Often as many as 8 or 10 bands are run together on one range as one herd.

The conception rate is high under these conditions, and Inner Mongolia averages about 80 foals per 100 mares per year, with some herds averaging as high as 90 to 95 foals. Mares are seasonal in the horse-breeding provinces of China where the breeding season is late May, June, July, and early August. There are few reproductive disease problems. The most common is uterine metritis. About 10 percent of the mares do not have estrus cycles and are barren. These are mostly old mares and are eventually culled if they continue not to foal.

Young stock and barren mares are culled from each band once a year. The level of culling depends on the need for cart horses and on the rains and available grass supply.

FOOD FOR HORSES

Mongolian horses normally exist on grass alone. In the winter they are herded to winter pastures that were not grazed in the summer because drinking water was not available; the heavy snows of winter provide water, and the tall growth of ungrazed pastures provides nutrition. Even so, winters are severe in Mongolia, and horses become thin by spring. The husbandry of livestock in Mongolia is dependent on the weather. Heavy loss of animals has occurred in years of drought or extreme snow depth. The provincial and national animal husbandry agencies are strongly urging the Mongolians to store forage and grains for supplemental winter feed, but this is a departure from tradition.

Cart horses are usually fed at least three times a day. They are usually rested and fed at midday. The diet is finely chopped forage, usually millet straw, and a grain mixture consisting of various combinations of grain sorghum, corn, oats, barley, and soybean meal. In spite of this reported apparently adequate diet, many cart horses seen were thin.

DISEASES AND PARASITES

The most serious health problem seems to be inadequate nutrition in years of drought or heavy snow and extreme cold.

The most common internal parasites are strongyles and bots. Horses in the pastoral area have few problems with infectious disease. Cart horses, however, are in closer communication with strange horses and have good opportunity to spread infections. Glanders disease and the noninfectious disease colic are common in these horses.

DISPOSAL AND FUTURE OF HORSES IN CHINA

Traditionally, the surplus horses of Inner Mongolia were brought to the Great Wall and sold to buyers of cart horses from villages and cities within the Wall. Much of the trading occurred during the festival called Nodom. Today the horses are not delivered to the Great Wall, but they are exhibited and sold at Nodom festivals throughout Inner Mongolia. The buyers usually represent agricultural communes, although some private sale is said to occur. The value of a horse is said to be declining because of increased use of mechanical transportation.

In fact, the question we were most often asked was "What use can we make of the horses produced in Mongolia after the period of mechanization is complete?" Our answer was to suggest that reduction in their numbers might permit increased production of food-producing animals or that the horses may become a food-producing animal. The latter expedient would not be an efficient use of land because horses are less efficient in converting grass to meat than are cattle or sheep, and the meat of cattle and sheep is more widely accepted in China as human food.

Most Chinese agricultural scientists with whom we spoke held that mechanization would never completely replace the horse because horses, oxen, and water buffalo do not get stuck in mud as tractors do and they do not remain out of use for long periods because needed spare parts or fuel are not available. All these arguments and more were also present when the United States and Europe underwent a mechanical revolution. This revolution is slower in China, but the change is occurring. As sad as it may seem, one day the Mongolian cowboy may be restricted to herding primarily cattle and sheep, and that maybe with a Jeep or a motor scooter.

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9

UTILIZATION OF ANIMAL PRODUCTS

Robert W. Bray

CONSUMPTION

Protein from animal products is recognized as a valuable constituent of the human diet in China. This recognition is evident in the plan to double the production of red meat by 1985. The average annual per capita consumption in 1979 was about 8 kg. Poultry and fish consumption figures were not available; however, it was estimated that the consumption of each may be as much as 3.0 kg per person.

Of the 8 kg of red meat consumed, 7 kg are pork and the remainder is beef, mutton, and goat meat. In addition, meat is also derived from horses and buffalo no longer useful for draft purposes. Although rabbits are raised and slaughtered in large numbers in Shanghai, most of the rabbit meat is exported. In some provinces, such as Sichuan, rabbits are raised for domestic consumption. Likewise, most of the Beijing ducks are either consumed in restaurants and hotels or exported.

Meat consumption varies widely throughout China and is strongly associated with the nature of the feed production and the quantity of livestock produced or available for meat purposes. It is estimated that people in Inner Mongolia consume between 70 and 100 kg of meat per person annually, about 10 times the national average. The principal meats consumed are beef and mutton since the kinds of meat produced are dictated by the presence of vast grazing areas in the autonomous region. We concluded that the limited transportation system, the short growing season, and the lack of adequate food storage facilities necessitate the use of large quantities of meat during the fall and winter.

On the other hand, rationing of meat varies by location from 0.5 kg to more than 9 kg per month; at certain times there is no rationing at all. We estimated that in the Guangzhou area the per capita consumption is about 70 percent pork, 10 percent poultry, and 20 percent fish and totals 15 kg per person per year.

Dairy products, including fluid milk and processed dairy products, are important in the diets of people in the pastoral areas. Dual-purpose cattle serve for both milk and meat, but milk is used only for local consumption. Throughout the densely populated areas of China, consumption of milk is largely limited to use by children and sale to foreigners. Statistics are not available on milk consumption. The present total production of milk is not sufficient for the total fresh milk need and obviously not for the manufacture of milk products.

SLAUGHTERING FACILITIES

Although a request was made at each stop in China to visit slaughtering and meat-processing plants, we were restricted to a visit to one small regional hog-slaughtering facility near Guangzhou, a rabbit-slaughtering and -processing facility in Shanghai, and a freezer storage area in a packing plant in Huhehaote. Slaughtering facilities vary in size and are found at regional, county, and municipal levels. At a packing plant in Guangzhou, about 3,000 head of hogs are slaughtered per day, but our visit was to the Huashan commune hog slaughtering facility, at which about 40 hogs are slaughtered per day. Large slaughtering facilities are located in Shanghai but were not included on our itinerary. Therefore our evaluation of slaughtering and meat-processing facilities is limited.

HOG-SLAUGHTERING AND CARCASS EVALUATION

The Huashan commune pork-slaughtering and -processing facility is located in a commune but is state owned. This facility supplies the meat for 75,000 people in the commune. Although its primary purpose is to produce fresh pork for this area, it also serves as a collection point for excess hogs to be transported to a major slaughtering plant in Guangzhou. Slaughtering begins at 3:00 a.m. and is completed by 6:00 a.m. 7 days a week, and the fresh meat is then transported to markets for immediate sale. Since there is no refrigeration in the facility and no or limited refrigeration in the markets, the meat must be consumed the same day it is produced.

Although space and antiquated equipment for sausage production are available, little meat is processed for sausage. The little that is processed is processed during the winter months because of the more desirable natural temperature and because processed meats are popular at this time, when the Chinese New Year celebrations take place. The sausage, in addition to seasonings, includes pork, soybean flour, rice wine, sugar, and salt and characteristically is coarsely ground and placed in casings. It is then either placed in a hot chamber at 60°C or dried in the sun.

We were impressed with the general cleanliness of the plant (although the equipment, such as cutting table surfaces, would not meet our inspection standards), the skills of the workmen, and the meat inspection. A veterinarian was present and was observed to be thorough in the post-mortem inspection. It was understood that all the slaughtering facilities in China have veterinarians and lay inspectors present for ante- and post-mortem inspection--much like the system in the United States.

Dressing percentage figures for swine vary widely in China because of the variation in what is considered carcass weight. Percentages vary from 70 to 73 percent (with a few reported as low as 60 percent) to 89 to 90 percent. In the first figure, the hogs are dressed head off and leaf fat removed; in the latter case, the carcass weight includes everything except blood, hair, and intestinal content. In view of the fact that swine diets consist of large amounts of fibrous materials, and because swine have a relatively low slaughter weight (average 75 kg), the dressing percentages are probably lower than for hogs in the United States.

Although there is a grading system available for pork carcasses, grades are not reflected in the meats sold at retail, much the same as in the United States. Carcass weight and fatback thickness are the major criteria used in grading, and the heavier and fatter hogs are graded the highest. The grades are designated as Prime or Deluxe 1, 2, and 3. Prime grades have a minimum backfat thickness of 3 cm, No. 1 grade between 2.5 and 3 cm, No. 2 grade between 2 and 2.5 cm, and No. 3 less than 2 cm. The grading is done by personnel in the slaughtering facility, which reportedly was of some concern to the farmers.

In a large retail meat market in Harbin, the individual in charge pointed out carcasses representing each of the grades but indicated that most of the meat sold is from carcasses grading No. 1 and No. 2. Animal scientists at the seminar in Peking indicated that 28 percent of the carcasses grade Prime, with 70-72 percent grading No. 1 and very few grading No. 2 or No. 3 (Figure 1).

RESEARCH ON PORK CARCASS EVALUATION

Meat animal carcass evaluation is essentially nonexistent. To our knowledge, no one has specialized in carcass evaluation or meat research,

FIGURE 1 Pork carcasses.

simply because it seems that the first task is to produce more meat. Some of the animal scientists engaged in swine-breeding research are collecting data on carcass traits and expressed an interest in U.S. research on characteristics of carcasses. They predict that the Chinese consumer will ultimately demand lean rather than fat pork and are directing their swine-breeding research toward the goal of producing hogs with a more desirable ratio of fat to muscle. Toward this end, they gather information in state or commune slaughtering facilities since such facilities are not available in the research institutes or colleges of agriculture. There they are restricted to such data measurements as dressing percentage, carcass length, backfat thickness, and loin eye area. Researchers in the Northeast College of Agriculture in Harbin are determining ratios of separable muscle to fat.

The animal scientists expressed an interest in carcass composition research done in the United States. The only expression of interest in meat quality (characteristic of the muscle) was from swine-breeding scientists in the Northeast College of Agriculture at Harbin. These investigators were interested in methodology that could be used in the live animal to predict the likelihood of pale, soft, and exudative muscle in the carcass.

CATTLE AND SHEEP SLAUGHTER AND UTILIZATION

In Inner Mongolia (Huhehaote), we visited a plant in which cattle and sheep are slaughtered, but it only operates during the fall and early winter months. Although there was no opportunity to view the slaughtering area, we did view frozen carcasses in the freezers. Animals are slaughtered when they come from the ranges. All animals kept over winter are for breeding purposes or for additional years of growth. Some livestock is shipped to other areas for slaughter or export, and some frozen carcasses are shipped by train to other areas during the winter. However, meat from cattle and sheep is stockpiled in freezers for consumption in Inner Mongolia during those months when slaughtering does not take place.

The beef carcasses we observed were almost devoid of external fat and would correspond to our U.S. grades of cutter and canners. The mutton carcasses were also devoid of any external fat. Although the consumption of beef and mutton is high in Inner Mongolia, we did observe in a retail market in Huhehaote fresh pork carcasses being cut up for sale, apparently because hogs are available for slaughter throughout the year. On the other hand, we saw frozen pork carcasses being chopped up for sale in a retail market in Xilinhaote.

UTILIZATION OF POULTRY

Poultry is relatively important in producing more protein in the diet of the Chinese. Many peasants raise chickens and ducks for both meat and eggs.

Beijing ducks are produced primarily for the restaurant and hotel trade and for export to Hong Kong and Japan. The Ma duck in southern China is popular because, in addition to providing both meat and eggs, it is a good scavenger and has less fat than the Beijing duck. The Chinese prefer chicken eggs, but the high rate of production of eggs by these ducks dictates duck production. The eggs are consumed both fresh and in the preserved form. So-called 1,000 day eggs are basically brine cured or dry cured by covering the eggs with layers of salted clay.

Poultry are usually sold alive to the consumer, who in turn slaughter them for immediate use. The Chinese prefer to consume older chickens, such as spent layers, rather than either the Beijing ducks or broilers.

Feathers are a significant by-product of the duck industry, and large quantities of feathers and down are used domestically and exported. More than 3 million kg were exported to the United States in 1977.

Poultry research at the Poultry Research Institute near Yangzhou is not involved in meat or egg utilization research. We believe that this type of research is almost nonexistent in China.

RABBIT-SLAUGHTERING EVALUATION AND UTILIZATION

We had the opportunity to visit a rabbit-slaughtering facility located in the center of Shanghai, which was formerly a facility for slaughtering large animals and was converted into a rabbit-processing plant in 1957. A 10-county area supplied the rabbits for the plant. Ninety percent of the rabbits are privately produced by families and more specifically are enterprises for children. The rabbits are raised in cages or pits and are fed principally grass or fodder.

The slaughtering and processing of rabbits ready for freezing resembles U.S. continuous pork-processing procedures. This plant is clean and has the capacity to slaughter 2,500 rabbits per hour; as many as 18,000 rabbits have been slaughtered there in 1 day. The rabbits are stunned electrically and hung by one leg on a continuous chain. The process takes 25 minutes from the point of slaughter until the rabbits leave the chilling chamber (10 minutes in chamber).

The rabbits are inspected alive at the point of purchase and again just before slaughter in the packing plant. Again, a veterinarian is in charge but has several lay inspectors to do the post-mortem inspection. Liver flukes and scar tissue from flukes cause condemnation of 25 to 30 percent of the livers; few carcasses are condemned outright.

The carcasses are separated into two categories, those with bruised spots trimmed out and those without blemishes. In most instances, the hind legs are removed from the blemished carcasses and the remaining portion is boned. The whole carcasses and parts are placed in plastic bags and frozen in a -30°C freezer and stored at -8°C.

The rabbit carcasses are graded according to weight. Grade A large is the largest size, with a minimum weight of 1,000 g, Grade A medium has a weight range from 600 to 1,000 g, and Grade A small weighs between 400 and 600 g. All the rabbit carcasses we saw were essentially devoid of fat, which we suspect reflected the quantity and quality of the feed supply.

The meat and hides are produced for export through the Export Food

Corporation to Japan, Great Britain, and some European countries. Very little of the rabbit produced in the Shanghai plant is consumed locally. Some households do slaughter rabbits for their own use. It was our understanding that in some provinces, such as Sichuan, rabbits are produced in rather large numbers and consumed locally.

RETAILING MEAT

Meat is usually sold either fresh or frozen at the retail level. The general lack of refrigeration at the retail level dictates that meat be sold as soon as possible after slaughter. Little meat is cured or canned, although we understood that there are a number of processing facilities in China for this purpose. In Harbin we saw some pieces of cured bacon, sausages stuffed in pigs' bladders and natural casings, and a limited amount of meat canned in glass jars (pigs' feet, spareribs, and luncheon meat).

Although we did not see a large number of retail shops, we saw enough to observe that people have to stand in lines to get their rations. The rural people still prefer fat meat, especially pork, as an energy source and as a source of cooking oil. On the other hand, urban dwellers tend to prefer leaner meat, perhaps because their incomes are higher and they feel less need for the calories in fatter meat.

The price of the meat purchased with a coupon is less than what the producer receives--obviously it is subsidized by the government. The prices of the cuts of meat are similar in some markets and vary slightly in others. In the retail market in Harbin, the carcasses are totally boned and the boned carcass is divided into cuts representing roughly the shoulder, ham, belly, and loin (fat included). Customers are allowed to select from one of the four sections. The loin section is two Chinese cents higher-priced than the belly and ham and five cents higher than the shoulder. The sources of carcasses in this market are the state-operated slaughtering facility and a commune slaughtering plant. In a retail market in Xilinhaote, Inner Mongolia, frozen carcasses of pork and mutton were being chopped into pieces with a cleaver and sold at presumably the same price (Figure 2).

UTILIZATION OF MILK

With the population of almost 1 billion people, it is obvious that an estimated dairy cattle population of 400,000 is not sufficient to satisfy the human needs. However, the Chinese people have not historically consumed milk. The dairies are operated by the state or municipalities and primarily serve people in the larger cities. Fresh milk is available only to children and ailing adults.

Milk is produced and delivered in either 38-l milk cans or tank trucks to centralized facilities for pasteurizing. We observed milk-cooling equipment in a state-operated dairy-production unit in Shanghai. After pasteurization, the milk is redistributed to ration holders. On occasion, some of the milk is dried; when sold, it is available on a first-come, first-served basis.

FIGURE 2 Various scenes of meat retailing.


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Butter is not available for general consumption. We learned that the cream for butter production is that separated from the milk that is utilized in the first 3 months of rearing the replacement heifers in dairy herds. Since the production of butter is small, butter is used primarily by restaurants and hotels.

Cheese is almost nonexistent in the more populated areas in China. It is made in the grazing areas, such as in Inner Mongolia. The team responsible for the cattle sees to it that the calves share the milk produced with them. The milk is utilized fresh as a sour-milk curd or as Mongolian cheese, which is dried curd.

UTILIZATION OF GOATS

The number of goats in China is established to be about 70 million. Some milk is produced from goats for family use; however, the major use of goats is for meat. At a dairy cattle farm under the municipal government of Canton, a herd of 400 dairy goats produces about 500 kg of milk per goat, and this milk is available for human consumption.

We did not see any goat meat for sale in retail stores.

UTILIZATION OF WOOL

Obviously, wool is an important clothing fiber in China and contributes significantly to the economy, especially in Inner Mongolia and in northeast China.

A woolen textile mill in Harbin, Heilongjiang Province, is the only mill that we visited. It produces cloth for apparel and heavy cloth for overcoats and blankets. Many of the products of this mill are produced for export. In 1978 this mill produced 10^6 m of fine apparel cloth, 400,000 m for heavy overcoats, and 300,000 blankets. Six smaller mills in the area produce some of the yarn or thread used in this mill.

FIGURE 3 A Chinese worker attending a weaving machine at the woolen mill in Harbin.

FIGURE 4 Woolen synthetic blend blanket material prior to being put into blankets at the woolen mill in Harbin.

The mill also blends wool with a synthetic fiber for cloth for apparel and blankets.

The wool at this plant is divided in four classes, varying in grade and staple length. First-class wool includes medium and fine wool and is used for clothing and winter overcoats. The fine wool is 62's-70's grade with a staple length 7 cm or longer, and the medium wool is 56's-58's grade and has a 4.5-cm or longer staple length. Second, third, and fourth classes are all used for blankets and have grades of 48's-54's, 36's-46's, and less than 36's, respectively. The prices paid by the mill for raw wool are set by the government. Coarse wool is used in making carpets. Cashmere production is quite significant in Inner Mongolia, and breeding stock from India has been imported to improve its quality (Figures 3 and 4).

10

REPRODUCTIVE PERFORMANCE OF DOMESTIC ANIMALS AND THE SCIENCE OF REPRODUCTIVE PHYSIOLOGY

Neal L. First and Warren C. Foote

Since 2000-3000 B.C., livestock have existed in China and neighboring countries that are distinctly different from breeds found in the western world. These breeds have evolved with time into strains or new breeds indigenous to communities the size of a county or river valley. One of the characteristics of most of the breeds of livestock in China is a high reproductive rate compared with that of livestock of European, Middle Eastern, or Indian origin.

REPRODUCTIVE RATE OF LIVESTOCK IN CHINA

The species in China most famous for its high reproductive performance is porcine. Swine in the United States and Europe reach sexual maturity at 6-7 months of age, have a first-service conception rate of 75 to 80 percent, and give birth to 9 or 10 piglets per litter; the native breeds of China descending from the Erhualian in the Tai Lake region reach sexual maturity by 4 months, have a first-service conception rate of 90 to 95 percent, and give birth to 13 to 15 piglets or more per litter (Figure 1).

These prolific pigs are usually high milk producers, and the ones we saw had 18 or more mammary glands[1] (see also Cheng, Chapter 2 of this publication). This high level of reproductive efficiency also exists after the artificial insemination of native breeds of swine. Conception rate is high after first-service insemination. Several communes that we visited reported 80 to 90 percent conception after first service with fresh semen.

The volume of semen and number of sperm required are much less than for European breeds. The Artificial Insemination (AI) Center of the Guangdong Institute of Animal Husbandry and Veterinary Research reported that the optimum volume of semen inseminated is 20 ml for native breeds, compared with 50-100 ml for European breeds of swine.

Reproductive performance of native cattle is also high (Figure 2). The first-service conception rate for the native yellow cow was said to be nearly 80 percent. It is only 60 to 65 percent for European breeds in the United States and about 60 percent for European breeds, such as Friesian, in China (Beijing District AI Center, Double Bridge Commune, Harbin District Cattle Breeding Service).

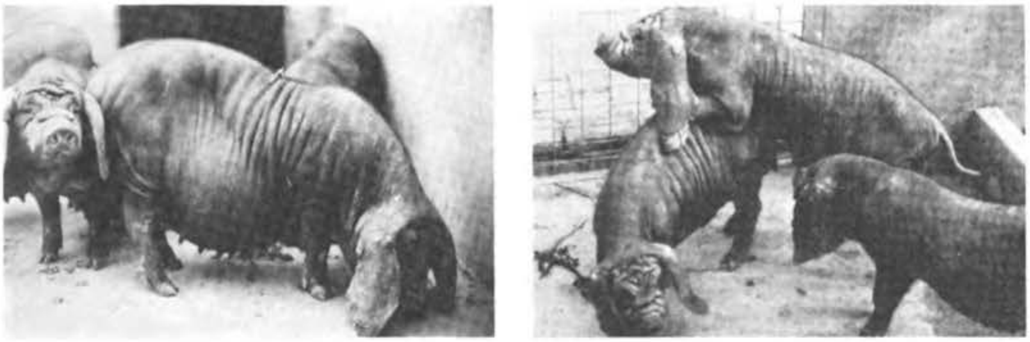

FIGURE 1 Erhualian, a prolific pig.

