A WORLD BANK COUNTRY STUDY

CHINA

Agriculture to the Year 2000

Annex 2 to
CHINA
Long-Term Development Issues and Options

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Preface

This report is one of six annexes to a main report entitled China: Long-Term Development Issues and Options. The complete list of annex volumes is:

Volume 1 - China: Issues and Prospects in Education
Volume 2 - China: Agriculture to the Year 2000
Volume 3 - China: The Energy Sector
Volume 4 - China: Economic Model and Projections
Volume 5 - China: Economic Structure in International Perspective
Volume 6 - China: The Transport Sector

(Note: Throughout this volume references to Annexes A, B, C and so on refer in that same order to Annex Volumes 1, 2, 3 etc.)

The main report and annex volumes were prepared principally by members of an economic mission that visited China twice in 1984, for four weeks in February/March and for five weeks in April/May. In addition to Beijing, the mission went to three provinces: one coastal and relatively high-income (Jiangsu); one inland and average-income (Hubei); and one interior and low-income (Gansu). It received a lot of information, as well as numerous valuable comments and suggestions, from officials and others in these provinces, as well as from those in many central agencies and institutions, including: the State Planning and State Economic Commissions; the Ministries of Finance, Agriculture, Coal, Communications, Education, Foreign Economic Relations and Trade, Labor and Personnel, Petroleum, Railways, Urban and Rural Construction, and Water Resources and Electric Power; the State Statistical Bureau; and various universities and research institutes of the Chinese Academy of Social Sciences. A series of seminars was organized by the Technical-Economic Research Center under the State Council. The generous and thoughtful assistance of all these people in China contributed greatly to the preparation of the reports.

The Bank mission was led by Edwin Lim (mission chief) and Adrian Wood (deputy mission chief), and also consisted of William Byrd (economist), Mats Hultin (senior education adviser), Erh-Cheng Hwa (senior economist), Timothy King (senior economist), Jacques Yenny (senior transport economist), Umnuay Sae-Hau (research assistant), Betty Ting (interpreter), Luc De Wulf (senior economist, International Monetary Fund), Benjamin King (consultant on statistics), Wouter Tims (consultant on planning and agriculture); and the following teams:

Agriculture: J. Goering (team leader, April/May), Tom Wiens (team leader, February/March), Lang-Seng Tay (irrigation specialist), Lo-Chai Chen (fishery consultant) and Fred Bentley (consultant on arid agriculture);

Energy: Roberto Bentjerodt (senior economist, coal projects), Weigong Cao (power engineer), Abdel El-Mekkawy (engineer, petroleum projects), Robert Taylor (energy economist), and Darrel Fallen-Bailey (consultant); D.C. Rao (Assistant Director, Energy Department) led the team in the field;

Industrial Technology: Gene Tidrick (team leader), Anupam Khanna (industrial economist), Reza Amin (industrial specialist), and Josephine Woo (research assistant);

Location and Trade: Ian Porter (team leader), Vernon Henderson (consultant on urbanization), John Sheahan (consultant on industrial location and trade) and Samuel Ho (consultant on rural nonfarm activities).

The following also contributed to the preparation of the reports: Wlodzimierz Brus (consultant on socialist economies), Gerhard Pohl (energy and transport), Robert Drysdale (Annex Vol. 1); Helena Ribe, Nikhil Desai (Annex Vol. 3); Shujiro Urata (Annex Vols. 4 and 5); and Lily Uy (Annex Vol. 6). Larry Westphal, Carl Dahlman and Bruce Ross-Larson organized background work on technology. Behrouz Guerami-N, Tejaswi Raparla, and Kong-Yam Tan helped with the multisectoral model, the input-output table and data for international comparisons. Ann Orr, Kenneth Hill, Moshe Syrquin, J.V.S. Sarma, Kenneth Cochran, Chang Hsin, Liu Ying and Cai Jinyong undertook research. Linda Mitchell and Terrice Bassler edited the reports; and Helen Kung assisted in their processing.

The reports also benefited from comments of a review panel consisting of Anne O. Krueger, Luis de Azcarate, Kemal Dervis, Janos Kornai (consultant) and managers of the East Asia and Pacific Regional Office.