The conception rate of sheep is similar to that obtained in Europe or the United States; about 80 to 90 percent of ewes conceive after one mating. However, some breeds have increased production capabilities. The best known of these is the Hu sheep (Figure 3). We saw a small flock of this breed on the Malu commune near Shanghai. They are reported to breed throughout the year and often lamb twice per year, with litters of two and three young most common and, less frequently, much higher numbers (Jiangsu Provincial Academy of Agricultural Sciences).

The reproductive rate of horses is not much higher than that of horses in other countries. Conception rate on state farms is about 65 to 70 percent for a single service, whether by natural mating or artificial insemination, and approximately 94 percent of the mares foal after a breeding season (Bainxile State Farm). This is slightly higher than in communes, where approximately 10 percent of the mares are barren and the first-service conception rate is about 50 percent (Figure 4).

Whether the high reproductive performance of Chinese livestock is due to heredity or to breeding practices is unknown. The high litter size performance of sheep and swine and the early sexual maturity of swine are likely to be due primarily to heredity. Breeds of European

FIGURE 2 Native Chinese cow.

FIGURE 3 Hu sheep.

origin in China, such as Landrace or Large White swine, have sexual maturity and a litter size comparable with those of the same breeds in Europe or the United States. For example, mature Landrace sows in China average litters of 11.4 piglets.[2]

The breeding programs being used on state farms and communes and promoted in China today call for upgrading native livestock by crossbreeding to obtain the desirable performance traits of foreign breeds. The trait desired in the cross is usually not fecundity. Extensive use of crossbreeding is likely to reduce the high reproductive rate of the native livestock and dilute the genes for high reproductive performance. In swine, crosses of native high litter size breeds with Landrace, Large White, or Russian White have produced breeds such as the Harbin White, Shanghai White, and Sanjiang.

FIGURE 4 Process of artificial insemination on the Bainxile State Farm in Inner Mongolia.

FIGURE 5 Individual care of pigs.

These new breeds have litters of a size intermediate between those of the native sows and the imported breeds. For example, the Shanghai White was developed by crossing the Meishan native pig with a Russian White and a Yorkshire. The cross resulted in a breed that produces about 12 pigs per litter. The Meishan produces about 15, and the parent European breeds about 11. A backcross to Meishan raised the litter size to 13.5. The Shanghai White weans about 11.5 piglets, and backcross 13, and the Meishan 14 (Shanghai Academy of Agricultural Sciences, Institute of Animal Science, 1979).

The level of management of reproduction seems to be high in China and this, too, likely contributes to the high level of reproductive performance of livestock (Figure 5). This high level of management is mostly the result of an abundance of labor for tasks such as estrus detection and an effective communication system for transfer of information from national and provincial research institutes to workers in communes or on state farms.

ARTIFICIAL MANIPULATION OF REPRODUCTIVE PROCESSES

Artificial Insemination

Artificial insemination is being used in China primarily to increase the number of females bred to high production males or males of exotic breeds deemed desirable in crossing with native livestock. Upgrading by crossbreeding is a major objective in the plans for increasing livestock productivity. The use of artificial insemination is most extensive on state farms. State farms produce breeding stock for the communes, and some maintain specific breeds, such as Simmental cattle, for the purpose of producing males to be used to upgrade livestock of the communes. On state farms, the frequency of use of AI is approximately 100 percent for dairy cattle, 50 percent for beef cattle, about 100 percent for sheep, approximately 50 percent for swine, and 50 percent for horses.

The use of AI on communes we visited was somewhat less. Depending on the province, approximately 75 to 100 percent of dairy cattle, about 20 to 50 percent of the beef cattle, about 80 percent of the sheep, 20 to 30 percent of the horses, and 50 percent of the swine are artificially inseminated. Frozen semen from Chinese Black and White bulls is used for nearly all dairy cattle inseminations. The other species are inseminated mostly with fresh, undiluted or diluted semen used immediately after collection to inseminate females on the same farm.

The artificial insemination programs for dairy cattle are centered around a state-operated provincial or district artificial breeding center where semen from Black and White bulls is collected and frozen. Black and White cows are inseminated on state farms or sometimes on communes near major cities.

We visited several breeding centers. The AI center for Beijing district serves the Beijing area but also makes semen available to other provinces when needed. This station, started in 1973, was developed by consolidating many small stations that were started around 1950. The center collects semen from Black and White dairy bulls as well as from Charolais, Angus, Shorthorn, Hereford, and Murray Grey beef bulls. In all, there are 50 bulls, of which 35 are producing semen. The remainder are selected young bulls not yet in semen production.

About 100,000 cows are bred each year with semen from these bulls. Each cow is inseminated twice in a heat period, and the first-service conception rate is 55 to 60 percent. This center trains technicians, imports some semen from other countries for specific matings, and supplies semen to other provinces when requested. It produces liquid nitrogen (Figure 6) and distributes it with semen and storage units (Figure 7) to the herds using its service. In the Beijing district, 100 percent of the dairy cows and 70 percent of the beef cows are artificially inseminated.

We visited the Harbin district cattle-breeding service. It was organized for three purposes: the processing and distribution of bull semen, leadership and direction in developing plans for genetic

FIGURE 6 Liquid nitrogen unit, Artificial Insemination Center, Beijing.

FIGURE 7 Semen and storage units, Artificial Insemination Center, Beijing.

improvement, and to provide directions and education in the management of reproduction. This center was organized in 1974 and is still being developed. It has 56 bulls of 7 breeds--Chinese Black and White for dairy, German and Austrian Simmental for dairy and beef, and Charolais, Limousin, Angus, and Hereford for beef. The station services 80 counties in Heilongjiang Province and has six branch centers. Each branch center is a part of a commune.

About 850,000 to 1.1 million pellets of frozen semen are distributed each year. Four pellets are used for each breeding; therefore approximately 250,000 cows are bred annually with semen from this center. The center produces liquid nitrogen and distributes it along with semen through the commune branch center to the production brigades. Approximately 75 percent of the dairy and 50 percent of the beef cows in Heilongjiang Province are artificially inseminated. The extender used to dilute the semen before freezing into pellets consists of 20 percent egg yolk, 12 percent sucrose, and 5 percent glycerol. This or a similar extender is used by most provincial AI centers in China.

The Shanghai District AI Center is operated by the Animal Science Institute of the Shanghai Academy of Sciences. There are 22,000 dairy cows in the Shanghai district, and all are artificially inseminated. In addition, this center provides semen for 16 other provinces. The first-service conception rate is 60 percent. About half of the herds are on an official milk test and record program. The semen is frozen in pellets or straws. Each pellet contains 12 million sperm, and one pellet is adequate for one insemination. The extender consists of 12 percent lactose, 7 percent glycerol, and 20 percent egg yolk.

Near Guangzhou, the Institute of Animal Husbandry and Veterinary Science operates an AI center for processing semen of dairy cattle, beef cattle, water buffalo, and swine: All the dairy cattle around Guangzhou and 50 percent of the few in rural areas are bred by AI. Most of the beef cattle bred by AI, approximately 20,000, are on state farms. About 60 percent of the 28 million sows in this province are artificially inseminated, some with frozen swine semen (Figure 8). Water

FIGURE 8 Collecting semen for artificial insemination of a sow.

buffalo are being inseminated experimentally, but AI is not in field use for this species.

This center relies heavily on the South China Agricultural College for research on freezing of semen, and the college and institute have developed and applied excellent technology for the freezing of semen. For all species, pellets of semen are frozen by liquid nitrogen vapor. A drop of semen is placed on a fine copper grid above the liquid nitrogen. The pellet reaches -120°C within 20 seconds. Each pellet contains 0.07-0.1 ml of semen. A pellet of bull semen contains approximately 15 million sperm, and a pellet of boar semen 3 million. Two pellets are used for a single cattle insemination, but about 800 pellets, or 2.3 billion sperm, are needed to inseminate one sow. For water buffalo, a single insemination dose is 20 million sperm.

These pellets are stored in liquid nitrogen and thawed at the time of insemination. Bull semen is thawed at 40°C, and boar at 50° to 60°. The semen extenders differ slightly for each species. The extender for bull and water buffalo contains 75 percent of a 12 percent sucrose solution, 5 percent glycerol, and 20 percent egg yolk. The swine semen extender contains 77 percent of a 12 percent sucrose solution, 3 percent glycerol, and 20 percent egg yolk.

The conception rate here with frozen dairy bull semen is not different from that at other AI centers in China--about 50 percent after first service of beef cattle. However, the conception rate obtained with frozen swine semen is very high compared with that at laboratories in other parts of China or the world. The average first-service conception rate from frozen swine semen is 73 percent, with some trials over 80 percent.

Frozen swine semen could provide an effective vehicle for distribution of germ plasm from the most outstanding performance-selected boars in China to be used to breed sows in communes throughout China. Semen from exotic or high-performance boars might be used at the commune level to breed the best sows, or sows of specific breeds to produce boars whose semen would be collected and used locally to upgrade the quality of pigs of the production brigades.

Several colleges, institutes, and breeding centers in China are developing procedures for freezing swine semen. The most successful technology seems to be located at the center operated by the Guangdong Institute of Animal Husbandry and Veterinary Science.

Artificial Insemination in Sheep

Artificial insemination in sheep with fresh semen has been used in China since the early 1950's, primarily for the genetic improvement of wool production. During this period, three new breeds of sheep have been developed: the Xinjiang Fine-Wool, the Inner Mongolian Fine-Wool, and the Northeast China Fine-Wool; and about the same number of semifine- or medium-fine-wool breeds are in the process of being developed.

In 1974, research on the freezing of ram semen was undertaken in Heilongjiang, Jilin, Inner Mongolia, and Xinjiang. During this first year, 369 ewes were inseminated, with an average 30-day nonreturned rate or lambing percentage of 22. By 1977, the number of provinces had increased to seven with the addition of Qinghai, Shǎnxi, and Sichuan. During that year, approximately 5,000 ewes were inseminated using frozen ram semen, with an average conception rate of 35 percent. However, during this period, considerable variation was obtained. For example, trials in the different provinces varied from less than 15 percent to greater than 55 percent conception.

Also during this period, more than 100 different diluents were tested for extending and freezing ram semen. Constituents included varying combinations and levels of lactose, glucose, sucrose, sodium citrate, egg yolk, resin, sheep serum, egg albumin, whole milk, and protein hydrolysate. Other additives to the semen extender include vitamin B_1, vitamin E, EDTA, ATP, *Astragalus membranaceus* extract, and pilose antler extract (antler in velvet).

The primary ingredients for the extenders are sugar, sodium citrate, or tris. The dilution procedure is accomplished in one or two steps, and the final glycerol content is from 2.7 to 4.5 percent. Sperm have not been diluted to a standard concentration; however, average sperm numbers of undiluted semen usually vary from 2.5×10^8 to 2.6×10^8, and dilution rates are generally from 1:1.5 to 1:4. From 0.05 to 0.2 ml of semen is used per insemination.

Semen has been frozen in ampuls, pellets, and straws. When ampuls are used, 0.5 to 1.0 ml of semen is frozen in 1.0- to 1.5-ml ampuls. Freezing is accomplished in nitrogen vapor for 5 to 6 minutes, and then the ampuls are placed in liquid nitrogen. Semen in 0.25- or 0.5-ml straws is frozen in nitrogen vapor for approximately 4 minutes (temperature drops from +5°C to -80°C) and then placed in liquid nitrogen. Semen in straws has also been frozen on dry ice. Semen is frozen in pellet form in nitrogen vapor or on dry ice. Semen is thawed at water bath temperatures varying from 40°C to 75°C and removed before the semen reaches 10°C.

The ewes to be inseminated are checked for estrus each morning, using teaser or aproned intact rams. Those in estrus are inseminated that morning and again in the evening and a third time the following morning if still in estrus. The semen is deposited on the os cervix. The levels of fertility mentioned here under primarily experimental conditions with frozen semen can be compared with estimates of 70 percent for AI with fresh semen under field conditions in Inner Mongolia.

Artificial insemination, using fresh semen under field conditions, is accomplished in Inner Mongolia by maintaining a semiportable laboratory in a *yurt* for preparation of semen collection and AI equipment and for evaluating and processing the semen. Under these conditions, semen is collected usually only in the morning but on some occasions also in the evening.

Ewes returning to estrus are reinseminated for a total of two or three estrus periods. Rams are often turned with the ewes following the period of AI in an effort to maximize fertility. The percentage of ewes inseminated that lamb varies from 80 to 90 percent or higher.

The freezing of ram semen in China is still considered to be in an experimental stage. The seven provinces involved in freezing of ram semen in 1977 cooperated during 1978 to measure and compare the different procedures in use. Information on this cooperative research was obtained from Lin Tongyong, Inner Mongolia Animal Science Research Institute, Huhehaote. The following eight research organizations, two from Xinjiang and one from each of the remaining provinces or autonomous regions, were involved in this cooperative effort: Xinjiang Autonomous Region--Animal Husbandry and Veterinary Research Institute, Xinjiang State Farm Bureau, Shihezi Institute, and Xinjiang Agricultural Scientific Academy, Wulumuqi; Inner Mongolia Autonomous Region--Inner Mongolia Animal Science Research Institute, Huhehaote; Shǎnxi Province--Agricultural Bureau, Shǎnxi Province, Taiyuan; Qinghai Province--Animal Husbandry and Veterinary Research Institute, Qinghai Province, Xilin; Jilin Province--Animal Science Research Institute, Jilin Agricultural Scientific Academy, Gongzhuling; Sichuan Province--Department of Animal Husbandry and Veterinary Science, Sichuan National College, Chengdu; Heilongjiang Province--Animal Science Research Institute, Heilongjiang Province, Qiqihaer.

The cooperative research was conducted on a state farm in Shihezi, Xinjiang, to evaluate and compare the eight different procedures of processing and freezing semen. Pooled semen was used, and fertility was checked in at least 100 ewes, each of the same breed from the same flock. The percentage of ewes lambing from insemination at one estrus varied from 29 to 41 percent. There was no statistically significant difference in fertility with the use of semen frozen by the different procedures in the cooperative program. The levels of fertility obtained were likely reduced because of required experimental conditions, including increased length of time that semen was held undiluted; additionally, insemination was done during September, which is not the optimal breeding season.

The research organizations conducting experiments on freezing ram semen use several indices in their laboratories to measure sperm fertility. These include (1) normal acrosome morphology rate, (2) post-thaw motility, (3) survival index (a measure of motility over time after thawing), (4) percentage of unstained spermatozoa, (5) post-thawed seminal plasma level of hyaluronidase, and (6) post-thawed seminal plasma level of glutamic oxalacetic transaminase. The general consensus is that none of these indices provides a satisfactory estimate of fertility.

The results from freezing ram semen and AI in China are comparable with those obtained in other parts of the world. We found no evidence of artificial insemination in goats in China except at a goat complex near Guangzhou. The procedures used were those adapted from freezing of semen and AI in cattle, and the resulting fertility was low.

Unquestionably, a large emphasis has been and is being placed on the use of artificial insemination to change rapidly the genetic composition and productivity of livestock in China, and AI programs in use seem to be effective.

Superovulation

We learned of research in Inner Mongolia to increase the lambing rate, which varies normally from 100 to 120 percent, by PMSG treatment. The source of hormone was unextracted pregnant mare serum. Dose response measured as lambing rate was compared among native Inner Mongolian Fat-Tail, Inner Mongolian Fine-Wool, and crosses between the two breeds. The level of hormone, measured in mouse units, required to produce approximately 150 percent lambing rate was 1,000 for the Inner Mongolian Fine-Wool, 1,500 for the native fat-tails, and a level intermediate between the two, or 1,250, for the crossbreds.

Although the researchers were able to increase the mean lambing rate by the use of PMSG, the increase varied from one to four or five lambs per ewe. The procedure is not considered a useful method of increasing lamb production, primarily because of the variation. This great variation in response to PMSG reported in Inner Mongolia is similar to that experienced in other parts of the world.

The PMSG activity of the unextracted serum was estimated by using increases in uterine size in mice. Mouse units are defined as the number of mice that can be injected per 1 ml of diluted serum with effective response. Effective response is defined as one in which an average of three of five mice demonstrate a standardized, severalfold increase in uterine size 72 hours after injection. Activity has not been measured in international units or compared with international units because of lack of standards.

Synchronization of Estrus

Experiments on the synchronization of estrus are just beginning. They are being conducted primarily at Beijing in the Institute of Animal Husbandry. Compounds such as progesterone, methallibure, and now clomiphene and prostaglandin $F_{2}\alpha$ have been studied. Other techniques for altering reproductive processes have received high priority in research but are not yet applied.

The synchronization of estrus is usually considered a labor-saving tool to avoid regular observation of animals for detection of estrus.

In China, where there is an abundant supply of labor, this technique may not have great field application. If superovulation techniques were perfected and titrated to an exact response, such as two ovulations in cattle, this technique would have application.

Embryo Transfer

Several institutes are currently adapting methods used for embryo transfer in the United States and Europe to Chinese conditions. The emphasis is on sheep and cattle. The principal objective for using embryo transfer in China is to increase rapidly populations of the pure exotic breeds used to produce males for upgrading native livestock. For cattle, these are breeds such as Simmental, Limousin, and Charolais; and for sheep, the fine-wool breeds.

The research is in an early stage and is as yet without field testing or trials with large numbers of animals. Experiments are under way in Heilongjiang Province, where sheep transfers are done by surgical methods with 70 percent survival of transferred embryos. The success there with nonsurgical recovery of eggs from cows is good, but the pregnancy rate from nonsurgical transfer is low. Surgical transfers have resulted in about 30 percent completed pregnancies.

A small-scale project with cattle was conducted by the Institute of Genetics in Beijing in collaboration with the No. 7 Farm of the Shanghai Dairy Company. Two cows were superovulated and inseminated. Fertilized eggs were recovered surgically from the right uterine horn and nonsurgically from the left. These eggs were transferred surgically to the right uterine horn and nonsurgically to the left in eight cows. Two calves were born from the eight cows. Both resulted from surgical transfer, one from each method of egg recovery.[3] The Institute of Genetics of the Chinese Academy of Sciences has been a leader in embryo transfer of sheep and cattle.

Nonsurgical collection and surgical transfer of embryos have been used successfully in China, but little success has been achieved thus far with nonsurgical transfer. The technology of freezing or sexing embryos has not been developed yet in China. When these techniques become available, as they are at research stations in other countries, and when they are highly efficient, it is likely that they will be used extensively on state farms.

BASIC RESEARCH

Most of the research in reproductive biology being carried on in China by colleges or institutes of animal husbandry or veterinary medicine under the Academy of Agriculture is applied, as is evidenced by major emphasis on experiments with preservation of semen, synchronization of estrus, and embryo transfer. Indeed, the amount of basic research in reproductive biology of animals in China seems very limited. Probably by intent and direction, the basic research mission is relegated to institutes under the Chinese Academy of Sciences. Therefore we visited some of the institutes of the Chinese Academy of Sciences to ascertain the amount of basic research being done in reproductive biology.

The Institute of Zoology of the Chinese Academy of Sciences has completed studies on isolation and purification of prostaglandins and identification of their pharmacological properties. Scientists at the institute are using assays for hormones, such as prostaglandins and progesterone, in blood and in milk. The role of FSH, LH, and LH-releasing hormone in controlling ovulation and superovulation is being studied. Much of this research has been done in collaboration with the Institute of Animal Husbandry of the Academy of Agricultural Sciences, especially when a technique that could be applied in livestock production is studied.

The Institute of Cell Biology of the Chinese Academy of Sciences in Shanghai is a strong basic research group. The current research is basic, but with applied potential. The areas of study that concern reproductive biology are three: mechanisms controlling maturation of oocytes in amphibians; the mechanism by which a Chinese herb, trichosanthes, causes abortion; and the male antifertility properties of gossypol. The reproductive biology laboratory is one of five laboratories at the institute. The others are cancer biology, gene expression, cell differentiation, and biological instrumentation.

The research being done in all sections of the institute is of excellent quality. The researchers have shown that a mucus secretion from the toad oviduct must coat the egg before sperm can penetrate the egg. Toad pituitary extracts induced oocyte maturation and ovulation, and large amounts of extract caused superovulation. Gonadotropic hormones are also used to cause superovulation in fish.

The studies with gossypol, extracted from cottonseed oil, have shown this compound to be effective in preventing spermatogenesis and the production of live sperm without interfering with interstitial cells of the testis or blood levels of testosterone or LH. This compound was shown to prevent spermatogenesis effectively in over 4,000 men who have been studied for 2-4 years. The side effects were minor, but they included transient weakness, reduced appetite, and altered potassium metabolism. If further studies of possible side effects continue to show this drug to be safe, gossypol may become an accepted contraceptive for men. In animal feeds, it has the undesirable potential of reducing fertility.

A plant protein from the tubers of trichosanthes that causes abortion has been used as herbal medicine in China for over 300 years. A major effort to study this herb started in 1976, and more than a dozen papers about it have been published, mostly in the journal *Ectologica Sinica*. The active agent is a single-chain polypeptide without a carbohydrate endgroup and has a molecular weight of 18,000. It has an isoelectric point of 9.4. The amino acid sequence has been partially characterized.

The drug is used clinically with prostaglandin $F_{2}\alpha$ to induce abortion at any stage of pregnancy. It selectively damages the plasma membrane of the syncitial trophoblast. This results in reduced production of human chorionic gonadotropin, degeneration of the trophoblast, and abortion. There are no known undesirable effects. On the positive side, it is reported to be effective against colon carcinoma. Plants containing this compound, or perhaps similar ones, could cause unwanted abortions in livestock.

This institute is well equipped, and the research is an excellent example of basic research with potential for application.

An overview of reproductive biology in China leaves the following impression: Chinese farm animals are highly fertile. Techniques such as artificial insemination have been effectively applied, and a strong communication system exists for transferring knowledge from the research stage to application. The techniques, applied knowledge, and equipment design have, by necessity, been borrowed from other countries because little emphasis was placed on basic research in the past. Current plans are to increase basic research.

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11

ANIMAL BREEDING AND GENETICS

Warren C. Foote and Neal L. First

China's 565 million farm mammals, a number reported by the State Statistical Bureau in 1978, consist of an estimated nearly 200 different breeds or genotypes of the major species. In many ways, these genotypes represent a unique gene pool from which increased production can be obtained by developing new genotypes from crossbreeding and selection or from improving existing genotypes through selection programs alone. These unique features include adaptation to a broad spectrum of environmental and management conditions.

Another unique feature is the high reproductive rate found in many of the genotypes, particularly of swine and sheep. The high level of adaptation, brought about primarily by natural selection with little artificial manipulation, was likely achieved at the expense of smaller size and a slower and less efficient growth rate.

The history of the countries or civilizations that make up modern China suggests that there has been less exchange of animals with neighboring areas than in most other countries of the world. This is particularly true of swine and horses. The genetic composition of sheep and goats was quite likely influenced from outside sources because of the nomadic nature of the management of these species. Several different types of yellow cattle are described. Some show genetic influence of the Brahma or Sindi from India and others the influences of the beef or dairy genotypes from Russia and possibly Europe.

Major efforts to improve livestock production, which have taken place during the last 40 years, have been made through crossbreeding with imported breeds. Good choices were made, and some crossbreeding and selection programs have been successful as a result of identification of measurable production traits and techniques, such as artificial insemination, adapted to help control breeding programs and extend the influence of superior sires. Examples of these production traits are milk production in the dairy cattle, fine-wool and semifine-wool production in sheep, and increased size and growth rate in swine.

The responsibility for developing animal breeding programs to achieve genetic improvement rests almost entirely with state farms and related institutes. These state farms and institutes in many cases have developed large artificial insemination centers in which performance or progeny-tested sires are selected and maintained and through which controlled breeding programs are administered.

Genetic improvement of livestock in China is geared to increase the availability of animal protein, in a continuing struggle for self-sufficiency, and to provide export items of food and fiber, in efforts to improve foreign exchange. This improvement must be accomplished, however, with maximum use of self-harvesting of feed from range areas, use of by-product feeds, and minimum use of grain. This has resulted in use of large quantities of roughage in swine production and in feeding of waste and surplus vegetables to dairy cattle.

GENETIC IMPROVEMENT IN DAIRY CATTLE

The approximately 400,000 head of black and white Holstein-type dairy cattle in China represent one of its most successful livestock genetic improvement programs. The date when black and white cattle were first used in China for upgrading the dairy cattle and their source are obscure. The native or local cattle that served as the basis for the modern dairy cattle appear to stem from at least two origins, both of which already contained some germ plasm from dairy breeds. One of these, the Sanho, was a mixture of native Mongolian cattle and Holstein breeding.

Holstein bulls were crossed on animals of this breeding to develop the black and white dairy cattle in the Beijing area and probably also in northeast China. A second local genetic type of cattle used in developing the modern dairy cattle in China was the Pinchow. We were told that this genetic type derived from crosses of Russian Milking Simmental and native Manchurian cattle. The Holstein bulls or their semen apparently came primarily from Japan, especially earlier, and from the United States.

The genetic improvement of dairy cattle in China came primarily from a grading-up process accomplished by importation of germ plasm and also by development of sources of purebred Holstein cattle in China. This backcrossing was carried out with a rigid selection program in which major emphasis was placed on level of production. These cattle are referred to in China as the Chinese Black and White and in some areas by local names, such as the Beijing Black and White.

One of the major dairy complexes in China is the Shanghai Dairy Corporation (a state farm). It is made up of 11 dairies. We visited dairy No. 7, which had a total of 1,600 females including 1,050 milking cows and 550 heifers (Figure 1). Average production based on a 300-day lactation from this dairy is 5,000 to 6,000 kg of milk with an average butterfat content of 3.4 percent. Super herds average 6,000 kg and more during their first lactation. Approximately 50 of the milking cows qualified for a super herd.

The replacement heifers are first bred at 17 months or at a weight of nearly 400 kg. Officials at the dairy reported a 15 percent replacement rate but hoped to increase it. Semen for breeding at these dairies as well as additional herds is provided from the Shanghai Breeding Center on the basis of performance of the parents and of individual growth and development performance. The final performance criterion is based on the first lactation records.

Stud bulls are selected from the progeny of cows in all the dairies

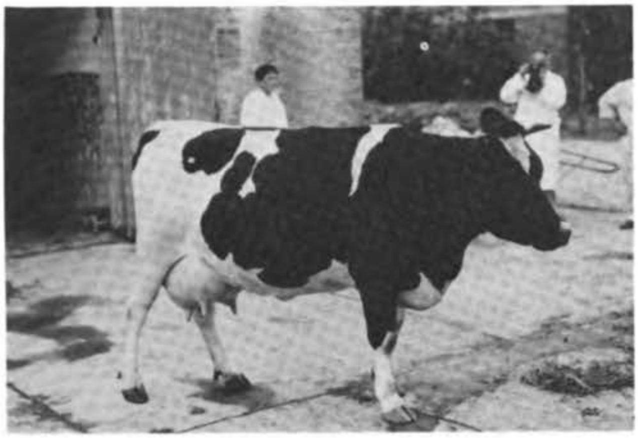

FIGURE 1 This is a first-lactation heifer from the super herd in dairy No. 7 of the Shanghai Dairy Corporation. Heifers qualifying for the super herd must produce 6,000 kg of milk or more during their first lactation.

and are finally selected on the basis of their own progeny-tested performance. Performance is based on daily individual cow records. The final decision for individual mating generally lies with the state farm or breeding center. One production-related trait that the Chinese dairy scientists are concerned about in their cattle is pendulous udders resulting from poor conformation and attachment. This is not one of the primary traits selected for in development of their dairy cattle.

GENETIC IMPROVEMENT IN BEEF AND DUAL-PURPOSE CATTLE

The genetic base for cattle used primarily for meat production and draft in China is the different types of yellow cattle. These yellow or native cattle have undergone some genetic change, depending on their location in China, such as the influence of the Brahma and Sindi breeding from India, the Simmental from Russia, and probably the Holstein from Europe or Japan. These animals are represented by all color patterns. Some of them have comparatively high milk-producing ability.

A breeding center at a state farm in Inner Mongolia has acquired bulls from several exotic breeds, including the Simmental, Charolais, Limousin, Black Angus, and Hereford (Figure 2). These bulls are being used through artificial insemination to develop beef as dual-purpose cattle by crossing on the native breed. The major production traits being selected for in Inner Mongolia are milk production and meat production.

Draft animals, which have been of primary importance in many areas, are receiving less attention because of the increased emphasis on food production and also because of China's plans for mechanization. Selection programs within native cattle, without crossbreeding, are also being used to improve production (Figure 3).

Another area in which there is considerable work under way for genetic improvement of beef or dual-purpose cattle is in the Harbin district, Heilongjiang Province, in northeast China. Here the local cattle, which were earlier crossed with Russian Simmental, possess considerable milk-production potential. They are reported by Cheng (Chapter 2 of this

FIGURE 2 Exotic breeds of bulls are used in the genetic improvement program in Inner Mongolia. The bull on the right is a Limousin and the one in the center is a Charolais.

publication) to be capable of producing 1,800-3,000 kg of milk per lactation.

The Harbin district is also an important center for developing improvement programs for dairy cattle. A breeding center at a state farm, organized since the Cultural Revolution, has bull studs of at least six breeds: Black Angus, Hereford, Charolais, Limousin, Simmental, and the Chinese Holstein or Black and White. All these are being used to some degree in developing beef-type animals, and the Simmental and the Black and White are also used for improving milk production.

Another breeding center, in addition to those in Inner Mongolia and in Heilongjiang, that is contributing significantly to the improvement of beef or dual-type cattle is the Artificial Insemination Breeding Center near Beijing. Although its primary responsibility has been the development of the dairy industry, it also collects and distributes semen from beef breeds, such as the Hereford, Black Angus, Shorthorn, Murray Grey, and Charolais.

These three centers, particularly the one at Harbin, have assumed

FIGURE 3 Calves are often kept in pens such as this while their mothers are grazing. Some of these calves are offspring from native dams bred to Limousin and Charolais bulls.

key roles in the development and direction of genetic improvement programs in beef cattle. Artificial insemination in beef cattle is used much less extensively than with dairy cattle but plays a major role in genetic improvement of beef cattle. Beef cattle improvement programs are just now getting under way.

GENETIC IMPROVEMENT IN SWINE

Native breeds or genetic types of swine in China are characterized by their adaptation to local regions, by generally higher levels of prolificacy compared with other breeds of swine in the world, and by their ability to utilize diets containing large proportions of roughage.

Several exotic breeds have been introduced into China and used for crossbreeding to develop new breeds of swine or for upgrading programs to improve production. These include the Landrace, Large White, Russian White, and Yorkshire. New breeds of swine have either been developed or are in the process of being developed.

Probably the best-established new breed is the Shanghai White, which is a cross between the native Meishan breed of the Taihu type and either the Russian White or, to a lesser extent, the Yorkshire. The Shanghai White is termed a dual-purpose (lard/meat-type) pig with increased mature weight and increased rates of gain compared with the native breed and with a level of prolificacy intermediate to the parent breeds. Important production traits of the native Meishan breed include prolificacy, a docile nature, and adaptation to the region. Meishans have a concave back and pendulous udder, and grotesquely wrinkled skin, particularly on the face and head.

Another new breed that is being developed in Jiangsu Province by the Provincial Academy of Agricultural Sciences is the Xinhua, which is a cross between the Huai breed of the Taihu type of native pig and the imported Yorkshire. This new breed type is generally smaller than other new breed types being developed but does retain a high level of prolificacy.

A cross between the Landrace and the Min Zhu, the Sanjiang White, provides the genetic base for another new breed. This new breed type was reported to be the first bacon-type breed under development and is being developed cooperatively between the Northeast College of Agriculture and the state farm complex in Heilongjiang.

The Harbin White, another new dual-purpose (lard/meat-type) breed, is a cross between the local native breed and the Russian White and Large White. It is similar in appearance to our Large White. Also in Heilongjiang, emphasis is placed on improvement of two native breeds, the Spotted Black and White and the Min Zhu Black.

Genetic improvement is being made in swine in Guangdong at the Provincial Agricultural Academy through upgrading of the native or crossbred pigs by artificial insemination using semen from the Landrace and the native Spotted Black and White.

In addition to using artificial insemination, which is used for as many as 50 percent of inseminations in some state farms, state farms are also providing breeding stock for use by other state farms and communes. Although genetic improvement programs have been developed and applied in China for improving swine production, movement away from native types, particularly the lard type, is slower than might be expected. This is because of the preference, particularly by people in the northern areas, for higher proportions of fat in their diet and also because of an apparent preference for meat from the native pig.

Although maximum heterosis and productivity usually come from a crossbred sow and production of crossbred pigs, much of the crossing of breeds in China seems directed toward developing new breeds. Animal-breeding research is needed in China to characterize the performance and cross-combining ability of breeds to be used in crosses. More direction is probably also needed toward use of specific breeds for a terminal-crossing program.

Several institutes have active breeding programs for maintaining the native breeds of high reproductive performance. This seems essential if the native breeds are to be used to impart high reproductive performance to a crossbreeding program. The large litter size and early maturity of these breeds are badly needed in U.S. crossbreeding programs. Frozen semen from these breeds is available in China and might be a means of importing these animals for research in the United States or Europe. Before this becomes reality, health restrictions must be worked out.

Theoretically, it should be possible to use genes from these pigs to develop a female line to be used in crossbreeding that would retain the milk production, growth, and carcass performance of breeds such as Yorkshire or Landrace but have the early maturity and large litter size of the Taihu descendants.

GENETIC IMPROVEMENT IN WATER BUFFALO

The water buffalo in China is used primarily as a draft animal and as meat when its productive life is completed. Water buffalo also have some considerable milk-production potential, and this is of particular interest from a genetic improvement standpoint. The native water buffalo can be divided into different genetic types relating to local environments. One observation is that they are larger in the north and become smaller the farther south they are observed.

Genetic improvement of milk production was undertaken with the importation of the Murrah breed of buffalo from India about 1965. With the increased emphasis recently placed on use of frozen semen and artificial insemination in the water buffalo, plans are being made for importing semen from the Murrah breeds of buffalo in India. A major part of this work is being carried out at the research institute near Guangzhou.

GENETIC IMPROVEMENT IN SHEEP

All the genetic improvement work in sheep in China has been directed toward improving wool production. This work has been conducted almost entirely in the autonomous regions of Xinjiang and Inner Mongolia and in the northeast part of China. Table 1 lists breeds of sheep imported and relevant available information concerning their description and use, and Table 2 provides some information concerning some native Chinese breeds of sheep.

Particularly in the past, wool has been considered a primary product from sheep for domestic consumption. However, more recently, with the normalization of relations of China with the United States and other countries, wool is recognized more and more as a significant export item to increase foreign exchange. The improved wool is used as apparel wool. Wool from native, unimproved sheep is used for making carpets. Because of recent increased emphasis on increases in meat production throughout China, particularly in the pastoral areas, plans are under way to increase meat production from sheep.

In China, success in the genetic improvement of wool, both in terms of quantity and quality, is second only to the success noted with milk production in dairy cattle. This is due to the identification of a small number of measurable characteristics that were relatively highly heritable and that could be objectively selected for and progress measured. In this selection scheme, wool grade and uniformity are given first priority. Staple length and the resulting increase in fleece weight are receiving increased attention now that the first traits have largely been achieved. For example, in Inner Mongolia and northeast China, breed standard minimum for staple length is 7 cm. Other production traits, such as body type, growth rate, and reproductive rates, receive much less or no attention. However, these traits have not been adversely affected by the selection program.

Three different breeds of fine-wool sheep have been developed and generally stabilized genetically. The first is the Xinjiang Fine-Wool breed, which was developed primarily from crosses of the Caucasian Merino and the Precose, both Russian breeds, with the native Kazakh. Offspring from this cross, and also the Caucasian Merino, were crossed with the Inner Mongolian Fat-Tail, in Inner Mongolia, to develop the Inner Mongolian Fine-Wool breed (Figure 4). The Northeast China Fine-Wool breed was developed by crossing the native Northeast China with the Soviet Merino, Caucasian and Stavrapol Merino (Russian), and also with the Inner Mongolian Fine-Wool type.

The Northeast China Fine-Wool is reported to have finer wool and heavier fleece weight than the Inner Mongolian Fine-Wool. In addition to these three new fine-wool breeds of sheep, the following additional improved wool breeds are also being developed: (1) The Inner Mongolian Semifine-wool. Development of this breed is considered to be nearly complete. Its progenitors include the Tsigai breed, from Russia, crossed with the Inner Mongolian Fat-Tail (Figure 5). The Lincoln and Romney were also used to a lesser extent, primarily to increase staple length. (2) The Northeast Semifine-Wool. Lincoln and probably Corriedale males crossed on the coarser-wool Northeast Fine-Wool sheep and also on the Northeast native sheep served as the genetic base for this new breed.

We were also told of a medium-wool sheep that is being developed in northeast China by crossing the Corriedale and the Lincoln with the native Northeast China sheep. Other new breeds are also reportedly being

TABLE 1 Breeds of Sheep Imported into China for Genetic Improvement of Native Sheep[a]

Breed	Type of Wool	Import Date	Present Location	Location Where Used for Crossbreeding	Source
Caucasian Merino	Fine	1930's	Inner Mongolia	Xinjiang	USSR
		1952	?	Northeast, Inner Mongolia	
Rambouillet	Fine	before World War II	Northeast (?)	Northeast	Japan
Soviet Merino	Fine	1950	Northeast	Northeast, Hebel	USSR
Askanian Merino	Fine	1951	Northeast	Northeast, Inner Mongolia	USSR
Tsigai	Medium	1951±	Inner Mongolia	Inner Mongolia, Qinghai	USSR
Karakul	Coarse	before 1956	Inner Mongolia	Inner Mongolia, Xinjiang Ningxia, Gansu, Northeast	USSR (?)
German Merino	Fine	1960's	Northeast	Northeast	Europe
Lincoln	Long	1965 ?	Inner Mongolia	Inner Mongolia, Jilin, Yunnan	Australia/
		1977	Jilin, Yunnan	Sichuan	New Zealand
Corriedale	Medium	1967-68	Northeast	Northeast	Australia/
		1967-68	Jiangsu	Jiangsu	New Zealand
Romney Marsh[b]	Long	1967-68	Jiangsu	Jiangsu	Australia/ New Zealand
		after 1970	Inner Mongolia	Inner Mongolia	New Zealand
Border Leicester	Long	after 1970	?	?	Australia/ New Zealand
Australian Merino[b]	Fine	1970's	Northeast Xinjiang	Northeast, Xinjiang	Australia
Dorset[b]	Fine	1978	Inner Mongolia	Inner Mongolia	?
Suffolk[b]	Medium	1978	Inner Mongolia	Inner Mongolia	New Zealand
Hampshire[b]	Medium	1978	Inner Mongolia	Inner Mongolia	New Zealand
Stavropol Merino	Fine	?	Northeast	Northeast	USSR
Altai Merino	Fine	?	?	?	USSR
Precoce	?	?	?	?	USSR

[a]Part of this information was obtained from T. Y. Lin, Inner Mongolia Animal Husbandry and Veterinary Scientific Research Institute, Huhehaote (personal communication) and An Min, Department of Animal Science, Beijing Agricultural University, Beijing (personal communication).

[b]Imported only in small numbers of only one or two rams, or several ewes of each breed as gifts from foreign countries.

TABLE 2 Reproduction and Production Data on Chinese Breeds or Genetic Types of Sheep[a]

	Breeds				
	Mongolian Fat-Tail	Wuzhumuqin (Uchumoochin)	Tan Yang	Inner Mongolian Fine-Wool	Hu (Lake Sheep or Wusin)
Location	All of Inner Mongolia	Inner Mongolia	Ningxia	Inner Mongolia	Jiangsu and Zhejiang
Products	Meat, wool, fur	Meat, fur, wool	Lambskin, fur, wool, meat	Wool, meat	Lambskin, meat, wool
Mature weight (kg)					
Males	50-65	65-75	45-55	75-85	40-60
Females	45-50	50-55	30-45	45-55	35-50
Tail type	Fat	Fat	Fat	Thin	Fat
Age at puberty of female (mo.)	7-8	5-7	5-6	6-7	4-5
Prolificacy	100-110	100-105	130-140	110-120	220-240
Lambing interval (mo.)	12	12	12	12	6
Fiber					
weight (kg)	1.2-1.5	1.0-1.3	1.2-1.8	10.15 (male) 4-6 (female)	1.0-2.25
staple (cm)	7-8	5-6	8-10	7.5	4.5-7.5
grade	--	--	--	62's, 64's	--
No. of times shorn/year	2	2	2	1	2
Type of management	Extensive	Extensive	Extensive	Extensive	Intensive

[a]Part of this information was obtained from T. Y. Lin, Inner Mongolian Animal Husbandry and Veterinary Scientific Research Institute, Huhehaote (personal communication) and An Min, Department of Animal Science, Beijing Agricultural University, Beijing (personal communication).

FIGURE 4 An Inner Mongolian Fine-Wool sheep from a flock near Xilinhaote, Inner Mongolia.

developed. These include the Qianghi Semifine-Wool, which is a result of selection following a cross of the Tsigai and the native Tibet ewes, the Sanbai, or Three North, lambskin breed, which is being developed by crossing the Karakul with the Inner Mongolian Fat-Tail, and a cross being developed in Jiangsu from the native Hu sheep and the Romney Marsh and Corriedale breeds.

Plans are being developed in Inner Mongolia at the Inner Mongolian

FIGURE 5 An Inner Mongolian Fat-Tail sheep. This breed was the native breed from which other newer breeds such as the Inner Mongolian Semifine-Wool and Inner Mongolian Fine-Wool were developed.

Animal Science Research Institute, Huhehaote, to develop a meat or dual-purpose type of sheep by crossing the Hampshire and/or Suffolk breed with the Inner Mongolian Fat-Tail and/or the Wuzhumuqin.

The introduction of new germ plasm and the development of new genotypes or breeds of sheep over the past 30 years have resulted in the development of comparatively large numbers of crossbred animals. For example, of the estimated 10 million sheep in Inner Mongolia, there are, in addition to approximately 100,000 Inner Mongolian Fine-Wools, approximately 2.8 million crossbreds, which means that they contain varying degrees of improvement from crossing the improved wool breeds (Figure 6).

GENETIC IMPROVEMENT OF GOATS

Although a significant proportion of the goats in China has been crossed with exotic breeds, there seems to have been no planned crossing program or subsequent selection program to take advantage of these new genetic combinations. Many of the goats that we observed in the agricultural areas (Figure 7) showed evidence of crossing with dairy breeds, such as the Saanen, Alpine, and possibly the Toggenburg, and also with Indian breeds, such as the Beetal and Jamunapari.