In addition to the main report and annex volumes, the following background papers have been prepared and are being issued as World Bank Staff Working Papers:

1. "The Asian Experience in Rural Nonagricultural Development and its Relevance for China"
2. "International Experience in Urbanization and its Relevance for China"
3. "Alternative International Economic Strategies and their Relevance for China"
4. "International Experience in Budgetary Trends during Economic Development and their Relevance for China"
5. "Productivity Growth and Technological Change in Chinese Industry"
6. "Issues in the Technological Development of China's Electronics Sector"
7. "The Environment for Technological Change in Centrally Planned Economies"
8. "Managing Technology Development: Lessons from the Newly Industrializing Countries"
9. "Growth and Structural Change in Large Low-Income Countries"

The main report, other annex volumes and background papers are available from World Bank Publications, P.O. Box 37525, Washington, D.C., 20013 or from World Bank distributors listed on the last page of this volume. Prices will be furnished upon request.

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MAPS

ACRONYMS AND ABBREVIATIONS

ATEC	-	Agro-technical extension center
BGDH	-	bao gan dao hu ("contracting all actions to the household")
CAAS	-	Chinese Academy of Agricultural Sciences
CAS	-	Chinese Academy of Sciences
CBE	-	commune and brigade enterprise
cu m	-	cubic meter
cun	-	village
FCR	-	feed conversion ratio
GBSF	-	General Bureau of State Farms
gm	-	gram
GVAO	-	gross value of agricultural output, including sidelines
GVAOR	-	a restricted definition of GVAO which excludes sidelines
ha	-	hectare
IARC	-	international agricultural research center
ICOR	-	incremental capital-output ratio
K	-	potassium
kcal	-	kilocalorie
m	-	million
MAAF	-	Ministry of Agriculture, Animal Husbandry and Fisheries
MCI	-	multiple cropping index
MWREP	-	Ministry of Water Resources and Electric Power
N	-	nitrogen
NGB	-	national grain base
NSC	-	National Seed Corporation
NVAOR	-	net value of agricultural output excluding sidelines
NYJJLC	-	Nong Ye Jing Ji Lun Ceng (Essays in Agricultural Economics)
P	-	phosphorous
PRS	-	production responsibility system
SH	-	specialized households
SSB	-	State Statistical Bureau
xiang	-	township

CURRENCY EQUIVALENTS

The Chinese currency is called Renminbi (RMB). It is denominated in Yuan (Y). Each Yuan is

1 Yuan = 10 jiao = 100 fen

In early 1984 the official exchange rate of the Yuan to the US dollar was around Y 2 = US$1. The internal settlement rate (ISR) of Y 2.8 = $1, however, was used in most merchandise transactions. The official exchange rate is now about Y 2.8 = $1. On January 1, 1985, the Government abolished the ISR.

WEIGHTS AND MEASURES

Chinese statistics are usually in metric units; in addition, mu and jin are often used:

1 mu	=	0.1647 acres = 0.0667 hectares
1 jin	=	0.5 kg

FISCAL YEAR

January 1 - December 31

TRANSLITERATION

The Pinyin system is used in this report.

Note: In tables, individual items may not sum exactly to totals because of rounding errors.

CHINA

AGRICULTURE TO THE YEAR 2000

Executive Summary

Performance Since 1979

1. In an effort to improve incentives and management at all levels of the agricultural economy, the Chinese Government since 1979 has moved ahead rapidly to implement a comprehensive restructuring of rural institutions. The major feature has been introduction of the production responsibility system (PRS), the generic name for various contracting arrangements which define the rights and responsibilities of owners of assets (state, collective, or private), on the one hand, and managers of these assets on the other. The common PRS variant used in agriculture is the bao gan dao hu (BGDH) or "contracting all actions to the household" system. Under BGDH, the individual household has replaced the collective (production team) as the basic farm management and production unit. At higher levels, the commune is being renamed township (xiang), with its economic role confined to managing commune and brigade enterprise (CBE) development, while the brigade is reverting to the designation village (cun) and losing much of its managerial and technical staff. Management of collectively-owned land is now contracted to households, usually in proportion to household size or labor force. Other collective assets are divided up, sold or contracted to individuals or groups willing to manage them. The household is obligated to pay taxes, make contributions to collective welfare funds, provide its share of state procurement requirements, and contribute labor to maintain or construct public infrastructure. All remaining output may be retained by the household. BGDH has provided substantial rewards to those farmers who are able to increase production since obligations to the collective have been fixed in absolute terms, rather than on a percentage basis, although amounts vary with the productivity of assigned land.