Although we saw none of these animals, we were told that both Angora and Kashmir goats had been imported into China, probably before 1949. Apparently, they have been crossed with native goats in the extensive goat-producing pastoral areas to improve fiber production. We found no evidence, however, of any follow-up selection programs for continued genetic improvement.

We obtained information in Inner Mongolia on three breeds of goat in

FIGURE 6 A Hu or Lake sheep from a small flock at the Malu Commune near Shanghai. The breed is known for its prolificacy and is usually kept in close confinement.

FIGURE 7 The Southeast China goat is a small, short-legged goat used for meat. They are either white or black in color. This goat was privately owned by members of a commune near Guangzhou.

that region--the Mongolian, Erlangsham, and Aerbasi--that are present in relatively large numbers (Table 3). Each of these produces secondary fibers or undercoats of downy wool similar to cashmere and used for the same purpose. In particular, the Erlangsham and Aerbasi may contain some breeding from the Kashmir goat of India. We found no evidence of genetic improvement in goats for meat production.

There is no artificial insemination practiced in goats in China, except possibly in a few state-owned goat dairies. This is likely true in part because goats are less accessible because of their location and type of management than other major farm animals. But it also appears to reflect a lack of emphasis on their genetic improvement.

One exception in which some selection in goats for genetic improvement has apparently been practiced is in a goat dairy near Guangzhou, where goats have been upgraded through breeding with the Saanen buck. There are reportedly small flocks of purebred dairy goats, such as the Saanen, located in Shǎnxi Province.

BASIC RESEARCH IN ANIMAL BREEDING

We did not observe research projects emphasizing basic research in animal genetics. Considerable basic research with plant genetics is being done at the Institute of Genetics, Chinese Academy of Sciences. These projects include sophisticated studies, such as the hybridization of DNA. However, animal genetics research involving cellular genetics or population genetics is not being done. The efforts in the animal area are more physiological, with the development of embryo transfer technology receiving high priority.

SUMMARY

All the genetic improvement work in livestock in China has been, and to a great extent is now being, carried out on a local basis. This is true

TABLE 3 Reproduction and Production Data on Chinese Breeds or Genetic Types of Goats[a]

	Breeds		
	Mongolian	Erlangsham	Aerbasi
Location	Inner Mongolia	Inner Mongolia	Inner Mongolia
Products	Fur, meat, down wool	Fur, meat, down wool	Fur, meat, down wool
Mature wt. (kg)			
Males	35-40	45-50	40-50
Females	30-35	35-40	30-40
Age at puberty of female (mo.)	7-8	7-8	7-8
Prolificacy (%)	102-104	103	104
Lambing interval (mo.)	12	12	12
Fiber			
weight (kg)	0.3	0.3	0.4
down (g)	150-200	220	300
staple (cm)	10-11	14	20
No. times shorn/ year	1	1	1
Type of management	Extensive	Extensive	Extensive

[a]Part of this information was obtained form T. Y. Lin, Inner Mongolia Animal Science Research Institute, Huhehaote (personal communication) and An Min, Department of Animal Sciences, Beijing Agricultural University, Beijing (personal communication).

even though large numbers of animals are involved in some programs and breeding centers may distribute semen over quite large geographic areas. This indicates that there are no national or even provincial programs at present and that each local program may be carried out often quite independently of others. There is broader distribution of genetic material among the improved dairy cattle, which constitute more or less one genetic type.

In recent years, there has been greater emphasis on cooperative efforts among state farms or research institutes, within and even between provinces, in an effort to improve production in livestock. Centers are developing in which careful attention is being paid to cellular, Mendelian, and population genetics and their application to increasing food production. The application of these efforts will greatly increase the effectiveness of genetic improvement programs in China.

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NUTRITION RESEARCH

James E. Oldfield and Virgil W. Hays

As we were told repeatedly, animal science research output in China virtually ceased during the Cultural Revolution. Universities and their attendant research institutes were closed for all intents and purposes during the decade 1966-1976. As Wiens[1] put it, "Most of the achievements of Chinese research in animal husbandry and veterinary science, including those of local as well as world significance, seem to have been made before the Cultural Revolution (1965)."

Evidently considerable revision and restructuring of the research establishment has taken place since 1965, and we had the impression that the research institutes had survived rather better than the universities and that considerable decentralization of the institutes had taken place. Among the disciplines contributing to animal science, the Chinese appear to have placed emphasis on applied areas of reproductive physiology--especially artificial insemination--and on some of the more theoretical aspects of animal genetics. Nutrition research appeared to be in the doldrums.

Briefing from government officials confirmed that China has understandably placed priority in the development of agriculture on the production of cereal grains, in which notable success has been achieved. The Chinese are naturally reluctant to allow competition by livestock for substances that can be used as human food; therefore their animal feeding practices are developed around forages of various types, including aquatic plants, and certain by-products of the human food industries, including milling by-products and sugar beet pulp. Considerable attention is paid to formulating rations based on such feedstuffs, and great interest is shown in the tables of nutrient requirements developed by the U.S. National Research Council.

To a great extent, nutrition research depends on instrumentation and analytical methodology, and deficiencies in these have contributed to the current state of animal nutrition research in China. With one or two exceptions, basic equipment items in the laboratories that we visited were either obsolete or lacking. Laboratory staffs, on the other hand, tend to be reasonably well read and up to date in their understanding of nutritional problems and are looking forward eagerly to provision of the tools and support with which they might get on with the search for solutions. The study necessary for this understanding must have been difficult, particularly in recent years, since the libraries visited generally contained somewhat patchy selections of the world's literature.

Although some attempts have been made to assemble data on feed composition, these were local rather than national in scope. This task is made more difficult by the lack of a nationally oriented feed industry. In fact, livestock feeding in China is very much forage and plant-waste dominated. These feed sources include weeds and field wastes, green-manure crops like vetches, leaves of vegetables, and surplus or cull crops such as cabbages, squashes, and melons. It is recognized that supplementation of these materials is necessary to permit reasonable productivity of the animals fed, and this is provided by grains and their milling residues when supplies permit.

Only about 10 percent of the total grain crop is used in this way, we were told, and grains to be used as feed are carefully selected, emphasizing use of barley, corn, sorghums (kaoliang), oats, peas, and soybeans, with rice and wheat reserved almost entirely for human food. Analytical definition of these varied feedstuffs has been attempted, largely following the traditional proximate analysis scheme. Great opportunities exist to expand on these basic characterizations in the future. In particular, analyses to establish the levels of essential minerals and vitamins would be useful in formulating more-productive feeding programs and in typifying important differences in the vast and extremely diverse array of feedstuffs.

In this connection, a curious paradox exists. Although knowledge of mineral deficiencies and their symptoms in both humans and animals is widely held, there appears to be little organized effort to apply the information systematically in practical animal husbandry.

Some research effort has been directed toward extending the usefulness of roughage feeds. At several lecture sessions held between the delegation and Chinese scientists and husbandmen, repeated questions were fielded on ways in which forage consumption could be increased by monogastric species, such as the pig. In some instances evidence was provided of some fairly fundamental approaches to this problem. Reports were heard, for example, of studies conducted on production of cellulases by molds, for fiber breakdown, at the Guangdong College of Agriculture and Forestry.

Such studies indicate both a laudable effort to maintain some rather basic research in the face of heavy pressure for short-term, quick-payoff studies and also a willingness to engage in multidisciplinary research approaches. There are few such examples, and opportunities to introduce some direction into animal nutrition research on a national scale seem attractive.

Two examples of such direction include the compilation of data on nutrient composition of feedstuffs in common usage in China and the charting of incidences and severity of deficiency diseases and their causes among Chinese livestock. It is paradoxical that although selenium deficiency in humans is recognized in China (Keshan disease), little progress is evident in its investigation as a livestock feeding problem.

The announced intention of the Chinese government to increase animal production in specific areas that would be noncompetitive with sources of human food provides an incentive for studies of forages and their use as feed. Two notable examples were viewed by our delegation.

In Inner Mongolia, near Xilinhaote, what appears to be an effective program of range forage research is under way at the Grassland Research Institute, directed by Dr. Li Ming. The institute's program includes identification and propagation of suitable species of plants to improve the livestock-carrying capacity of the Mongolian rangelands and also efforts to reduce problems caused by undesirable plant species, including poisonous weeds. Naturally, the rigorous climate and growing conditions in the inland, northern area strongly influence the types of plants that will grow there effectively. Various wheatgrasses and barley grasses are under investigation; surprisingly, crested wheatgrass, the standby of Western American ranges, is not highly rated.

Emphasis is being placed, rightly we thought, on identification of suitable legumes that would increase soil fertility and provide needed protein in the diets of grazing animals. Many alfalfa cultivars have been assembled, and a native, hardy, yellow-flowered type seems particularly promising. Most of the plants under study at the institute had been gathered from nearby, native range stands, thus ensuring a degree of hardiness. They were then brought to the institute plots for multiplication and seed production and then, we were told, were farmed out to communes for further development under local soil and weather conditions. The staff members were encouraged by the responses that they had been able to obtain by fertilization--specifically the treatment of seeds with the trace elements boron and molybdenum, which significantly increased early yields. Further studies are planned to investigate intake and digestibility of these selected plants by livestock, but so far as we could tell, these studies are not yet under way.

Reduction of competition by unwanted plants is being accomplished by a number of techniques, including use of selective herbicides. Big sagebrush does not appear to be a problem in the pastoral areas visited, but a small, spiny broadleaf that grows quite profusely causes damage to mouths of grazing animals, as well as using needed soil moisture, and is a target for removal. A visit to a state farm about 60 km from Xilinhaote suggested that research into mineral supplementation might be productive. There appears to be some need for phosphate feeding, and the practice of adding suitable sources to the drinking water, as practiced during the development of the King Ranch in Texas, seems potentially attractive.

Later, at the Jiangsu Academy of Agricultural Sciences, we heard presentations on the feed value of various aquatic plants, including *Pistia*, *Eichornia*, and *Alternanthia* genera. Efforts in this direction are logical because there are limited land areas for livestock feed production, considerable tracts of inland waterways are available, and growing conditions are suitable for large yields of selected water plants. The species under investigation are capable of yields of over 182 metric tons per 0.06 hectare, wet weight, and more than one crop annually could be grown. The dry matter content of these plants varies widely, and high dry matter yield is an important selection criterion.

The search for alternative feed sources for livestock has included some imaginative approaches. In Beijing, both institute and university investigators described studies in production of leaf protein meals and concentrates using, among other things, the leaves from *Acacia* shrubs that are widely used to border highways and major city traffic routes. The protein content of such meals is satisfactory for their use as protein supplements, and presence of interfering or toxic factors in them does not appear to be a problem.

Although the restrictions on evaluation of an extremely varied national research program in the short time span available to us are obvious, our impression was that animal nutrition has great, but as yet largely untapped, potential.

REFERENCE

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13

ANIMAL HEALTH

John L. Hyde

INTRODUCTION

This report discusses diseases of food-producing animals and methods for controlling or preventing such diseases.

We had no opportunity to see diseases in the field or to see autopsies or sick animals at the institutes that we visited. The only obvious clinical lesion observed was in a single pig; it was an opening in the skin of the jowl area made either by a lance or by a break to the outside, probably a jowl abscess. Occasionally, we saw what appeared to be the beginning of atrophic rhinitis. Most of what we learned about animal health in China came from presentations by Chinese scientists.

The research facilities that we visited varied from poor to fairly good. The equipment was 12 to 15 years old and appeared to have been used very little. One of the institutes that we visited, the Veterinary Institute in Harbin, appeared to be doing the most advanced virological research on animal diseases in China. Finally, we did not visit enough diagnostic laboratories to obtain firsthand information on the number of samples or animals presented each year and how well the laboratories were integrated.

Thirty days is hardly sufficient time to learn very much about the art and science of veterinary medicine in China. We did, however, visit several research institutes. As far as the basic knowledge is concerned, one would not find fault with the older, classical studies, such as pathology, anatomy, bacteriology, parasitology, physiology, and prevention of disease through the use of bacterin for vaccines. However, in the veterinary institutes that we visited, except at Harbin, Chinese scientists are not applying newer techniques and knowledge, although they are aware of them. This newer knowledge is primarily in the areas of virology, immunology, and cell-mediated immunity, and some new methods are being applied in clinical pathology. In particular, again except at Harbin and to some extent even there, Chinese scientists are not using the latest techniques available for studying diseases caused by viruses, including diagnosis, pathogenesis, the immune response, and studies in molecular biology. This last statement must be taken as pertaining only to veterinary research.

We did visit some human disease facilities in which the work is quite good, especially in endocrinology, mineral deficiencies, reproduction, and pathogenesis. The one veterinary diagnostic laboratory that we visited, where there were eight people working, received about 100 samples a year. When asked what they did if they were concerned about a virus's being present, the workers replied that they referred the sample to the local hospital.

In summary, it is evident that, given time, the Chinese will progress rapidly because they are eager to learn and are extremely capable of working with new techniques. They will have to spend some money on more up-to-date equipment if they are to attempt research in those areas that are important in understanding basic mechanisms of disease processes. Remember, however, that these observations and opinions are based on a visit of a mere 30 days in a huge country with numerous institutes, many of which we did not see.

ANIMAL HEALTH--CONTROL IN GENERAL

Bacterial and viral respiratory diseases, a problem in most animals, are, of course, more serious in areas where there is more stress because of environmental changes--i.e., changes in temperature, humidity, and exposure. Except possibly at two or three facilities, we saw no diagnostic virology being done as we know it in the United States. Although knowledge of bacterial diseases is fairly good, the diagnostic capability for viral diseases leaves much to be desired in the way of accuracy and completeness.

Foot-and-mouth disease is said to have been eradicated in some places and controlled in other places by vaccinating along the borders, especially the southern borders. The Chinese are vaccinating against types A and O; there is no vaccine for the Asia type of the disease. The vaccine used is a mouse-attenuated live vaccine.

Japanese B encephalitis is present in virtually all parts of China. A vaccine with virus attenuated in cultured hamster kidney cells is used for horses and, in some areas, for pigs. There is also a vaccine for use on humans. Many species of animals susceptible to Japanese B encephalitis virus are not protected by vaccination.

Swine influenza; colibacillosis; actinomycosis; coccidiosis (mostly in chickens and rabbits, but sometimes in other animals); indigestion in ruminants, pigs, and horses; and internal parasites in all species, including chickens, are problems in raising animals. Neoplasms similar to those encountered in the United States are seen. There are plans to begin work next year at Harbin on colibacillosis and pseudorabies.

Anthrax and blackleg are seen in all ruminants, and malignant edema occurs in ruminants as well as in horses and swine. Necrobacillosis is seen in sheep and cattle. Salmonellosis occurs in ruminants, horses, chickens, and pigs. Tetanus can be a problem in ruminants as well as in horses and swine. Pasteurellosis is a problem in most animals, especially in sheep, pigs, cattle, and goats. Colibacillosis is seen in all species. Although vaccines are used against it, brucellosis occurs, especially in cattle, sheep, pigs, and goats. It is questionable whether the mastitis-metritis-agalactia syndrome is present in China; however, mastitis from *Escherichia coli* does occur in sows.

Leptospirosis occurs in pigs, sheep, horses, dogs, cattle, and man. Although man is vaccinated against *Leptospira pomona* 396 and *L. grippotyphosa*, no *Leptospira* vaccines are available for animals.

Selenium deficiency is found in certain parts of China. Essentially, all species of animals, including man, are affected. The principal lesions in animals are seen in the skeletal muscles, much like those we see in lambs and calves in this country in so-called white muscle disease. Deficiencies in other minerals, including iron and sulfur, also cause disease. There is avitaminosis A, B_1, and B_2, especially in poultry.

Diseases of Swine

We asked about the presence of vesicular diseases in China wherever we traveled. We were especially interested in finding out whether anything resembling swine vesicular disease had ever been present. The Chinese said that they had never seen it. This is curious since the Italians concluded from their traceback after the first outbreak of the disease in Italy that swine imported from China were the source of the infection.

The major disease problems in swine are digestive diseases, transmissible gastroenteritis, swine edema, erysipelas, atrophic rhinitis, enzootic pneumonia (mycoplasmosis pneumonia), and swine abscesses.

Swine edema is caused by a hemolytic *Escherichia coli*. It appears at 3 to 4 months of age or shortly after weaning. The edema is seen along the mesenteric and gastric mucosa and is accompanied by an abundance of ascitic fluid, sometimes with fibrin.

Erysipelas, pasteurellosis, and hog cholera are controlled by use of a triple vaccine, really a virus/bacterin mixture. The attenuated bacterins for erysipelas and *Pasteurella* are not so effective as the Chinese would like. They are administered orally or parenterally, but more organisms are needed for oral than for parenteral administration. Hog cholera vaccine is a virus attenuated in rabbits (lapinized). It is lyophilized and administered twice a year. Vaccination is compulsory and apparently is very effective, because hog cholera or classical swine fever is not much of a problem.

In the Harbin area, research is in progress on transmissible gastroenteritis and atrophic rhinitis. Work on prevention of atrophic rhinitis is concentrated on the *Bordetella bronchiseptica* organism.

Enzootic pneumonia, caused by *Mycoplasma hyopneumoniae*, is a problem, especially in breeding herds. Work on enzootic pneumonia is being done in Beijing, Shanghai, Nanjing, and Guangzhou.

Swine abscesses are a problem, mostly in the south. The disease is referred to as streptococcosis of swine.

Brucellosis is a problem in swine, especially in the southeastern part of China. Sows are vaccinated. Any animals found positive are slaughtered. Strain 19 brucella organisms were used for vaccination against brucellosis in the past, but this vaccine is no longer being produced. The Chinese now use two strains, referred to as Strains 2 and 5. Strain 2 was developed from *Brucella suis* and is given orally in drinking water to pigs and sheep. If it is injected parenterally, it produces abscesses. The Strain 5 brucellosis vaccine, made from

Brucella melitensis, is administered by inoculation or aerosol, mainly in sheep and cattle, and apparently is satisfactory.

Beta hemolytic streptococci produce an acute, high fever with hemorrhage. This disease is differentiated from that caused by *E. coli* in that it is more acute and involves a higher fever. The disease can occur at any age and is most prevalent in the south of China. It can resemble erysipelas. Once this disease is detected, antibiotics are effective in treating and controlling it.

Some other diseases that occur in swine, as well as in other animals, are anthrax, salmonellosis (serotypes unknown), tetanus, and toxoplasmosis. In some parts of China, the incidence of toxoplasmosis in pigs is as high as 30 percent. There is concern about rotaviruses, and there is some evidence that rotaviruses are a problem in China. Pseudorabies is present but apparently sporadic. Trichinosis is present. Tuberculosis is also present; however, most of the tuberculosis in swine originates as bovine tuberculosis. The Chinese have not seen the avian type yet; if it is present, it has not been recognized.

Diseases of Chickens

Newcastle disease is controlled by vaccination with chick embryo vaccine containing virus of Strains 1, 2, F, and LaSota attenuated. Strain 1 is the Indian strain Mukteswar; Strain 2 is the Hitchner strain. Newcastle vaccine is administered by aerosol, which is calculated to supply 1 ml of virus-containing allantoic fluid for 500 chickens at 1 month of age. The vaccine is also administered in drinking water and intranasally at 1 day; then, at 1 month, the chickens are exposed to the aerosol. If chickens are exposed by aerosol at an early age, e.g., 1 day, they often develop mycoplasmosis. Fowl plague or pathogenic influenza in birds has not been observed. Infectious bronchitis is a problem, especially in state-owned confined-rearing operations; research to develop a vaccine is under way.

Leukosis is widespread. The Chinese are doing what everybody else is, i.e., living with it. Leukosis is the greatest obstacle to establishing specific-pathogen-free birds.

Infectious laryngotracheitis is quite common in the southern part of China. There are no protective measures, but work is under way to develop a vaccine.

Adenovirus infections are being looked for, and indications are that they may be present in some flocks.

Chicken pox was a problem, but it is now controlled by using a pigeon pox virus vaccine. Marek's disease is controlled by vaccination. Viral encephalitis has been suspected in birds, but no virus has yet been isolated.

Mycoplasma synoviae is present in broilers in China but apparently is not a major problem; there is no vaccine, and the development of one has been given low priority. Chlamydial infections are thought to be present but so far have not been identified; if present, they must not be a serious problem. Chronic respiratory disease is seen mostly in confined operations.

Aflatoxin problems are seen in pigs and poultry fed moldy grain. Aflatoxin in chickens is seen mostly in the southern part of China and is associated with moldy peanut meal. In the north, it is due to moldy corn.

Immunization against fowl cholera is by aerosol; each bird is exposed to 100 million to 200 million attenuated *Pasteurella multocida* organisms. The organisms are cultivated at 20°C to 22°C and passaged several times, until they are determined to be safe for use.

Salmonellosis in poultry is widespread.

Infectious coryza is not seen much; no protection is yet available. The use of antibiotics in feed is said to be effective.

Diseases of Ducks and Geese

Fowl cholera, salmonellosis, and parasites (especially coccidia) are the most serious diseases of ducks. Piperazine is used to control roundworms.

Pesticide residues were a big problem when DDT was used. More organophosphates are used today, and these can have serious effects, including paralysis and death.

In addition to diseases mentioned above, some major diseases of ducks in the United States are also seen in China. They are duck virus hepatitis, *Pasteurella anatipestifer* infection, colibacillosis, salmonellosis, necrotic enteritis, aflatoxin poisoning, and duck plague (duck virus enteritis).

According to the Chinese, the most serious disease of geese is a viral disease, gosling plague. The characteristic lesions are granular swellings on the intestine. Apparently, every few years there is an epidemic of this disease. It is seen only in young geese. For control, older geese are vaccinated, which results in passive antibody transfer to the newborn, protecting them until they pass the age of susceptibility or become immune from exposure while carrying the protective antibody. Fowl cholera is not a serious problem in geese. According to the Chinese, coccidiosis is not seen in geese.

Diseases of Cattle

The shipping fever syndrome in cattle that we see in the United States either does not exist or is not recognized in China. When animals are shipped by rail, they are off-loaded, fed, and watered along the way. The estimated time for shipping cattle from the railroad depot, 400 km from Huhehaote in Inner Mongolia, down to Shanghai, Guangzhou, or Hong Kong is about a week.

The Chinese said that they do not see bovine virus diarrhea or mucosal disease and parainfluenza-3; if these diseases are present, they have not been recognized. Bluetongue is not seen in China in either cattle or sheep.

The malignant catarrhal fever that occurs in China is much like that seen occasionally in the United States. It is always associated with the presence of sheep, and usually one or two animals in a herd are affected. The 20- to 30-percent infection rate that we have seen in the United States in recent years has not been seen in China. *Pasteurella hemolytica* evidently is a significant problem in cattle.

Paratuberculosis is seldom found and, when found, is in imported cattle. Here again, it is questionable just how carefully the Chinese are looking for this disease. As in the United States, paratuberculosis is probably far more prevalent than is recognized.

Foot rot is rarely a problem in cattle.

Bovine leukosis is seen clinically and histopathologically; frank lymphatic leukemia also occurs, mostly in the northwestern part of China in cattle imported from Germany. This is another instance of the hazards of importing animals from foreign countries apparently without any previous testing or regulations requiring testing for diseases that do not exist in China.

Mycotoxicosis in cattle, from eating moldy sweet potatoes, was formerly seen quite frequently. Lesions are primarily in the lungs; there is severe pulmonary emphysema. In 1955, there was a severe outbreak in the central part of the northwestern part of China. However, mycotoxicosis today is no problem since the Chinese know the cause and avoid it.

Ringworm occurs in cattle.

As in this country, poisonous plants can be a problem, especially in the pastural areas and under conditions of drought and overgrazing.

Diseases of Sheep and Goats

Foot rot does occur in sheep, but evidently it is not so big a problem as it is in the United States. Caseous lymphadenitis has not been seen in sheep.

Enterotoxemia is a problem primarily in sheep. *Clostridium perfringens* vaccine, types C and D, are used for prevention.

Rabies outbreaks occur along the border in mountainous areas where foxes are found. It is seen in cattle and horses, and other species may also become infected.

Sheep pox is occasionally seen in the pastural areas (Inner Mongolia); sheep are vaccinated to prevent the disease.

Listeriosis is recognized in the sheep population.

Internal parasites, including *Echinococcus granulosus*, are one of the more economically important problems in sheep as well as in other species of animals.

White muscle disease (selenium deficiency) occurs in sheep much as it does in the United States.

There is a goat abortion problem in Inner Mongolia. The cause is not known, but the history indicates that abortion occurs only in the first or second pregnancy; that is, older animals do not have a problem with abortion like that seen in young does.

There is a problem of fly maggots in wounds sustained by animals in Inner Mongolia.

Diseases of Horses

The filaria, *Onchocerca cervicalis*, which gets into the spinal cord and brain and is sometimes seen in the eye of horses in the United States also occurs in China.

Piroplasmosis is seen; the Chinese know that *Babesia caballi* is present, but they are not sure about *B. equi*.

Equine influenza occurs, and no effort is made to prevent it by vaccination.

Glanders and strangles are present. Glanders is diagnosed by the mallein test.

Aneurysms are occasionally found in horses.

Horses are vaccinated to prevent anthrax, tetanus, and Japanese B encephalitis, and a *Pasteurella* bacterin appears to be of some benefit against pasteurellosis.

In Inner Mongolia, we were told that horses contract contagious pneumonia. Lesions consist of a heavy, thickened pleura.

Parasites in Livestock

Parasites are a problem in many areas of China. Roundworms are a significant problem in swine. In some areas, coccidiosis is not severe in swine, and it is seldom seen after 1 year of age; in others, coccidiosis is severe, especially in poultry. The swine kidney worm is seen, but how much damage it causes is not known. *Sarcosporidia* is a problem in swine as well as in cattle. *Echinooccus granulosus* is seen in pigs, cattle, and sheep. The tapeworms *Taenia saginata* and *T. solium* are known. *Trichinella spiralis* is reported in pigs.

Trypanosoma evansi is seen mostly in water buffalo. There are no clinical signs of infection in cattle, but the parasite can be found in cattle. Babesiosis is seen occasionally throughout the country, mostly in the low ranges around the Yellow River. The Chinese say that it is seen in imported breeds. The yellow indigenous cattle are resistant but can be carriers of the parasite, which is transmitted by ticks. Schistosomiasis (caused by *Schistosoma japonicum*) is seen in cattle, water buffalo, and humans. *Fasciola hepatica* (and, in southern China, *Fasciola gigantica*) is seen in sheep, cattle, and water buffalo. Lungworms are present in sheep, pigs, and cattle.

Internal and external parasites are a problem, especially in birds raised on ground. Histomoniasis (blackhead) is seen in chickens, but it is not important. The Chinese have no method to prevent it.

HERBAL MEDICINE

As far as herbal medicine is concerned, we concluded that we have much to learn from the Chinese. After all, they have used herbal medicines for 4,000 years, and, according to them, such medicines do work. It should be pointed out, however, that when the Chinese encounter an infectious disease that does not respond to herbal medicine, or for which herbal medicine is not indicated, they readily switch to antibiotics where appropriate.

Acupuncture

In Guangzhou, we were privileged to observe the use of acupuncture for anesthesia during surgery, a rumenotomy, on a bovine animal (South China cow) (Figure 1). Having seen movies before about the use of acupuncture for such surgery, we were not particularly skeptical about its effectiveness, but actually to see the whole process is very convincing.

The preoperative preparation of the animal was excellent. The surgical site was shaved and disinfected with iodine. The surgeons used aseptic techniques with one exception: they did not wear gloves except when they removed contaminated material from the rumen. The scrub for surgery was meticulous and well done, as were the draping procedures and packing during the surgery. The surgeons were as competent in their work as any surgeons in other parts of the world.

FIGURE 1 Use of acupuncture anesthesia for surgery on a cow, Guangzhou.

Before surgery, three needles were inserted into the animal. She did not seem to object to the insertion of the needles. One needle was inserted just posterior to the last thoracic or rib vertebra. Another was inserted behind the last lumbar vertebra into the lumbosacral fossa. The third needle was inserted on the left side of the animal dorsally in the area to which we refer as the paralumbar fossa, where we usually do our local blocks for a rumenotomy.

After the needles were inserted, clamps from a wire leading to a box that served as a voltage and amperage regulator were placed on the top of each needle. The current was turned on and the animal became slightly rigid and was easily laid down on the operation mat. The voltage applied was 70 V, and the amperage was 70 mA; this current was continued throughout the surgical procedure.

From the beginning, i.e., the insertion of the needles and application of current, until the surgeons finished, the procedure lasted about 33 minutes. The only time the cow moved was during the initial incision into the skin and during closure of the skin, and then with only a few slight twitches. Halfway through the surgical procedure, an animal caretaker offered an eggplant vine to the cow, which she readily ate. At the end of the surgery, after the current was turned off, the animal stood up and started eating. She showed no signs of postoperative discomfort and she did not stagger.

The professor responsible for the surgery said that he was somewhat discouraged about the way acupuncture is being abused around the world. He definitely stated that it is not useful for every procedure but it is effective in most procedures for ruminants. With the horse, it is not always useful for surgical procedures but does seem to be of help in lameness and joint problems.

It would be a great opportunity for a person interested in anesthesia to spend 1 to 2 years at this veterinary institute in Guangzhou to learn the details of acupuncture and its proper application. In addition, perhaps arrangements could be made for one or more persons interested in pharmacology to participate in studies currently under way at various installations to determine the active ingredients in some of the herbal medicines.

CONCLUSIONS

One of the most significant observations that we made was of the great number of people taking care of animals. As a result, animal care is excellent and animals are tame. It seemed that wherever we went, if there were only three or four ducks or pigs or even one animal, there was always someone with them. This continual care and observation probably helps to decrease mortality and morbidity among livestock and poultry in China.

There appears to be no question that China has germ plasm, especially of swine, that might benefit the American producer. At the same time, the Chinese want to obtain American germ plasm, not only from swine, but also from other animals. Before we can consider importation of germ plasm, we must have definitive information on the animal disease situation in China. Although the Chinese tried to give us the full picture, it seems likely that they have animal diseases of which they are not aware. This assumption is based, in part, on the knowledge that the Chinese have imported animals from countries in which diseases exist that are said not to be present in China. Also, Chinese diagnostic work, especially virological diagnosis, needs much improvement.

Although the Chinese scientists are up to date on the veterinary literature, general impressions from the scientific standpoint lead to the following two important areas of concern:

a. Do the Chinese know the animal disease situation in China today? The information we obtained from the Chinese researchers and a visit to one diagnostic laboratory leaves the question largely unanswered. After the overthrow of the Gang of Four, Chinese scholars are just getting started again after many years, so there is a great shortage of the younger, well-trained people. However, the Chinese believe that the shortage will be alleviated after a few years.

b. The importation of animals into China has been indiscriminate, probably because of a lack of uniform rules and regulations. At one point, we were told that the Minister of Trade issues import permits for semen. Unless he is following the advice of someone, such as a veterinarian, who is well informed about the world animal disease situation, the Chinese are certainly taking great risks in importing animals or germ plasm from many countries.

For example, although scrapie in sheep has not been reported in China, one wonders if it is not there, because sheep have been imported from Europe. The Chinese are well aware, though, that some rapid and significant actions must be taken to prohibit the importation into China of animals with diseases that are not now found in China as well as animals with diseases that are already seen there. In other words, the Chinese must be sure to import only healthy animals.

Finally, it should be noted that the Chinese scientists whom we met are most eager for their younger, more promising students to gain experience and training at institutes of higher learning in other countries. Several mentioned the possibility of students' visiting the United States. We were impressed with their knowledge of up-to-date research and animal science in general.

The Chinese appear to have information to offer to countries that, in some ways, are more advanced in science and veterinary medicine. In this connection, it must be emphasized that there was no opportunity to spend time with Chinese veterinary practitioners; thus knowledge of the true art and science of veterinary medicine, with the exception of research, was not available to our group.

14

AN ANTHROPOLOGIST'S VIEWPOINT

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Before I departed for my first field research as a fledgling anthropologist, one of my teachers told me not to be too concerned about how much material I collected in the first month or two. "Later you will see that most of it was wrong anyway."

In 30 days, the Animal Sciences Delegation traveled nearly 7,000 miles, from Beijing to Huhehaote and Xilinhaote in Inner Mongolia, back to Beijing, and then to Harbin, Shanghai, Nanjing, Yangzhou, and finally Guangzhou. We never spent more than half a day on any of the sites we visited and never talked for more than an hour or two with any of the people we met.

This was usually time enough for my companions to assess the animals we saw--their breeds, their types, their weight, and their performance; but it was not enough time for the social scientist to learn much about the people who raise and eat these animals. A year in China would probably show me that I did not understand most of what I saw on this first trip.

Let me begin by placing the localities that we visited in perspective. On the basis of natural boundaries, transportation networks, and marketing systems, Skinner divides all China proper into eight major regions, each of which is subdivided into a core and a periphery, the cores consisting of densely populated lowlands dominated by major cities and the peripheries of sparsely populated uplands lacking large urban centers.[1] The Animal Sciences Delegation visited three of these eight regions--North China, the Lower Yangtze, and Lingnan. We saw nothing of Northwest China, the Middle Yangtze, the Upper Yangtze, Yun-Gui, and the Southeast Coast.

What is more important about the representativeness of what we saw, however, is that with the exception of the time spent in Inner Mongolia, our visit was confined to the cores of these three regions. Indeed, the trip to Inner Mongolia excepted, our view of China was formed in the major cities and their immediate suburbs. We were always within the circle in which vegetables from the countryside are exchanged for night soil from the city. This is important because it is unlikely that conditions within this charmed circle can be taken as representative of conditions in the country as a whole.

My impression of the animal industry in China may also be biased by the types of facilities that we visited. With the exception of the pastoral areas of Xinjiang and Inner Mongolia, there are three levels of administration in rural China, which are usually referred to in English as the production team, the production brigade, and the commune. Roughly speaking, the team encompasses a village, the brigade a cluster of villages, and the commune a market town and its natural hinterland.[2]

All these units operate farms engaged in some aspect of animal production, but the facilities become larger as one moves up the administrative hierarchy. Most of our time in the countryside was spent on state farms or enterprises managed by communes. We saw little (except from the bus) of units operated by teams and brigades and even less of the production activities of individual families. This means that, although we may have seen enough to permit our drawing sound conclusions about such facilities as artificial insemination stations, our ground is not so firm when we turn to animal production in general. The majority of all animals are raised by brigades, teams, and families.

One further point has to be made about the perspective that we were offered. In analyzing political events in their own country and abroad, the Chinese commonly assign the participants to such social categories as bourgeoisie, intelligentsia, and worker. Whether one finds this the most useful way of dissecting social phenomena, one surely has to agree that professors and scientists do not have the same perspective on events as truck drivers and vegetable farmers. They have different interests, different information, and different experiences. It is therefore important to note that almost all the people we spoke with in China were research scientists or administrators. We saw thousands of farmers from our bus, but we had little chance to talk with them.

Having pointed out some of the limits imposed on our view of China, I hasten to add that I am not accusing our hosts of trying to mislead us. They did not invite us to China to conduct a comprehensive survey of the animal sciences and animal production. They invited us to exchange information and ideas. We visited advanced facilities rather than typical facilities and talked with scientists rather than with farmers because that was most appropriate to our mission. The focus was on the future, not on the present or the past. In other words, my remarks are directed to our readers rather than to our hosts. The reader should know that although we saw a great deal in China, what we saw is still only a tiny fraction of the whole.

My first impressions of the People's Republic of China (which came in Beijing) were sharply contradictory. On the one hand, I felt that I was experiencing life in a society radically different from what I had learned to expect of China during five years in Taiwan. On the other, the manner with which our hosts greeted us at the airport was familiar and reminded me of similar events in Taipei. But the struggle between these two reactions was brief.

Once I had gotten used to People's Liberation Army uniforms and bobbed hair, my initial sense of being in a very different place subsided, largely because I found that most of the forms of behavior I had learned in Taipei were acceptable in Beijing. In fact, I think the most important discovery that I made in China is that it is Chinese. Although I have never subscribed to the view that culture is nothing more than a rationalization of more fundamental processes, I had expected to find Chinese culture transformed by the revolutionary changes in government and the economy. It is not. Those implicit patterns of behavior that identify a person as Chinese rather than Japanese or Greek endure.

This is not to deny that many (if not most) aspects of Chinese social structure have changed dramatically. One has only to ride through the countryside to see that this is a new society if not a new culture. The first thing to catch my attention was groups of 20 to 100 people working side by side in the fields. In Taiwan, farmers work alone or in groups of two or three. This difference is, of course, a manifestation of the shift from individual to collective ownership and management, but I suspect that the change involves more than these terms imply.

Many of the farmers whom I knew on Taiwan were sustained through long hours of backbreaking labor by the thought that they had inherited their land from their ancestors and would pass it on to their descendants. They worked for grandfathers and grandchildren as well as for themselves. But these thoughts are no longer valid on the China mainland. What then sustains the farmers working in the fields? Is the ideology of collective labor sufficient? Or is collective labor itself a critical condition? These are some of the questions that I asked myself as we hurried from poultry farm to pig farm.

Others were aroused by the composition of the groups I saw in the fields. With the exception of those few areas occupied by the Hakka, I rarely saw a woman working in the fields in Taiwan. On the mainland, however, I saw at least as many women as men. Indeed, it is my impression that women do most of the agricultural work in the suburbs of Beijing, Harbin, and Shanghai. Who then does the work formerly done by the women? To say that women on Taiwan do not work in the fields is not to say that they do not work. The women of the family that I lived with for two and a half years worked all day, every day. In addition to cooking, caring for children, and keeping house, they preserved foods and cared for all the animals except the water buffalo. Who carries this burden now? Do women do double duty in the fields and in the home? Do the elderly take up the slack? Or is the answer demographic? Are the women in the fields people freed from domestic duties by a later age at marriage and lower fertility?

By freeing many women from the home and the bonds of domesticity, the Chinese have greatly enlarged their labor force. It is not at all clear, however, that they are able to make effective use of the additional labor. In his chapter on the economics of animal production, Van Arsdall notes that "the labor supply is excessive relative to need, except perhaps for certain critical periods and workers with special skills" (chapter 3). The examples he gives also impressed me as evidence of serious underemployment. Most of the facilities we visited appeared to have two or three times as many employees as needed. Although it has not proceeded very far, an effort is being made to mechanize animal production. Perhaps this is premature. Animal production is not hampered by a shortage of labor, and all reports indicate that industry cannot absorb a large influx of young workers. Older workers are now encouraged to retire early just to make places for the next generation.

In the past, some China scholars accompanying delegations of this kind were not allowed to visit places not listed on the group's itinerary. Requests to visit a museum or spend a morning in a commune were sometimes denied. But I was not restricted in this fashion. While other members of the delegation were conducting seminars or touring laboratories, our hosts kindly arranged for me to make side trips to see things that were of particular interest to me as an anthropologist.

I spent half a day at the famous Evergreen commune near Beijing, another half day visiting a brigade a few miles south of Huhehaote, and most of a day talking to the members of a neighborhood committee in Shanghai. Although much of my time was spent discussing aspects of family organization that have little relevance to animal production, I think that my impressions of the places I visited are relevant and therefore worth reporting here.

Knowing that Evergreen was a model commune frequently visited by foreign delegations, I was disappointed when I learned that my request to visit a commune had produced this choice. In fact, the afternoon I spent at Evergreen was the most interesting and most profitable of the entire trip. In part, this was because the head of the commune, Wang Shunying, was both candid and efficient. Rather than subjecting me to the usual brief introduction, she simply asked me what I wanted to know and then introduced me to people who had the answers. But that is not the only reason I found the visit so valuable. Because it is one of the wealthiest communes in the country, Evergreen has been able to realize more fully than most the aspirations of the rural population. Thus one may look at the programs initiated at Evergreen as concrete examples of what the future may hold for rural China.

In rural China, an individual's income is a share (variously determined) of the income of the basic accounting unit to which he belongs. In most of the country this unit is the team, which typically consists of 30 to 40 families living in what is sometimes called a natural village. One of the boldest of the many experiments tried during the Great Leap Forward was to make the commune itself the basic accounting unit, but this attempt to expand the collective universe failed (some say disastrously), and the team was quietly reinstated as the basic unit. I was therefore fascinated to discover that Evergreen had recently instituted commune accounting. The team and the brigade continue as administrative units, but income is calculated as a share of the communal total.

Whereas the value of a day's labor previously depended on the efforts of 150 to 200 people living in the same village, it now depends on the efforts of the 43,000 members of the Evergreen commune. I asked Wang Shunying why Evergreen had returned to commune accounting. To my surprise, her answer was practical rather than ideological. She said, in effect, that to mechanize its operations, the commune had to consolidate fields and buy more Canadian combines. "These tasks were too big for any team to carry out alone." Thus it appears that the economic principles that are delivering the American family farm into the hands of agribusiness are providing the basis for collectivization and more nearly universal communism in China.

When my questions turned from commune affairs to marriage customs in the old days, Wang took me to visit several elderly women living in a village near the commune headquarters. Noticing that most of the houses we passed did not have a pigpen, I asked Wang why it was that people at Evergreen were not raising as many pigs as people in the other communes. She replied, "Because we have a higher standard of living. People don't want to be bothered raising pigs if they don't have to. It's a lot of work and takes a lot of time." This is interesting because it suggests that the government's plan to double meat production may come into conflict with its drive to raise rural incomes.

According to information provided by the Ministry of Agriculture, more than 70 percent of China's pigs are raised by families rather than by collectives. Thus a decline in domestic pig production consequent on rising income could make it difficult to maintain, let alone increase, the amount of meat available in the market. Until only recently, the government discouraged domestic piggeries by viewing them as throwbacks to capitalism. The number of pigs people could raise at home was severely limited, and in most areas families were not allowed to keep their own sows. The situation at Evergreen indicates that rising income may force a complete reversal of this policy.

The physical facilities of the brigade outside Huhehaote were roughly comparable with those that I observed at Evergreen. The homes at Evergreen were better furnished and displayed a few more consumer goods, but the differences were not great. What distinguishes a wealthy collective like Evergreen from a relatively poor one like the brigade at Huhehaote is the quality of the medical facilities, the schools, and the welfare programs. At Evergreen women retire at age 60 and men at age 65, and both are paid a pension by the commune. The one woman I asked told me that she received 24.60 yuan per month and showed me her pension book to prove it. At the brigade near Huhehaote there is no retirement age and no pension program. Both men and women work as long as they are able and afterward are largely dependent on their children for support.