2. The shift in control over resources from collectives to individuals has raised the question of the adequacy of investment for rural development. Collectives appear to be handicapped by diminished income from agriculture and growing difficulties in drafting team labor for public works projects. The uncompensated "social labor obligation" to maintain infrastructure was estimated in 1982 to amount to Y 12 billion out of a total of about Y 65 billion in rural gross investment. Recent budget cuts designed to reduce the central Government deficit have meant declining state investments in agriculture. Of the 1982 investment figure of Y 65 billion, investment by the state appears to have accounted for only 5%, though it represents perhaps one fourth of directly productive investment. Collectives accounted for Y 13 billion of fixed investment in 1982, of which about 60% was derived from the net incomes of the CBEs. Estimates suggest that private rural savings are large enough to be a major source of finance for rural development, if these savings can be effectively mobilized without undermining the newly-established production incentives.

3. In order to improve living standards for farmers and provide incentives for increased production of certain essential commodities, the Government in 1979 made major adjustments in the level and structure of farm prices. Prices were increased by about 21% for grain, 15% for cotton, 25% for oilseeds, and 25% for pigs. The farm price structure was built around quota, above quota, negotiated and free market prices. After fulfilling obligations for quota and above quota deliveries, producers may sell remaining supplies at negotiated prices which fluctuate at approximate parity with free market prices. Negotiated prices apply to sales to the state by individual farmers for production which may be legally sold on the free market. If no quota exists for a product, the above quota or negotiated price normally applies. As a result, increased procurements generally take place at higher than average prices and impart an uptrend to the weighted average price received by producers. With this more flexible, if complex, price structure in force, the number of agricultural commodities subject to state-established prices is declining. Measures are underway to further simplify the structure of agricultural prices.

4. The agricultural sector has performed exceptionally well since 1979. The gross value of agricultural output (GVAO) in 1983 grew by 9.5%, following growth of 11% in 1982, 5.7% in 1981, and 2.7% in 1980. Grain production in 1983 reached a record 387 million tons, some 17% higher than in 1979, due largely to a remarkable 22% increase in average yields. Though Chinese agriculture continues to be heavily crop oriented, the period has seen a steady decline in the share of crop production, a marked increase in sideline production (gross value of hunting and gathering and industries run by brigades and teams) and more modest relative gains in livestock.

5. Both incomes and consumption have risen markedly since 1979. In nominal terms, per capita incomes of farmers in 1983 were 2.3 times those of 1979. Incomes of employees in state enterprises (mostly urban dwellers) rose by 66% during this period and were nominally 70% higher than rural incomes in 1983. In real terms, rural incomes may have increased by 70% while urban incomes were up by about 40%. Consumption gains have been substantial, especially in red meat (up 53%) and vegetable oils (up 48%). By 1982 the daily average Chinese diet provided over 2,700 kCal of food energy. Urban residents generally have access to more animal protein, edible oils, fruits and vegetables, whereas rural residents consume considerably more grain per capita. While urban/rural and interregional disparities remain in per capita nutrient availability, China's food procurement and distribution system has provided basic food nutrients to most of the population most of the time.

Future Demands on the Sector

6. Average per capita consumption levels in China markedly exceed those of other low income countries and an unusually high proportion of calories comes from grain. At 2,580 kCal (1980-82 figures), the daily energy availability exceeds the 1975-77 average for middle income countries (2,560 kCal) and the world (2,570 kCal). While daily protein availability of 66 g exceeds the average for all developing countries (57 g) and approaches the world average (69 g), only about 10% of protein intake is from animal sources, as compared to a world average of 35% and 21% for developing countries.

Similarly, the availability of animal and vegetable fat in 1980-82 was 5% below the average in developing countries and more than 40% under the world average. At present, per capita availabilities in China exceed estimated requirements of food energy by more than 20% and of safe minimum levels of protein intake by more than 85%.

7. If consumption patterns in China follow those observed in other countries, higher incomes will bring about a substantial restructuring of consumption over the coming decades. This would involve a marked reduction in direct per capita consumption of grain and a corresponding increase in consumption of animal products, along with other forms of dietary diversification. Analysis of food consumption demands in 2000, using alternative assumptions of 3.5% and 5.5% per capita GNP growth, shows in both cases a radical adjustment from the present dietary pattern to a more varied diet, in which meat, eggs, fish, milk, pulses, fruits, sugar and vegetable oil are larger components. Direct consumption of cereals and tubers would decline by 15-20% overall, largely in the coarse grains and tubers. Within the fine grains category, it is likely that per capita consumption of wheat, in China's cities in particular, will rise steadily in response to higher incomes and preferences for more convenience foods.

8. The amount of indirect grain consumption depends heavily on the efficiency of production in the animal husbandry and food industry sectors. While estimates based on high and low feeding efficiency factors vary considerably, they clearly indicate that high future demand for livestock products would require correspondingly large increments of feed grains and protein meals. Assuming rapid economic growth, the difference between added feed-grain requirements under efficient versus inefficient livestock production systems would exceed 85 million tons of feed-grains annually by the year 2000. More difficult to project are the requirements of the industrial sector for non-food products and additional demands which might be placed on the sector to generate export earnings in support of overall economic growth. If the Government's income and population growth targets were met, total grain supply in 2000 would have to increase by about 50% from 1980-82 levels (2.2% p.a.) and more than a third would be committed to livestock feeding (versus 10% at present). Feed grain requirements would exceed Government projections of supply. On the demand side, price and foreign trade restrictions can be used to encourage consumption behavior to conform to available production. Other countries, both developed and developing, have used these measures to hold food consumption to levels below those expected or "normal" for a given level of GNP per capita. Present Chinese price policy has probably had the reverse effect, because food prices have been kept low relative to prices of industrial consumer goods and the supply of urban services (e.g., housing) has been subsidized and restricted. Because basic nutritional requirements have already been met on the average in China, some restraint of consumption may be acceptable from a nutritional point of view. On the supply side a key consideration may be the nutritional and resource tradeoff between direct consumption of grain and its use in livestock feeding.

Determinants of Future Growth

9. Land and Water Development. Unique features of China's agriculture include the relatively small portion of the total land area which is cultivated (about 10% as compared with 75% in India) and the large portion of the total cultivated area which is irrigated (45%, as compared with 23% in India). Uncertainties exist regarding the actual cultivated area in China. Although official figures of just under 100 million ha continue to be used, the actual figure may be a quarter to a third higher (and actual yields correspondingly lower). Official figures indicate that the cultivated area has declined marginally in recent years. The reported area of cultivated land in 1983 (98.4 m ha) was only about half a million ha larger than it was in 1949. Future availability of agricultural land largely depends on (a) the extent to which reclamation will compensate for land lost to non-agricultural uses and (b) the extent and effectiveness of future irrigation development.

10. The Government assumes that China's cultivated area will remain essentially unchanged over the next 15-20 years, as land lost to roads, urbanization and industrial development is approximately offset by newly-reclaimed land. Estimates show perhaps 3-5 m ha as suitable for development in the medium-term for sustained production of annual crops. These figures may be compared with the reported loss of about one m ha annually to non-agricultural uses in 1959-78. Annual losses at present are not known but, outside major municipalities, there are few legal restrictions on conversion of farm land to non-agricultural uses. The current surge of rural housing construction suggests that losses of agricultural land will continue to be substantial, despite government efforts at prevention.