Evergreen was selected as an appropriate place to take a visiting foreigner because it is wealthy and widely regarded as a model commune. Although the brigade I visited at Huhehaote was probably one of the wealthiest in the vicinity, I think that it was selected because it is an integrated community. My hosts made a point of telling me that the members were not all Han Chinese. The brigade's 812 families include 63 Mongolian families and 3 Manchu families. But it could be that our cadres selected this collective because they thought that I would be interested in seeing its exotic animals.

Like Evergreen and other suburban communes I visited with the delegation, the brigade specializes in vegetable production, devoting 73.6 percent of its acreage to vegetables. What makes the unit distinctive is that it has diversified by developing a secondary specialty in Chinese medicine. The brigade devotes approximately 100 *mu* (roughly 2 percent of its acreage) to medicinal herbs and also operates a deer farm and a ranch raising black-faced "thunder chickens" (*wu-chi*). The deer are raised for their horns, which are valued as aphrodisiacs, and I was told that the thunder chicken is commonly prescribed as a cure for "women's diseases."

My visit to the brigade near Huhehaote was probably one of the major social events of the season. By the time Pat Tsuchitani and I emerged from a briefing in the brigade headquarters, the square outside had filled with people come to ogle the foreigners. Needless to say, my appearance in a neighborhood in Shanghai did not arouse comparable interest. After a brief walking tour of the neighborhood, I was taken to see a shop in which rugs are woven for export to West Germany (organized, I was told, to provide employment for local youths returning from the countryside), a nursery (providing care for 550 children, 62 of whom live there and return home only once a week), and two families (one of which was selected because the cadre who introduced me knew I was interested in uxorilocal marriage).

The family visits were the most instructive because they gave me another perspective on the fact that the income of urban workers is almost double that of farmers. Having just visited farm houses in communes near Beijing, Huhehaote, and Harbin, I was not impressed with the material circumstances of Shanghai workers. The most affluent of the two families I visited (with three able-bodied workers and only one dependent) lived in two and a half rooms at the top of two long, dark flights of stairs. There was only one window in the apartment, and water was available only on the first floor.

My purpose in requesting a visit to a neighborhood committee was to find out what these committees do. The urban counterpart of the rural team (if it is the basic accounting unit) is the factory or office in which one is employed. The neighborhood committee does not organize work or allocate income. What then is its role? When I put this question to my hosts in Shanghai, they told me that the neighborhood committee provides care for the elderly, mediates domestic disputes (including mother-in-law/daughter-in-law as well as husband/wife), assists workers who need help with cooking or child care, and organizes street-sweeping teams. At this point the speaker paused and looked to the head of the committee for instructions, whereupon the person who had introduced me broke in, "Go ahead and tell him. It doesn't matter. Tell him." The head of the committee nodded, and the speaker continued, "And we are also responsible for keeping track of bad elements." In sum, the role of the neighborhood committee is very like that of the church in a small American town. It assists those who are in need, advises those who are troubled, and notes the presence of deviants.

I had just finished breakfast on the morning of our first day in Huhehaote when I heard firecrackers and the unmistakable rumble of Chinese gongs outside our hotel. Could it be a religious procession? A god on tour? I rushed outside to find 200 or 300 brightly dressed children assembled in long rows in a square in front of a government building. They were obviously deployed to greet a procession of women who were just entering the square. The women wore large red flowers on their grey and blue jackets and carried a placard indicating that they were being honored for having not borne more than one child.

We were told that the government is not promoting birth control among Mongols (who appear to have a low birth rate in any case), but there is a vigorous birth control campaign under way among the Han population of Inner Mongolia. The clinic of the brigade mentioned above includes a birth control center and a surgery specializing in tubal ligations and abortions. Intrauterine devices can be obtained free of charge at the brigade clinic, and oral contraceptives are available for a nominal fee from the commune hospital.

Although all known means of birth control are widely available in China, it appears that age at marriage is still the keystone of the population control policy. In Harbin I asked one of our interpreters how old men and women had to be before they could get married. He replied, "People can marry whenever they want. Marriage is a matter of love." I persisted, "But suppose a 19-year-old boy and an 18-year-old girl want to get married." He answered, "Oh, they couldn't do that. That's too young," and then he added, grinning, "We have to distinguish formal and informal rules. In theory people can get married whenever they want, but in reality men cannot marry before age 27 and women before age 25."

What my informant termed the informal rule appears to vary from one area of the country to another. I was given ages 29 for men and 25 for women in Nanjing and 25 for men and 23 for women in Guangzhou. But the important fact is that there are rules everywhere and that they appear to be no less effective for being informal rather than formal.

Judging from the experience of people we met during the trip, marriage is commonly delayed far beyond the age set by the informal rules. One reason for this may be the cost of housing. Although the authorities provide housing for workers in the cities, the farm family that wants to expand its house or construct a new one must bear the costs itself. Since these costs can be considerable (5,000-7,000 yuan on a commune near Shanghai), it could be that marriage is sometimes delayed by economic constraints. A family may only begin to accumulate the savings needed to provide housing for its married sons when the sons are old enough to join the work force. Thus it could be that a young man has to work for a number of years before he can even consider marriage, particularly if he has two or three brothers. The Chinese preference for normative explanations should not cause us to overlook economic constraints of the kind that operate in other societies.

I have recorded these few observations on birth control because it is important for us to remember that realization of the goals set by the Ministry of Agriculture depends on the rate of population growth. Unless the generation now approaching the age of marriage produces substantially fewer children than the preceding generation, there is little hope of increasing the amount of animal protein in the Chinese diet. Given the great potential for growth inherent in the age distribution, it may be difficult even to maintain the present standards. Indeed, it is not unduly pessimistic to forecast an absolute decline in animal production if the birth control campaign does not reach its goal. Ambitious reclamation projects and the application of ever more intensive forms of cultivation have greatly increased agricultural production in China, but if population growth is not controlled soon, the time must come when grain that is now fed to animals will be needed for humans.

I will conclude with a few observations on anthropologists, animal scientists, and pigs. Although anthropologists have written extensively about the relationship between human beings and pigs in such places as the New Guinea Highlands, those of us who specialize in Chinese studies have paid little attention to the pig.[3] The only notable exception is Ahern, who has examined the meaning of pig sacrifice in certain Taiwanese rituals.[4] The pig has lost whatever ritual significance it may have had on the China mainland because ritual itself is defunct, but the animal has acquired an entirely new and far more revealing social significance. To discover the various levels of social organization found in rural China and trace their articulation, one need only note the location and movement of pigs. The pigsty has replaced the ancestral altar, the T'u Ti Kung temple, and the landed estate as *the* marker of social units in rural China. The differences among family, team, brigade, and commune are given clear expression in pig production, and the relative importance of domestic and collective sties is a sensitive indicator of the political atmosphere.

To appreciate fully the role of the pig in Chinese society, anthropologists will need the help of animal scientists. That is clear. But I think that the reverse of this proposition is also true: To understand swine production in China, animal scientists will require some assistance from anthropologists. Hays reports being told that "individual families are able to get their pigs to market weight much quicker than communally reared pigs. The difference was attributed to more abundant food supply and better care at the family level" (chapter 4). Suppose that domestic pig production is superior in some respects to collective pig production. Why then do the Chinese not close the communal sties and reinstate the family as the primary producer? Part of the answer is that this would run counter to strongly held political premises, but I think that there are even more compelling reasons.

In his discussion of the relationship between animal production and family income, Van Arsdall reports in some detail information provided by a family on the Xinfa commune near Harbin (chapter 3). While half of the delegation was visiting the family he describes, the other half talked to two of their neighbors. One of these families owns its own sow and sells both piglets and fattened pigs; the other buys piglets from the state farm and sells them when they are grown. Last year the family with the sow sold 20 piglets and six fattened pigs for a total of 1,500 yuan; their neighbor sold three fattened pigs for 660 yuan.

Why does the second family not follow the example of the first? That is, why do they not raise a sow? Their answer when I asked is that they do not have anyone to take care of a sow. The husband and wife both work in commune enterprises, and their children are too young to help with animal care. Their neighbor can manage to keep a sow because he has two adult sons and a daughter-in-law. She takes care of her small child, her invalid mother-in-law, and the sow. In my host's words, "It's hard to raise a sow if you don't have a daughter-in-law."

In contemporary China (as in traditional China), a woman goes to live with her husband and his family on marriage. The result is that families expand with the marriages of their sons and then contract again when these men establish separate domiciles. During some phases of this developmental cycle, there is labor to invest in pig production; during other phases there is not. When marriage was early, fertility was high, and women stayed at home, there was labor available for animal production during most phases of the cycle, but delayed marriage, low fertility, and female employment have changed all that. Pig production is now limited to one phase of the cycle and thus to those families that are passing through that phase. To increase domestic pig production, the authorities would probably have to abandon their goals for age at marriage, fertility, and female employment. In other words, the collective pigsty is now a necessity. The family can no longer play the role it once did because it is not what it once was.

I offer this as one example of the many ways in which animal production is conditioned by social factors. Whether the argument is right or wrong is not important. What is important is that we recognize that there are many areas in which animal scientists and social scientists can cooperate to their mutual benefit.

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15

A LOOK TO THE FUTURE: CHINA'S ANIMAL INDUSTRY

Jacob A. Hoefer

China is forging ahead to modernize its agriculture. It is serious about increasing animal production and has established a goal of doubling animal product intake by 1985. This is a mind-boggling target. China's current animal production is large in total, but it is still only enough to provide about one tenth as much meat per capita as the United States. Increasing per capita consumption from 8 to 16 kg by 1985 has implications of major proportions for the agricultural economy of China as well as for the world. In rough numbers, this could be 14 billion pounds (carcass weight) of additional pork, or more than the entire U.S. production for 1979.

The resources needed to double animal production in China are mammoth. The Chinese may not achieve their stated goal, but if they do, an enormous amount of feed energy will obviously be required. The Chinese like pork and poultry, and although the Mongolians and other minorities eat a great deal of beef and mutton, the average Chinese consumes little of these meats. Milk and other dairy products are likewise produced in limited quantities but are scheduled for expansion. Fish intake is probably significant, although data are almost nonexistent.

The numbers involved in a doubling of China's per capita intake of meat are staggering. If 1 billion Chinese eat 8 additional kilograms of meat by 1985, regardless of species source (e.g., pork, poultry, beef), and if one assumes an estimated 5-kg feed conversion (all animals averaged, including breeding herds), 40 billion kg of feed would be required. This translates into 44 million tons or approximately 1.6 billion bushels (56 lb/bu). These numbers are, of course, only crude estimates, but they serve to indicate the scale of the Chinese undertaking to double their animal production.

The key to China's ambitious undertaking is feed supply, which is directly related to the food supply for humans. The Chinese are efficient in utilizing by-product materials as feedstuffs and also in incorporating aquatic plants into rations for swine, which under U.S. production systems are largely concentrate consumers. If China is to realize its goal, feed supply will likewise have to be greatly increased--either through increased production or by importation. More attention will also have to be given to improved efficiency of utilization.

China appears not to have yet made the needed major policy decisions about species emphasis. Where will the resources be placed and how will the proportionalizing among the species take place? Swine have always been first in priority, followed by poultry. Cattle have not received much attention as a potential meat source in spite of the fact that China has vast grazing areas that resemble some of our western range states.

Since swine and poultry may compete with humans for some concentrates, perhaps the Chinese should look to the herbivores, more specifically to the ruminant grazing animals, as logical choices for expanded production because these animals can utilize resources not directly useful to man.

China has some good dairy cattle, largely Black and White, but the numbers are very low. Other cattle are average in quality and are not very good sources of meat because they are grown largely for dual-purpose uses, e.g., draft and meat (when slaughtered at old age) or draft and milk. The Chinese have plans to increase their numbers of good dairy cows because of their conviction that human nutrition must be improved and increased milk intake would be helpful for their millions of young people. Their program encourages people to drink more milk.

In the past, China appears to have emphasized numbers at the expense of quality and efficiency. Chairman Mao is quoted as having said that China should have "one pig for every person" or "one pig for every *mou* of tillable land." *Imagine one billion pigs!* For comparison purposes, the United States has on the average about one pig for four persons and has produced in some years approximately one pig for every two people. In China, this philosophy of numbers is now giving way to more attention placed on product quality and efficiency of production.

Our delegation had the impression that China has not addressed adequately the matter of a defined set of standards or goals that describe the kinds of animal they want to produce or the kind of performance expected. Until they do this, progress in developing superior animals of high performance will be slow.

China may be handicapping its ambitious expansion program by having too many animals on essentially maintenance-plus rations. Fewer animals, well fed, could conceivably produce more product.

With respect to animal improvement, it is interesting to note that China has in place a controlled system of reproduction through artificial insemination that could rapidly bring about great genetic improvement. What is lacking is a decision on the part of the leadership in both animal science and political administration about the kinds of animal (by species) that China wants to produce, e.g., a fat hog or a muscular, lean one or a dual-purpose, draft, dairy, or beef cow.

China's animal science is well advanced in reproduction physiology, possibly more so than that of the United States in artificial insemination, as well as in applied reproductive physiology. We were impressed with the technology we were shown at the several AI studs and state farms that we visited. Intensive research is going on with both fresh and frozen semen, and a very high percentage of animals are artificially inseminated (see Chapter 10). State farms are responsible for conducting genetic breeding research and provide seed stock to the communes for multiplication (called popularization).

In some districts and municipalities, all animals are inseminated with semen provided by the centrally located AI stud. For example, in the

Shanghai municipality, 100 percent of the dairy cows are bred artificially. The Chinese government, through its state farms and commune organization, can exercise complete control over all animal-breeding programs and in this way could change the genetics of its animal population rapidly. What is lacking is a clearly defined target. What kind of animal is wanted or needed?

China has many breeds of livestock. We heard estimates of 50-100 different breeds of swine alone. China provided the seed stock for many of the modern breeds around the world. Unfortunately, the science of population genetics has not been organized on a national scale in China, and cooperation among animal-breeding scientists is almost non-existent. As a result, the mass of data needed by population geneticists is not available to serve as the base for selection and subsequent animal improvement.

We found great variation in type among the many swine we saw; almost all are prolific, an important production trait, but from an anatomical and muscle development standpoint the differences are extreme. Also, at almost every stop we found a new breed; it seemed to us that a high value of prestige and recognition is associated with the development of a breed named after some local feature. Like too many animals, too many breeds without a national organization to give coordination and guidance to selection and improvement may be a distinct handicap.

The Chinese like pork and poultry meat, and they are probably among the world's largest producers of these products. It is understandable that in any animal expansion planned for the future, these two industries will receive high priority in the allocation of resources. We had to remind ourselves frequently that in a planned economy resources are allocated by the government. However, in discussions with our animal science peer groups in China, it became apparent that China's animal scientists and agricultural economists recognize the crucial nature of competition for concentrates (for feed or food) and that if energy resources are to be used wisely and efficiently, grazing animals must receive more resources in terms of research, education, and technology. In addition to improving the animals through selection and breeding programs, there appears to be great opportunity for development of better animals through range forage improvement, increased carrying capacity, use of irrigation, application of fertilizer, use of needed protein and mineral supplements, winter feed storage, etc.

A serious limiting factor that plagues the entire food industry of China is a lack of transportation, refrigeration, and processing capability. In Inner Mongolia, we were surprised to see thousands of beef and mutton carcasses frozen and stacked like cordwood in a large cold storage plant. The animals were slaughtered in the fall, frozen, and stored for distribution throughout the year to local markets, few of which had refrigeration. Some of the carcasses may be shipped to other parts of China and to Hong Kong. The dehydration losses from storage in this manner for 6 to 10 months must be great.

The delegation was astonished at the number of horses, donkeys, mules, and oxen used for transportation and limited field work in the northern half of China. It would take an extremely large amount of mechanical horsepower to replace the animal horsepower now in use.

Accurate numbers are not available, but our observations of the great number of animals seen daily pulling heavily loaded two-wheeled carts and wagons are clear evidence of the important part that the draft animal plays in China's agriculture. The 5-horsepower, two-wheeled tractor is likewise seen everywhere doing all kinds of chores and must be considered an important contributor to China's economy. However, it appears to us that animal horsepower is not likely to be replaced for many years to come.

There are obviously many unanswered questions that relate to the new energy balance involved in the substitution of different forms of energy, e.g., machine for animal, machine for man. In southern China the water buffalo is still essential for field work, but in some communes the tractor is beginning to replace the buffalo in rice fields.

The energy question is a difficult one for all nations; it is certainly not a unique China problem, but time and again we raised the question: "To what extent does modernization of agriculture equate with mechanization of agriculture?" To the Chinese leadership, modernization is a package--the best of science and technology to agriculture as a total food-production system. It means good agronomic practices, soil and water management, fertilizer, pesticides, varieties, superior animals and breeds, nutrition, processing, etc.--all the things essential for efficient production and utilization of resources.

To the commune leadership, mechanization receives heavy emphasis in modernization. To the question, "What happens to displaced field workers?", the answer was simple: "We absorb them in commune factories." We saw some of these factories in which the products were intended entirely for foreign export. China needs to generate foreign exchange, and it appears that the Chinese intend to put heavy emphasis on light industry.

The energy issue is an interesting one throughout China. Leadership is certainly well aware of the world situation, but they view their own resources as being adequate for many years. Coal supplies are among the largest in the world, and although petroleum is not readily available, the Chinese think that they have rich untapped reserves that will more than meet their needs. In fact, they talk about becoming an oil-exporting nation.

The delegation was not able to schedule a visit to a major slaughter plant, although we did see a small operation in Guangzhou. This plant slaughters about 40 hogs daily and distributes the meat in semiboned carcass (half sides) form to a commune of 75,000 people. Three villages are included in this distribution. The plant has a veterinary inspector present at kill time. Sanitation appeared reasonably good at this plant, although we suspect that sanitation is a problem in slaughter plants.

The government, through a food company, is the purchaser of the animals from the commune and in turn sells the meat to the people at a reduced price. With complete control over prices (buying and selling), the government can encourage or discourage the production of specific commodities. Prices appear to be fairly uniform throughout the entire country.

Scientific research in agriculture now has a higher priority than at any time since liberation in 1949. However, it is difficult at this writing to assess the full effect of the massive reorganization, which is still in process, since the downfall of the Gang of Four in 1976. There now appears to be a full commitment to the four modernizations and equally importantly a recognition that modernization, to be successful, must be based on sound science. Consequently, support is developing for colleges, universities, research institutes, and the research scientists and professors who work in the laboratories and teach the rapidly expanding student body. The educational atmosphere is optimistic now compared with the feeling that existed during the 1966-1976 period.

Animal science research appears to be reasonably strong in applied physiology of reproduction, in cellular and physiologic genetics; and relatively weak in nutrition, feed chemistry evaluation, population genetics, applied animal breeding, and meat science. Economics and farm management are also neglected areas.

Coordination among the many research institutes appears to be the responsibility of the Chinese Academy of Agricultural Sciences, which is overseen by the Ministry of Agriculture. Coordination, program planning and development, and implementation are not so good as the planners would like; but steps are being taken to establish better linkages among the various institutes and also for more-effective interaction of the institutes with the colleges and universities. There is evidence of cooperative efforts among some of the units. The Chinese recognize the strengths of an integrated teaching, research, and extension (public service) system and expressed much interest in our land-grant system, which encompasses all three of these functional areas.

Normalization of relations between China and the United States offers many exciting possibilities for cooperative arrangements. The visit of our delegation of animal scientists is just the beginning of a series of exchanges that may result in the improvement of animal science and animal production in both countries.

APPENDIX A: ITINERARY
ANIMAL SCIENCES DELEGATION TO THE PEOPLE'S REPUBLIC OF CHINA
June 11 to July 9, 1979

BEIJING

June 11	Arrival on JAL #783 from Tokyo Discussions with hosts on the itinerary
June 12	
Morning	Red Star Chicken Farm
Afternoon	Beijing Bull Station Number 1 Livestock Team, Northern Suburb Farm
Evening	Banquet hosted by Yang Xiandong, Vice Minister of Agriculture and President, Chinese Agricultural Association (held at the Fang Shan Restaurant in Bei Hai Park)
June 13	
Morning	Group A: Institute of Genetics, Chinese Academy of Sciences Group B: Institute of Zoology, Chinese Academy of Sciences
Afternoon	Chinese Academy of Agricultural Sciences Beijing Institute of Animal Science
June 14	
Morning	Jacob A. Hoefer presents report on U.S. land grant system (held in the Minzu Cultural Palace)
Afternoon	Meeting with He Kang, Vice Minister of Agriculture and Vice Chairman, National Agricultural Commission Visit Beijing Zoo
June 15	
Morning	Seminar sessions in the Minzu Cultural Palace
Afternoon	Double Bridge Duck and Pig Farms

June 16

All day	Seminar sessions in the Minzu Cultural Palace

June 17

All day	Visit the Eastern Qing Dynasty Tombs, the Dong Ling in Cunhua County, Hebei Province

June 18

All day	Visit the Great Wall and Ming Tombs
Evening	Delegation hosts banquet for Chinese Agricultural Association in the New Beijing Duck Restaurant

INNER MONGOLIA

June 19

7:35 a.m.	Depart from Beijing by air for Huhehaote, Inner Mongolia Autonomous Region (IMAR), arriving at 9:00 a.m.
Morning	Discussion of 5-day itinerary in IMAR with hosts from the Chinese Association of Agriculture of Inner Mongolia
Afternoon	Institute of Animal Science of IMAR

June 20

Morning	College of Agriculture and Animal Science of Inner Mongolia; Institute of Veterinary Science of Inner Mongolia
Afternoon	Seminar sessions

June 21

9:35 a.m.	Depart from Huhehaote by air for Xilinhaote, IMAR, arriving at 10:55 a.m.
Afternoon	Visit a production brigade of horses, cattle, and sheep on the grasslands outside Xilinhaote

June 22

All day	Visit a state farm on the grasslands about 60 km from Xilinhaote; observe horses, cattle, sheep

June 23

Morning	Visit Grassland Research Institute
11:45 a.m.	Depart from Xilinhaote by air for Beijing, arriving at 3:10 p.m.

June 24	
Morning	Sightseeing
2:00 p.m.	Depart from Beijing by air for Harbin, arriving at 3:40 p.m. Discuss itinerary with hosts from the Chinese Association of Agriculture of Heilongjiang Province

HARBIN

June 25	
Morning	Municipal Breeding-Stock Farm Xiangfang Dairy Farm; Pig Feedlot
Afternoon	Harbin Institute of Veterinary Research
June 26	
Morning	Jacob A. Hoefer presents report, "The Animal in the Food Chain--U.S. and the World" Visit Heilongjiang Provincial Reproduction Extension Service for Domestic Animals
Afternoon	Seminar sessions Sightseeing along the Sungari River
June 27	
Morning	Xinfa Commune Livestock Farm
Afternoon	Seminar sessions
June 28	
Morning	Discussions in several small groups Visit Woolen Mill
12:45 p.m.	Depart from Harbin by air for Shanghai, arriving at 3:30 p.m. Discussions with hosts from the Shanghai Branch of the Chinese Association of Agriculture

SHANGHAI

June 29	
Morning	Group A: Frozen Rabbit Processing Factory Group B: Animal Science Institute, Shanghai Academy of Agricultural Sciences
Afternoon	Malu People's Commune

June 30

Morning	Group A: Shanghai Dairy Farm #7 Group B: Brick Bridge People's Commune Breeding Center Group C: Shanghai Institute of Cell Biology, Chinese Academy of Sciences
Afternoon	Seminar sessions: Swine Nutrition Reproduction Poultry

NANJING

July 1

6:10 a.m.	Depart from Shanghai by train for Nanjing, arriving at 10:52 a.m. Discussions on itinerary with hosts from Chinese Association of Agriculture, Jiangsu Branch
Afternoon	Institute of Animal and Veterinary Science, Jiangsu Provincial Academy of Agricultural Sciences

July 2

Morning	Jiangsu Provincial Academy of Agricultural Sciences
Afternoon	Depart from Nanjing for Yangzhou

July 3

Morning	Irrigation Project
Afternoon	Jiaodu Poultry Science Research Institute, Jiangsu Province

July 4

Morning	Return to Nanjing, then depart at 11:50 by air for Guangzhou, arriving at 2:35 p.m.

GUANGZHOU

July 5

Morning	Institute of Animal Husbandry and Veterinary Science, Guangdong Academy of Agricultural Sciences
Afternoon	Visit a slaughterhouse

July 6

Morning	South China Agricultural College
Afternoon	Visit Renhe swine farm

July 7	
All day	Lectures and discussions in several small groups
July 8	
All day	Sightseeing and shopping
July 9	
Morning	Depart by train for Hong Kong

APPENDIX B: NAME LIST OF HOSTS, SEMINAR PARTICIPANTS, AND OTHER PEOPLE INVOLVED IN THE VISIT

BEIJING

HOSTS FROM THE CHINESE ASSOCIATION OF AGRICULTURE

Yang Xiandong	Deputy Minister of Agriculture Chairman of the Chinese Agricultural Association (CAA)
Cheng Shaojun	Vice Chairman of the CAA Chairman of the Chinese Society of Animal Husbandry and Veterinary Science Vice Dean of the Chinese Academy of Agricultural Sciences (CAAS)
Sun Sengfu	Secretary General of the CAA
Chen Lingfeng	Deputy Chief of the Central Animal Husbandry Bureau, Ministry of Agriculture Vice Chairman of the Chinese Society of Animal Husbandry and Veterinary Science
Ma Ling	Deputy Chief of the Foreign Affairs Bureau, Ministry of Agriculture Deputy Secretary General of the CAA
Cheng Peilieu	Vice Chairman of the Chinese Society of Animal Husbandry and Veterinary Science Professor, CAAS
Liu Jinxue	Professor, Animal Husbandry Research Institute, CAAS
An Min	Professor, Beijing Agricultural University
Peng Erdong	Director of the CAA Chief of the Office of the CAA
Su Ping	Chief of the Scholastic Exchange Office, Ministry of Agriculture

Yu Ming	Chief of the Scientific and Technological Exchange Division of the Scientific and Technological Bureau, Ministry of Agriculture
Wang Xinghai	Deputy Chief of the No. 1 Division of the Foreign Affairs Bureau, Ministry of Agriculture
Dong Wei	Deputy Secretary General of the Chinese Society of Animal Husbandry and Veterinary Science Professor, Beijing Agricultural University
Zhao Huada	Chief of the Beijing Municipal Animal Husbandry Bureau
Liu Ming	Chief of the Beijing Municipal Farm Administration
Liu Qingxin	Chief of the Animal Husbandry Institute, Beijing Academy of Agricultural Sciences
Wang Huaiman	Secretary in Charge of Foreign Affairs, CAA
Yan Hanping	Secretary, CAA
Zhu Weiyung	Interpreter, CAA
Lin Luogen	Interpreter, CAA

RED STAR POULTRY FARM (State Farm)

Lu Huamin	Director
Jing Liang	Director of the Beijing Society of Animal Husbandry and Veterinary Science Director of the Beijing Animal Husbandry Bureau

INSTITUTE OF GENETICS, CHINESE ACADEMY OF SCIENCES

Shao Qiquan	Deputy Director; Associate Professor
Ye Xiao	Head of the Planning Department
Du Ruofu	Head of the 2nd Laboratory; Associate Professor
Chen Xiulan	Associate Professor, Embryo Transfer in Cattle
Chen Yucheng	Assistant Researcher, Embryo Transfer in Sheep
Tan Liling	Assistant Researcher, Embryo Transfer in Cattle
Chen Guangchao	Assistant Researcher, Chicken Breeding

Yuan Kaiwen	Staff of the Planning Department

CHINESE ACADEMY OF AGRICULTURAL SCIENCES

Cheng Shaojun	Vice Chairman, CAA Chairman of the Chinese Society of Animal Husbandry and Veterinary Science Vice Dean, Chinese Academy of Agricultural Sciences (CAAS)
Zhang Yihua	Vice Director of the Scientific Research Division
Yang Zhongyuan	Head of the Research Institute of Animal Science
Li Bingdan	Director of the Swine Research Laboratory, Research Institute of Animal Science
Liang Keyong	Deputy Chief of the Animal Science Laboratory, Scientific Research Administration Division
Chen Yuxin	Director of the Poultry Laboratory, Division of Animal Science
Zhou Zhenghuan	Agronomist from the Foreign Affairs Division
Zhou Bingnian	Animal Husbandry Specialist

BEIJING INSTITUTE OF ANIMAL HUSBANDRY

Liu Qingxin	Director
Wang Shude	Deputy Director
Cui Zhongda	Deputy Director; Head of the Laboratory of Poultry Disease
Qang Jing	Technical Advisor; Director of the Feeds and Nutrition Laboratory
Zhao Shuguang	Director of the Swine Rearing Research Laboratory
Jing Guangjun	Poultry Production Research Laboratory
Lin Zhifu	Director of the Swine Disease Research Laboratory

INNER MONGOLIA AUTONOMOUS REGION

HOSTS FROM THE CHINESE ASSOCIATION OF AGRICULTURE OF INNER MONGOLIA, HUHEHAOTE

E Rihe	Acting President of the Board of Directors, Chinese Association of Agriculture of Inner Mongolia
Lu Weiqun	Vice President of the Board of Directors, CAA of Inner Mongolia Deputy Dean of the College of Agriculture of Inner Mongolia
Lu Renyang	Vice President of the Board of Directors, CAA of Inner Mongolia Chief of the Agricultural Department of College Agriculture and Animal Science
Guluzabu	Deputy Secretary General of the CAA of Inner Mongolia Director of the Animal Science Research Institute of Inner Mongolia
Liu Zhenyi	President of the Animal Science Branch, CAA of Inner Mongolia Chief of the Animal Science Department of the College of Agriculture and Animal Science of Inner Mongolia; Professor
Lan Qiannu	Vice President of the Veterinary Branch, CAA of Inner Mongolia Chief of the Veterinary Department of the College of Agriculture and Animal Science; Professor
Yun Zhenlong	Staff Member, Foreign Affairs Office, Huhehaote
Ma Yongshen	Staff Member, Foreign Affairs Office, Huhehaote

ANIMAL SCIENCE RESEARCH INSTITUTE OF INNER MONGOLIA, HUHEHAOTE

Hasi	Deputy Director
Zhao Guiyuan	Director of the Veterinary Medicine Department
Tian Guliang	Director of the Animal Science Department
Hang Weicai	Director of the Animal Breeding Research Laboratory
Lin Tongyong	Deputy Director of the Animal Breeding Research Laboratory

Lin Huizhong	Director of the Animal Breeding Laboratory
Na Shen	Director of the Grassland Research Laboratory
Lu Dexun	Director of the Animal Feeding and Nutrition Laboratory
Wang Qianyuan	Associate Researcher, Veterinary Department
Mei Wenhui	Associate Researcher, Veterinary Department

HOSTS FROM THE CITY OF XILINHAOTE

Laxibalazhuer (La-xi-ba-la-zhu-er)	Member of the Administrative Committee of the Chinese People's Association for Friendship with Foreign Countries in Inner Mongolia
Gong Bu	Deputy Director of the Agricultural Commission of Xilinglo Prefecture
Bi Shigu	Deputy Chief of the Animal Husbandry Bureau of Xilinglo Prefecture
Shurgulatu (Shu-r-gu-la-tu)	Deputy Chief of the Foreign Affairs Office of the Xilinglo Prefecture
Xie Xinxing	Staff Member from the Office of the Agricultural Commission of Xilinglo Prefecture
Bashennima (Ba-shen-ni-ma)	Chief of a Production Brigade of Yujin People's Commune
Batuyinhe (Ba-tu-yin-he)	Herdsman
Temurbagen (Te-mu-r-ba-gen)	Deputy Director of the Bainxile Animal Husbandry Farm

GRASSLAND RESEARCH INSTITUTE, XILINHAOTE

Wang Liangui	Deputy Director
Li Ming	Chief of the Scientific Research Division, Associate Professor
Zhong Yu-an	Chief of the Feed Research Laboratory
Chen Fenglin	Chief of the Grass Cultivation Research Laboratory

HARBIN, HEILONGJIANG PROVINCE

HOSTS AND SEMINAR PARTICIPANTS

Xu Zhenying	Vice Chairman of the Council of Animal Science and Veterinary Medicine Professor of the Northeast College of Agriculture Specialist in Animal Feeding and Breeding
Hu Xiangbi	Research Fellow and Deputy Director, Harbin Institute of Veterinary Research, Chinese Academy of Agricultural Sciences; animal anatomy and poultry disease
Wang Chinggao	Associate Professor, Northeast College of Agriculture; animal feeding
Xue Deyan	Lecturer, Northeast College of Agriculture; animal feeding
Fan Yuehang	Director of the Provincial Animal Reproduction Extension Service; animal reproduction
Zhuang Qingshi	Senior Animal Husbandman (SAH) of Yanjiagang Farm; pig breeding and feeding
Meng Xianjiang	SAH of Xiangfang Farm; pig breeding and feeding
Wang Xingzhou	Deputy Director, Feeding Laboratory of Heilongjiang Provincial Research Institute of Animal Science; animal feeding and breeding
Zhong Shifang	SAH and Director of the Reproduction Research Laboratory of Heilongjiang Provincial Institute of Animal Science; cattle and sheep reproduction
Huang Guoqing	Assistant Chief SAH of "Red Prairie" Grazing Farm; livestock breeding and reproduction
Li Changqi	SAH of the Harbin Municipal Breeding-Stock Farm; pig reproduction
Hu Dianjin	Lecturer, Northeast College of Agriculture; animal feeding
Wu Chengkun	Lecturer, Northeast College of Agriculture; animal feeding
Lou Yunguan	Deputy Director of the Provincial Bureau of Animal Industry Chairman of the Council of Animal Science and Veterinary Medicine Society; animal husbandry

Tan Guiyuan	Associate Professor, Northeast College of Agriculture; animal physiology
Liu Shengwu	SAH of the Provincial Animal Reproduction Extension Service; reproduction and improvement of cattle
Li Shian	SAH of the Provincial Bureau of Foreign Trade; reproduction and improvement of cattle
Sheng Zhilian	Associate Professor, Northeast College of Agriculture; animal genetics
[illegible]	Associate Professor, Northeast College of Agriculture; animal [illegible]
Qin Pengchun	Associate Professor, Northeast College of Agriculture; animal histoembryology
Chen Runsheng	Lecturer, Northeast College of Agriculture; pig breeding and feeding
Wei Xiao	SAH of Xiangfang Farm; pig breeding
Fu Runfu	Associate Professor, Northeast College of Agriculture; animal infectious diseases
Sun Zongyu	Lecturer, Northeast College of Agriculture; animal infectious diseases
Shao Weimin	SAH and Deputy Director of Xiangfang Farm; pig reproduction
Song Zhicai	SAH and Director of the Sheep-Raising Laboratory of Heilongjiang Provincial Research Institute of Animal Science; sheep feeding and reproduction
Zhang Dapeng	Lecturer, Northeast College of Agriculture; embryo reproduction of cattle
Li Yali	SAH of the Science and Technology Division of Heilongjiang Provincial Bureau of Animal Industry; animal reproduction
Wang Shichang	Associate Professor, Northeast College of Agriculture; veterinary surgery
Jiao Dianpeng	Associate Professor, Northeast College of Agriculture; animal infectious diseases

Zheng Tienxiang	Secretary General of the Provincial College of Animal Science and Veterinary Medicine Society Assistant Head of the Veterinary Medicine Division of Heilongjiang Provincial Bureau of Animal Industry; veterinary science
Yuan Xizhen	SAH and Head of the Animal Husbandry Division of Heilongjiang Provincial Bureau of State Farms; animal husbandry
Li Shouchu	Associate Research Fellow and Deputy Director of Heilongjiang Provincial Research Institute of Animal Sciences; animal virology and immunology
Zhang Yunching	SAH and Vice Principal of Shuangcheng Agricultural School; animal microbiology
Ma Siqi	Assistant Research Fellow and Director of the Pig Disease Laboratory of Harbin Veterinary Research Institute of CAAS; pig diseases
Wang Xikun	Assistant Research Fellow and Director of the Poultry Disease Laboratory of Harbin Veterinary Research Institute; poultry diseases
Li Weiyi	Assistant Research Fellow and Deputy Director of the Poultry Disease Laboratory of Harbin Veterinary Research Institute; poultry diseases
Pan Xingguang	SAH and Deputy Director of the Pig Disease Laboratory of the Harbin Veterinary Research Institute; pig diseases
Chen Jingyu	Deputy Director of Science and Technology of the Harbin Veterinary Research Institute; animal immunology
Zhou Shengwen	Assistant Research Fellow and Director of the Pathology Laboratory of the Harbin Veterinary Research Institute; animal pathology
Dai Moan	Lecturer, Northeast College of Agriculture; economics of animal industry
Fu Youfeng	Lecturer, Northeast College of Agriculture; veterinary internal medicine

SHANGHAI

HOSTS

Yan Ming	Manager, Agriculture Office of Shanghai Chairman, Shanghai Branch of the Chinese Association of Agriculture
Li Bingjun	Deputy Chief, Shanghai Agricultural Bureau Vice Chairman, Shanghai Branch, CAA
Xu Shoutai	Vice Dean, Shanghai Academy of Agricultural Sciences Chairman, Shanghai Animal and Veterinary Science Association
Zhang Yongchang	Director, Animal and Veterinary Science Center of the Shanghai Farm Bureau Deputy Director of the Shanghai Animal and Veterinary Science Association
Liu Rishan	Manager, No. 3 Office of the Animal Science Institute, Shanghai Academy of Agricultural Science
Wu Shongxin	Interpreter, Shanghai Branch, CAA
Zhang Guangzhu	Staff Member, Shanghai Branch, CAA

SHANGHAI INSTITUTE OF CELL BIOLOGY, CHINESE ACADEMY OF SCIENCES

Yao Zhen	Deputy Director
Jiang Tienji	Researcher
Zhen Mibai	Researcher
Wang Yulai	Associate Researcher

MALU PEOPLE'S COMMUNE

Sheng Qingrong	Deputy Director
Peng Yongtian	Office Manager
Zhao Xinyi	Cadre
Yang Peide	Cadre

BRICK BRIDGE PEOPLE'S COMMUNE, BREEDING CENTER, SHONG JIANG COUNTY

Zhao Shuilong	Technician, Animal Husbandry Bureau of Shong Jiang County

Wang Buoya — Technician, Animal Husbandry Bureau of Shong Jiang County

Chang Cuigeng — Director of the Breeding Center

NANJING

HOSTS AND SEMINAR PARTICIPANTS

FEED AND NUTRITION GROUP

ANIMAL AND VETERINARY SCIENCE INSTITUTE, JIANGSU PROVINCIAL ACADEMY OF AGRICULTURAL SCIENCES

Wu Jitang	Researcher
Pan Xigui	Associate Researcher
Chao Wenji	Assistant Researcher
Yi Peizhi	Junior Researcher
Yun Ming	Junior Researcher
Shen Youzhang	Junior Researcher
Zhu Jinjia	Junior Researcher

ANIMAL AND VETERINARY SCIENCE DEPARTMENT, NANJING COLLEGE OF AGRICULTURE

Han Zhenkang	Professor
Lu Zhinian	Associate Professor
Wang Huaishan	Lecturer
Chao Guangxin	Lecturer
Hang Liuyu	Lecturer

REPRODUCTION GROUP

ANIMAL AND VETERINARY SCIENCE DEPARTMENT, NANJING COLLEGE OF AGRICULTURE

Xan Chenxia	Professor
Chen Xiaohua	Associate Professor
Zhu Jinre	Associate Professor

Chang Pingshen	Associate Professor
Sheng Jiashen	Lecturer
Lin Qilu	Lecturer
Zhen Yianhui	Lecturer
Chen Qihe	Lecturer

ANIMAL AND VETERINARY SCIENCE INSTITUTE, JIANGSU PROVINCIAL ACADEMY OF AGRICULTURAL SCIENCES

Wang Yongzhong	Assistant Researcher
Wu Jiafeng	Assistant Researcher
Fan Biqing	Assistant Researcher
Ge Yunshan	Assistant Researcher
Zhu Yianpu	Assistant Researcher
Chen Jiao	Assistant Researcher
Yang Ri	Junior Researcher

ANIMAL AND VETERINARY SCIENCE GROUP

ANIMAL AND VETERINARY SCIENCE INSTITUTE, JIANGSU PROVINCIAL ACADEMY OF AGRICULTURAL SCIENCES

Zhen Qingri	Researcher
Shu Hanxiang	Researcher
Wang Daofu	Researcher
Pang Naizhen	Assistant Researcher
Ding Zailin	Assistant Researcher
Wu Shushu	Assistant Researcher
Fan Wenming	Assistant Researcher
Lin Jiwang	Assistant Researcher
Ji Hao	Assistant Researcher

Mao Hongxe	Assistant Researcher
Shu Keqing	Technician
Jiang Daochen	Technician
Shu Dehui	Technician
Lu Changhua	Technician
Shu Jingfu	Technician

ANIMAL AND VETERINARY SCIENCE DEPARTMENT, NANJING COLLEGE OF AGRICULTURE

Chen Wanfang	Associate Professor
Shu Wanyian	Associate Professor
Wang Zhijian	Associate Professor
Wang Weilin	Lecturer
Wang Xiaolong	Lecturer

YANGZHOU

JIAODU POULTRY SCIENCE RESEARCH INSTITUTE, YANGZHOU, JIANGSU PROVINCE

Breeding Laboratory

Chou Chinxuan

Su Dongden

Chang Shoushong

Liu Baoying

Kuan Zheng

Feeds and Nutrition Laboratory

Zhao Lianyuan

Li Yucai

Mechanized Feeding

Li Wanxing

Yao Daiming

Zheng Mingyung

Poultry Disease Control

Hsu Tsueyun	Deputy Director of the Institute
Kao Shaoxiang	
Chen Ngo	

GHANGZHOU

HOSTS

Lo Yunfu	Vice Chairman, Board of Trustees, Guangdong Agricultural Association Vice Head, Guangdong Agricultural Academy
Wu Dan	Vice Head, Animal Husbandry and Veterinary Science Division, Bureau of Agriculture, Guangdong Province
P. J. Kwong	Vice Chairman, Board of Trustees, Guangdong Animal Husbandry and Veterinary Science Association Professor and Head, Department of Animal Husbandry and Veterinary Science, South China Agricultural College
Lawrence Y. L. Li	Professor and Vice Head, Department of Animal Husbandry and Veterinary Science, South China Agricultural College
Liu Chengxiang	Vice Head, Animal Husbandry and Veterinary Science Research Institute, Guangdong Agricultural Academy
Liu Fu-an	Associate Professor, Department of Animal Husbandry and Veterinary Science, South China Agricultural College
Zheng Jianyuan	Research Assistant, Guangdong Agricultural Academy, Trustee Member, Guangdong Animal Husbandry and Veterinary Science Association
Jiao Qiuyao	Vice Section Head, Administration, Guangdong Agricultural Academy