11. Given China's land scarcity, irrigation and drainage take on particular significance as means to increase the sown area. MWREP projects additions to the irrigated area by 2000 of 8-10 m ha (from 45 m ha to 53-55 m ha). The amount of land actually irrigated has not increased significantly in 1978-83. About half (4.3 m ha) of MWREP's planned expansion of irrigated area would fall in the rice region south of the Huai River, largely through upgrading of existing facilities. Another large component (1.6 m ha) would occur in the North China Plain, primarily through the project to divert Yangtze River water northward. The remainder would be split between the Northeast and the arid areas of the Northwest loess region as well as the two provinces of Xinjiang and Gansu. In addition to expansion of irrigated area, an estimated 23 m ha of cultivated land require drainage facilities to prevent waterlogging and to reduce salinity.

12. Fertilizers. Increased use of chemical fertilizers has been an important factor in China's impressive agricultural performance in recent years. Application rates for chemical fertilizers doubled between 1977 and 1981 and by 1982 averaged 169 kg of nutrients per cultivated ha. Since 1979 chemical fertilizer use has been stimulated by greater availability and improved fertilizer:product price ratios resulting from recent price reforms. China also has a long history of using organic fertilizers and organics will continue to be important sources of nutrients, particularly for phosphorus, potassium and some trace elements. MAAF estimates that half of nutrient offtake will come from organic sources by 2000. This is likely to be

optimistic if utilization patterns in China follow those in other countries as agriculture modernizes.

13. About 85%, or 13.8 million tons, of China's total consumption of chemical fertilizer is produced domestically in some 2,200 plants. Production is characterized by a small number of product types and low nutrient content. Recently China has developed the capacity to design and construct efficient, large-scale plants for the production of nitrogenous fertilizers, but the four plants expected to be operational by 1990 will increase total production by less than a million tons. For both potassium and phosphate production, achieving rapid growth will require an early commitment of funds and manpower to master new technologies in the design and construction of large plants. By the year 2000 MAAF expects consumption of chemical fertilizers to reach 30 million tons of nutrients or half of total fertilizer requirements. It assumes domestic production of 24 million tons, elimination of imports of nitrogenous fertilizers, but continued imports of phosphorus and potassium to meet large domestic shortfalls. In recent years, fertilizer imports have averaged ten million product tons (2-3 million nutrient tons) at a foreign exchange cost of over US$ 1 billion p.a.

14. About 20% of domestic fertilizer production is distributed through the state system at centrally-established prices. This system of allocating fertilizer has been used as a policy instrument to encourage production and marketing of key commodities. In the past it has tended to favor food crops relative to feed grains and pulses; the high, stable yield areas relative to lands of lower quality; irrigated areas relative to non-irrigated areas; and the state farms relative to the collective sector. This pattern of allocation appears much less efficient today. At the new higher levels of application, marginal yield responses in the high yield localities are reportedly below marginal yield responses in the low yield areas. There is therefore reason to reallocate available supplies, perhaps by allowing the market to play a large role. Important tasks for the Government are to improve the efficiency of distribution and strengthen fertilizer testing programs to guide production and utilization.

15. Seeds. Recognizing that high quality seeds in adequate quantity are critical inputs to increased crop yields, the Government since 1979 has given special support to strengthening China's seed industry. Now in place is a National Seed Corporation (NSC) under MAAF which functions as China's chief regulatory and policy/planning agency for seeds. There are also about 2,300 NSC-affiliated but locally-financed and administered seed companies which handle multiplication, processing, storage, certification and distribution of stock and certified seed. Breeder seed is supplied primarily by provincial agricultural research institutes. Multiplication of stock and certified seed is carried out by seed farms either managed by or under special contract to the local seed companies. The Central General Bureau of State Farmer (GBSF), also under MAAF, operates a parallel system of seed companies and farms. Though the basic mechanisms are in place, both processing facilities and quality assurance procedures are inadequate. NSC and GBSF-affiliated companies supply about 40% of total national seed requirements (17 million tons), but less than 1% of this seed has been properly processed and certified using modern methods. As a result, farmers for the most part are forced to rely on

poor quality seed which translates into high seeding rates, high production costs, and less than optimum yields. The Government's current program of seed industry development is aimed at modernizing over 300 seed production, processing and distribution centers by the year 2000.