NUTRITION GROUP

DEPARTMENT OF ANIMAL HUSBANDRY AND VETERINARY SCIENCE, SOUTH CHINA AGRICULTURAL COLLEGE

Lawrence Y. L. Li	Professor and Vice Head

Wu Xianhua	Associate Professor and Vice Head
Li Yungshen	Associate Professor
Zhao Wenqi	Associate Professor
Zhang Joling	Associate Professor
Zhang Ji	Associate Professor
Xu Lide	Associate Professor
Xie Guoxin	Associate Professor
Wu Jienying	Associate Professor

ANIMAL HUSBANDRY AND VETERINARY SCIENCE INSTITUTE, GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES

Li Baocheng	Trustee Member
Liang Chaoliu	Trustee Member
Chen Deqiang	Trustee Member
Ho Ting	Trustee Member
Li Yuhua	Trustee Member

OTHER PARTICIPANTS

Li Hanpeng	Foshan Veterinary School
Chen Yungda	Animal Husbandry and Veterinary Science Division, Guangdong Bureau of Agriculture
Liao Jiwen	Guangdong Provincial Food Company
Ho Zhihai	Guangdong Provincial Food Company
Liao Yianguo	Livestock Section, Guangzhou Municipal Bureau of Agriculture and Forestry
Wu Xiyun	Livestock Section, Guangzhou Municipal Bureau of Agriculture and Forestry
Tan Fouyong	Livestock Section, Guangzhou Municipal Bureau of Agriculture and Forestry
Jiang Zhihua	Guangzhou Agricultural School

Dai Cheng	Panyu County Livestock Bureau
Liao Shaoguo	Livestock Section, Guangzhou Municipal Bureau of Farm Administration

SWINE DISEASES GROUP

DEPARTMENT OF ANIMAL HUSBANDRY AND VETERINARY SCIENCE, SOUTH CHINA AGRICULTURAL COLLEGE

Lu Fangyu	Professor
Ou Shoushu	Staff
Huang Yinxien	Staff
Ou Xiuhua	Staff
Yang Peiqiong	Staff
Lin Shaorong	Staff
Liu Zhenming	Staff
Li Naijin	Staff
Deng Shuangyue	Staff
Deng Yunxia	Staff
Chen Deguang	Staff
Huo Hanji	Staff
Liao Shizhen	Staff
Huang Qingyun	Staff

ANIMAL HUSBANDRY AND VETERINARY SCIENCE INSTITUTE, GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES

Zheng Jinlan	Trustee Member
Yie Yangshan	Trustee Member
Lui Uiren	Trustee Member
Li Haijin	Trustee Member
Chen Nanyun	Trustee Member

ANIMAL HUSBANDRY AND VETERINARY SCIENCE DIVISION, GUANGDONG BUREAU OF AGRICULTURE

Wu Men

Zhang Yiji

Ren Duan

LIVESTOCK SECTION, GUANGZHOU MUNICIPAL BUREAU OF AGRICULTURE AND FORESTRY

Wang Nienju

Chung Zhenguang

Wu Xinwa

GUANGDONG MUNICIPAL BUREAU OF FARM ADMINISTRATION

Huang Longti

Yuan Guoan

Ho Jinzhang

APPENDIX C: AGRICULTURAL RESEARCH ORGANIZATION IN CHINA

Patricia Jones Tsuchitani

Agricultural research in China is conducted by the *Chinese Academy of Agricultural Sciences (CAAS)*, which is under the jurisdiction of the Ministry of Agriculture, and by academies or research institutes under the jurisdiction of provinces, municipalities, and autonomous regions. Central policy is coordinated through the *National Agricultural Commission* and professional and exchange activities through the *Chinese Agricultural Association*. The latter organization was the host for the visit of the CSCPRC Animal Sciences Delegation as well as visits of several other agricultural delegations in recent years.

The Chinese Academy of Agricultural Sciences was established in 1957. In 1971 it was merged with the Academy of Forestry Sciences to form the Chinese Academy of Agricultural and Forestry Sciences, but in 1978, the two academies were again split. The Chinese Academy of Forestry Sciences is now under the jurisdiction of the Ministry of Forestry.

The CAAS at present has 31 research institutes with more than 6,100 workers located throughout China. Following is a list of those institutes, with an asterisk denoting the institutes visited by the Animal Sciences Delegation:

CHINESE ACADEMY OF AGRICULTURAL SCIENCES, BEIJING

1. Crop Research Institute
2. Research Institute for the Utilization of Atomic Energy in Agriculture
3. Germ Plasm Research Institute
4. Animal Husbandry Research Institute
5. Vegetable Research Institute
6. Agricultural Economy Research Institute
7. Agricultural Mechanization Research Institute
8. Agricultural Meteorology Research Laboratory
9. Research Institute for the Division into Districts in Agriculture (Institute of Agro-Region Classification)
10. Plant Protection Research Institute
11. Epiculture Research Institute
12. Soil and Fertilizer Research Institute
13. Field Irrigation and Drainage Research Institute
14. Cotton Research Institute

15. Oil Bearing Crops Research Institute
16. Xingcheng Fruit Trees Research Institute
17. Zhengzhou Fruit Trees Research Institute
*18. Grassland Research Institute, Xilinhaote, Inner Mongolia
19. Lanzhou Veterinary Science Research Institute
20. Traditional Chinese Veterinary Science Research Institute
21. Lanzhou Animal Husbandry Research Institute
*22. Harbin Veterinary Science Research Institute
23. Sericulture Research Institute
24. Citrus Research Institute, Sichuan
25. Tea Research Institute, Hangzhou
26. Research Section for the History of Chinese Traditional Culture Practice
27. Tobacco Research Institute
28. Fiber (cotton excluded) Research Institute
29. Sugar Beet Research Institute
30. Animal Schistosomiasis Research Laboratory
31. Biological Control Research Laboratory

In addition to the national Academy of Agricultural Sciences, there are 30 other academies or research institutes located in Beijing and other cities, provinces, or autonomous regions of China. These institutions are *not* affiliated with CAAS. Following is a list of those institutes, with an asterisk denoting those visited by the Animal Sciences Delegation:

Academies located in the three municipalities:

*1. Beijing Academy of Agricultural Sciences
2. Tianjin Academy of Agricultural Sciences
*3. Shanghai Academy of Agricultural Sciences

Academies of *Agricultural Sciences* located in the following provinces and autonomous regions:

4. Fujian
5. Gansu
*6. Guangdong
7. Guangxi Zhuang Autonomous Region
8. Guizhou
9. Heilongjiang
10. Hubei
11. Hunan
*12. Jiangsu
13. Jiangxi
14. Jilin
15. Liaoning
16. Inner Mongolia Autonomous Region
17. Ningxia Hui Autonomous Region
18. Shandong
19. Shānxi
20. Sichuan

21. Xinjiang Uygur Autonomous Region
22. Xizang (Tibet) Autonomous Region
23. Yunnan
24. Zhejiang

Academies of *Agricultural and Forestry Sciences:*

25. Anhui
26. Hebei
27. Henan
28. Qinghai
29. Shănxi

30. In addition, there is a *Research Institute for Animal Husbandry and Veterinary Sciences* in Xizang (Tibet) Autonomous Region.

This information was provided by Wang Huaiman, Secretary in Charge of Foreign Affairs, Chinese Agricultural Association.

APPENDIX D: INFORMATION ON SELECTED AGRICULTURAL INSTITUTIONS IN CHINA

Robert W. Bray and Neal L. First

ANIMAL HUSBANDRY AND VETERINARY SCIENCE INSTITUTE, BEIJING, OR BEIJING INSTITUTE OF ANIMAL HUSBANDRY

The Beijing Institute was restored in 1975 following a period of inactivity during the Cultural Revolution. Its mission is the application of science to livestock production. To accomplish this, it has 50 staff members working in five laboratories--pig breeding, genetics (pig production), poultry breeding (poultry production), feeds and feeding (nutrition and nutrient requirements of pigs and layers), swine diseases, and poultry diseases.

The research in pig breeding is devoted primarily to studies with crossbreeding, development, and utilization of hybrid pigs. The poultry-breeding efforts are devoted to developing a pure line of layers and determining their crossbred combining ability.

The feeds and feeding laboratory is studying the nutrient requirements and ration formulation for swine and poultry. The laboratory of swine diseases is studying pneumonia, other respiratory diseases, and toxoplasmosis. The laboratory of poultry diseases is studying mycoplasmosis and Newcastle and Marek's diseases.

INSTITUTE OF GENETICS, CHINESE ACADEMY OF SCIENCES, BEIJING

This institute was established in 1950, and the original staff was trained primarily in plant genetics, but by 1959 the staff had grown to 200 people and included both plant and animal genetics research. There are now 250 researchers and about 180 technicians in the institute, with research activities in crop and animal sciences, human genetic diseases, microbiology, biochemical genetics, cell biology, cytogenetics, and population genetics. The institute is divided into laboratories for specialized research, such as molecular genetics, animal and human genetic diseases, plant genetics, and evolution genetics. The laboratories are supported by a technical support laboratory. Much of the research is quite basic and includes work in superovulation, surgical and nonsurgical embryo transfer, low-temperature storage of embryos, sexing of embryos, immunogenetics, and diagnosis of genetic defects in humans.

INSTITUTE OF ZOOLOGY, CHINESE ACADEMY OF SCIENCES

There are 10 divisions within the institute--vertebrate taxonomy, insect taxonomy and function, invertebrate taxonomy and function, animal ecology, insect ecology, insect toxicology, endocrinology (primarily mammalian), cytology of animals and fish, pheromones, and new technology.

It is a large institute with approximately 600 staff members. The institute has a large collection of preserved specimens and one of the finest and most complete collections of birds in the world.

Four scientific journals are published by the institute.

The mission of the institute is both basic and applied research. Within these missions, each division determines its own research projects.

Sometimes the basic research of this institute develops products or methods that may have application in animal agriculture. For example, basic research on prostaglandins has been under way here since 1970. Their potential use in human and veterinary medicine was realized. A plant in Shanghai was established for the production of prostaglandins.

In 1975 this institute began studies with the Animal Husbandry Institute of the Academy of Agricultural Sciences to develop ways to use prostaglandin $F_{2}\alpha$ for the synchronization of estrus cycles in cattle. More than 100 cattle were studied, and now the product is being field tested by the Institute of Animal Husbandry. The Institute of Zoology also has responsibility for development of assays for hormones and is currently studying the mechanisms of action and application of the gonadotropic and hypothalamic gonadotropin-releasing hormones.

ANIMAL SCIENCE RESEARCH INSTITUTE OF INNER MONGOLIA, HUHEHAOTE

This institute was established in 1954 and is located in excellent facilities. The institute is divided into seven laboratories--animal breeding, reproduction, feeds and nutrition, grassland production, infectious diseases, parasitology, and common animal diseases. The research program is determined primarily by professionals, but before the research is initiated, the proposed program is discussed with a research council, which apparently is made up of representatives from various communes. The research is primarily applied. We were informed of a study of protein requirements for baby pigs, nitrogen utilization and retention, the losses in feeding roughage to a local breed of sheep, twinning studies in sheep, and studies of using frozen and fresh semen in reproduction in sheep and cattle.

THE COLLEGE OF AGRICULTURE AND ANIMAL SCIENCE OF INNER MONGOLIA

Two colleges were combined in 1952 to form the present college, and by 1958 the college had a faculty of 17 and an enrollment of 126 students. Rapid growth followed, leading to an enrollment of 1,700 students and a faculty of 300 by 1966. The Cultural Revolution destroyed the program, but the college was reestablished in 1978 and currently has 380 faculty members and 700 students.

The animal husbandry program was initiated in 1958 and includes instruction and research on cattle, horses, sheep, camels, pigs, and chickens. We were impressed with the taxonomy laboratory, which has an outstanding collection of 2,000 species of plants. The parasitology laboratory also has an excellent collection of internal and external parasites. We were especially impressed with the anatomy laboratory, which has an excellent display of freeze-dried animals displaying anatomical systems (muscle, skeleton, nervous, and circulatory systems).

The animal husbandry program is divided into two major divisions, animal husbandry and pastoral studies, with emphasis on animal husbandry in pasture areas in Inner Mongolia. The animal research emphasis is directed toward breed improvement, animal management, and animal by-products. Plans are in progress for developing an extension program.

GRASSLAND RESEARCH INSTITUTE, CHINESE ACADEMY OF AGRICULTURAL SCIENCES, XILINHAOTE, INNER MONGOLIA

The Grassland Research Institute is located on the outskirts of Xilinhaote. The associate director, Dr. Li Ming, described the program and facilities. The buildings provide laboratory and space for exhibits relating to grasses important to the area. Several hectares of land are available for plot work with legumes and grasses. The institute also makes field trials on state farms and communes. Under study are 100 varieties of alfalfa and about 200 varieties of grass. Interesting current research involves crossing wild alfalfa types (yellow-flowered) with the rambler variety from Canada to develop a more winter-hardy variety. Studies also include some cereal breeding and vegetables. Digestibility and palatability studies with animals are now being initiated.

HARBIN INSTITUTE OF VETERINARY RESEARCH, CHINESE ACADEMY OF AGRICULTURAL SCIENCES

This institute was established in 1948 and is under the leadership of the Chinese Academy of Agricultural Sciences. The staff has increased from 18 in 1948 to 148 technical scientific personnel. Of this total, 31 are high- and middle-level researchers, and of the total, 31 are women. Some of the scientific personnel were trained abroad and most have 20 years' experience. During the Cultural Revolution, the institute was allowed to exist; however, the research effort was seriously curtailed. This institute was one of the most active and best equipped of those we visited outside Beijing.

We visited laboratories that had the following research work in progress:

(1) Two strains of swine gastroenteritis (TGE) in pigs (attempting to develop a vaccine using swine kidney tissue culture);
(2) Swine erysipelas (developing an attenuated vaccine);

(3) Athrophic rhinitis (work in progress on developing a serological test for *Bordatella bronchaseptica* infections);

(4) Marek's disease (using a herpes virus vaccine developed at Michigan State University);

(5) Infectious bronchitis (developing a vaccine);

(6) Fowl cholera (*Pasteurella multocide*) (preparing an attenuated vaccine);

(7) Pathology laboratory (a basic research laboratory studying immunology and morphology of Marek's disease and pathogenicity of TGE);

(8) Genetic engineering laboratory (attempting to develop a microbial system for producing vaccines for Marek's disease and erysipelas).

The institute develops biologics that are turned over to drug factories for mass production and ultimate distribution to the communes. The institute has a library with a staff of seven people and has available 30,000 books and 400 journals and periodicals--many from the United States.

ANIMAL SCIENCE INSTITUTE, SHANGHAI ACADEMY OF AGRICULTURAL SCIENCES

This institute was established in 1949, and its main purpose is to conduct applied research pertinent to the Shanghai area. The institute is divided into four departments--feeds and feeding, animal breeding, parasitology, and poultry and pig farms.

There are also five laboratories within the institute. The laboratory of reproduction and breeding is developing the Shanghai White breed of swine. It is selecting within and attempting to improve the native large-litter-size breeds and also studying the crossbred combining ability of the native pigs with the Shanghai White.

Methods for freezing swine semen are also being studied. The feeds and feeding laboratory is evaluating single-cell proteins from petroleum yeast and studying the use of this protein in swine and poultry diets. The swine diseases laboratory is studying enzootics (mycoplasma), pneumonia, and transmissable gastroenteritis. The parasitology laboratory is studying cystomonises, japonica, and parasites of cattle. The pathology laboratory is conducting some research, but its greatest role is diagnostic testing in support of the communes throughout this province.

SHANGHAI INSTITUTE OF CELL BIOLOGY, CHINESE ACADEMY OF SCIENCES

This institute was established in 1950 and was originally named the Institute of Experimental Biology. It consists of five laboratories.

The laboratory of cancer biology is studying the mechanisms of carcinogenesis and cellular transmission of viruses. It is studying gene expression in cancer cells and doing experiments within somatic cell hybridization.

The laboratory of cell biology is studying gene expression and techniques in genetic engineering.

The laboratory of cell differentiation is studying the control of differentiation, the structure and function of chromosomes, and the origin of eukaryocytes from prokaryocytes.

The laboratory of instrumentation is making ultrasound holographs.

The laboratory of reproductive biology is studying the mechanisms by which a herbal drug from the trichosanthes plant causes abortion; the use of a cottonseed oil extract, gossypol, as a male contraceptive; and the mechanism of oocyte maturation.

The institute has a staff of 360, and the quality of the work is excellent. During the Cultural Revolution, the major emphasis was on cancer research, but now it is on basic research in cell biology.

INSTITUTE OF ANIMAL AND VETERINARY SCIENCE, JIANGSU PROVINCIAL ACADEMY OF AGRICULTURAL SCIENCES

This institute was established in September 1978 from what was formerly a department. The total personnel in the institute consists of 120 faculty and technical assistants. Of this total, 22 are classified as researchers in animal husbandry and 44 as researchers in veterinary science. Six individuals are involved in administration, but three of these are doing part-time research.

Currently the institute is involved with twelve major projects, six in veterinary science and six in animal science. The six in veterinary science are mycoplasmosis in pigs, diagnostic research for cholera and gastroenteritis, vaccines, taxophasmosis in swine, schistomeniosis, and traditional drugs derived primarily from herbs. In animal husbandry, the research includes pig breeding with a small black breed developed from the Taihu, breeding fine-wool sheep, rabbit breeding, reproductive physiology in the pig, feeds and feeding research, and studies on mechanizing the rearing of pigs. Most of the animal husbandry work is done on state farms and communes.

JIAODU POULTRY SCIENCE RESEARCH INSTITUTE, YANGZHOU

Although this institute is a provincial institute, it is also regarded as the national poultry research institute. It was established in 1969 but was not developed until after the Cultural Revolution. The institute has 30 hectares of land and about 25 buildings. It is staffed with 203 workers, of whom 49 are researchers. The institute is divided into four research laboratories--breeding and genetics, feeds and nutrition, mechanization for raising poultry, and poultry diseases.

About 20,000 birds are available for research; they include broilers, layers, ducks, and geese. Research includes the study of local feeds for duck production, artificial insemination research with ducks and geese, chicken breeding for greater egg and meat production, mechanized layer research, and, of special interest, the breeding of the Taihu chicken, which has black skin and a purplish comb. The skin and combs are believed to be useful for medicinal purposes.

INSTITUTE OF ANIMAL HUSBANDRY AND VETERINARY SCIENCE, GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES

This institute was established in 1973, but before then it was the Department of Animal Husbandry and Veterinary Medicine of the Academy of Sciences of Guangdong. Currently, there are about 60 researchers and technical assistants and about 50 administrative officers and farmhands in the institute. The facilities include, in addition to laboratories, a bull stud, a piggery, and a poultry farm.

The major divisions and research areas are (1) cattle--involved in crossbreeding between imported breeds and native cattle, (2) swine--breeding research with emphasis on selection of native Large White and Black and crossing Landrace with native breeds, (3) poultry--emphasis on selection and crossbreeding, (4) nutrition--feeding and digestibility studies, (5) forage crops--studying imported and native varieties, (6) infectious diseases--studies for prevention and curative measures and methods for manufacturing vaccines, (7) poultry diseases--researching various poultry diseases, and (8) analytical laboratory--studying the composition of various kinds of feedstuffs.

SOUTH CHINA AGRICULTURAL COLLEGE

This college was established in 1952 as the result of a merger of several agricultural departments from the universities in Guangdong. Although all the agricultural (crops) programs were brought together, not all the animal husbandry programs were merged. The college is made up of eight departments--agronomy, forestry, animal husbandry and veterinary science, agricultural engineering, horticulture, cereal culture and plant protection, soil chemistry, and fundamental (basic) research. The college faculty is made up of 36 full professors, 46 associate professors, 325 lecturers, and 296 instructors.

The main function of the college is to teach students to be agricultural technicians, and the secondary function is research. In addition to offering undergraduate programs in 15 areas of specialization (curricula) including animal and veterinary science to about 1,400 students, the college now offers postgraduate work to about 60 students.

Before the Cultural Revolution, the college provided training for both domestic and foreign students and is now planning once again to receive foreign students. The college offers short courses for individuals at the county level and special farm equipment training for management personnel. The research work is assigned to the college by the provincial and national government, and each project is accompanied by a budget. The college also has a small budget for problems the researchers deem important. The research is done by teachers and a few full-time researchers. Currently the college is involved in 160 research projects.

We were informed that promotions at this college are based on knowledge in the field of training and a knowledge of the work being done abroad in that field. A foreign language is required for advancement beyond the level of lecturer. Postgraduate students are provided a wage while they are in school. Undergraduate students come primarily from the local province and are accepted on the basis of scores on a national exam. The exams were being given during our stay in the Canton area. On completion of college, students are assigned to positions by the state government.

At this college, we were provided a demonstration of the use of acupuncture as a means of anesthesia for veterinary surgery.