16. The Policy Environment. Introduction of the PRS has significantly improved agricultural production incentives and can share credit with price reform for the outstanding growth record of Chinese agriculture since 1979. Recent movement towards an enlarged role for prices and market forces can be expected to enhance the climate for agricultural growth. There is a concern within the Government, however, that for a farm sector comprising a vast number of independent decision makers, such moves would lead to imbalances in the quantities and mix of crops grown relative to national requirements. Quotas for sown area of grain thus reportedly have been retained in order to prevent farmers from shifting a large portion of land under their control from grain to more profitable industrial crops. Analysis of domestic procurement prices relative to border prices for major commodities suggests the need for continued adjustments as the basis for promoting growth and efficiency in the sector. A number of important commodities, including timber, fish, and pork, appear to be underpriced relative to international prices and in fact may be too low to stimulate expanded production. On the other hand, some products such as sugar crops, natural rubber and edible oils may be overpriced. With regard to production inputs, prices of chemical fertilizers appear to be near economic levels. Prices of electric power in rural areas are relatively cheap while some farm machinery remains costly by international standards.

17. A key question is whether over the next two decades productive investment in the sector will be adequate to sustain agricultural growth at rates needed to achieve national growth and income targets. State investment in agriculture, according to current Chinese estimates, is not expected to grow by more than Y 1-2 billion annually. Collective investment (excluding that in CBEs) may continue to decline. Therefore, the ability to effectively tap private savings for productive investment is likely to be a critical determinant of the adequacy of agricultural investment. Measures to attract private savings might include granting private use rights over collective or state property, making time deposits attractive through higher interest rates, instituting a tax on idle assets, and encouraging rural credit institutions to devote a larger proportion of credit to longer-term lending.

18. The Government's investment priorities in agriculture appear to differ substantially from present subsectoral shares. The share of proposed investment which would benefit crop cultivation (about 30%) is less than half of the crop share in GVAOR (about 75%), whereas the other subsectors' shares are at least twice their present product shares. While these investment "weights" are generally consistent with the structural change that the Government supports in agriculture, they may not be an effective means of achieving production and income objectives. More than half of total investment would be absorbed by dairy and forestry development. Given the current high costs of dairying operations, massive investment in dairy development appears difficult to justify on efficiency grounds. And, while forestry development in general warrants priority on need and environmental grounds, expenditure on afforestation will add relatively little to annual product in the next few years because of the slow maturing nature of this type of investment.

19. Agriculture Support Services. Because yield increases will be the source of most of China's agricultural growth, a strong research program aimed at improving production technology is of particular importance. Although it is difficult to prescribe an optimum level of investment in research, estimates elsewhere suggest that building an effective national research capability requires an investment of up to 2% of the annual value of agricultural output. For China, this would imply an annual expenditure of up to Y 4 billion, considerably more than current levels. The bulk of agricultural research in China today is carried out by 390 research institutes at the provincial level and above which operate under the general professional guidance of MAAF's Chinese Academy of Agricultural Sciences (CAAS). Research personnel in these institutes number about 18,800. Another 15,300 researchers work in 49 crop and livestock research institutes run by the provinces. Some research is also carried out in China's 85 agricultural colleges and universities. Despite some very notable research achievements, work at many research institutes is hampered by inadequately qualified staff and poor research facilities. A large part of the intellectual leadership for agricultural research in China is provided by staff who are more than 60 years of age.

20. China has some 85 institutions of higher education in agriculture and related fields, with a student enrollment (1981/82) of about 100,000. This represents only 8% of those enrolled in institutions of higher learning. Agriculture is generally not the first choice of candidates for college and those admitted into agricultural college and universities frequently have lower scores on admission tests. There is also a problem of retaining agricultural technicians in this sector after training is complete. Special quotas for admission of rural students to agricultural training institutions and additional salary incentives for those working in rural areas have been implemented to ease these problems.

21. The restoration of a farming system organized around individual households has placed new demands on agricultural extension services. Whereas previously the various levels of collective organization could serve as major foci in the delivery of production inputs and technical assistance, now the extension organization must establish direct links to nearly 200 million production units which operate much as do small family managed farms elsewhere. In response to this requirement, the Government is in the process of consolidating previously separate local agricultural services, including seed production, fertilizer distribution, and soil analysis units, into a single, county-level agrotechnical extension center (ATEC). Efforts also are underway to link extension more closely with agricultural research and education. ATECs already in existence - about 300 out of a projected 2,300 - are working more closely with local research institutes and colleges in such areas as varietal testing, extension methodology, and training and upgrading of local farmers and technicians.

22. Provision of agricultural machine services has also been affected by development of the household farming system. Reductions in field size, as well as the farmer's desire to obtain maximum control over timing of farm operations and to minimize cash expenditures, have caused a decline in demand for large and medium-scale machinery, a corresponding rise in demand for draft animals, and continued strong demand for small-scale pedestrian tractors. About one third of all tractors in the collective sector now are privately owned. The emerging organizational form for provision of machine services involves private or collective custom land preparation by specialized operators or teams whose earnings are supplemented by short-haul transport work. Successful development of custom hire machine services would help reduce grain and forage consumption by draft animals.

23. Efforts to restructure agriculture and increase specialization are constrained by the limited capacity of the rural transportation, processing, storage and distribution systems. Inland transport - especially the rural road system - and port facilities must be improved in order to handle the projected expansion in traded commodities. Relative neglect of transportation networks under past policies of local self-sufficiency has made rural transport a particularly acute problem. Solutions have been slow in coming in large part because of inadequate coordination between agricultural planning agencies and agencies responsible for transportation. Grain storage is becoming an increasingly serious problem largely because of inadequate investment in the past and the surge in production in recent years. Cold storage capacity for perishable fruits, vegetables and animal products will have to grow very rapidly if the changing pattern of consumer preferences is to be accommodated. Improved inland transportation and storage facilities in turn would provide a basis for agro-industrial development which requires assured deliveries of high-quality, uniform raw materials.

Prospects for Major Agricultural Products

24. Food Crops. The Planning Bureau within MAAF has targeted grain production to grow by about 2% annually from the average 1980-82 base while the area sown to grains would continue to decline marginally by about 0.1% p.a. The roughly 40% projected increase in rice production is expected to come entirely from higher yields. A major factor expected to contribute to increased yields is the projected expansion in area planted to hybrids from the 1983 level of nearly 6.8 million ha to 13.3 million ha by 2000. With a net yield advantage (taking into account the larger areas required for seed production) of about 20% over conventional varieties, an increase from current levels of the hybrid area by the implied 7.7 million ha, would generate nearly a third of the projected increment in rice production by 2000. Area expansion for hybrids would depend on successful introduction over the next few years of new early maturing varieties in double cropping systems. This seems feasible from technical and organizational viewpoints. With a yield advantage for hybrids of 0.75-1.0 tons per ha, the incremental benefit-cost ratio of about 5:1 suggests that hybrid rice is economically attractive to producers.

25. Wheat is the second most important grain in China after rice and accounts for about 20% of grain production and 25% of the area sown to grain. MAAF's Planning Bureau projects both wheat and corn production to grow

more rapidly (2.6% p.a.) than other major grains. With an assumed small decline in the sown area, this implies annual growth in wheat yields of 2.6% p.a. to 3.3 tons per ha. This would require continued attention to wheat disease problems, good water control in irrigated areas, and a proper nutrient balance in fertilizer applications.

26. Corn production accounts for about three quarters of coarse grain output and 18% of total grain output. Production since 1979 expanded at 3.2% p.a., or about one-half as fast as wheat. The Government projects virtually no change in the cropped area to 2000, but yields are to grow by about 70%, or 2.8% p.a., 1979-81 to 2000. China's corn yields (adjusted for likely under-reporting of the planted area) are slightly higher than average yields in developing countries, but less than half those in developed countries. Much the same pattern holds for other coarse grains. Factors restraining yields of coarse grains include poor seed quality, inadequate irrigation during times of moisture stress, low application of chemical fertilizer and poorer cultural practices compared with e.g., wheat and rice. Growth of total coarse grain production at a substantially higher rate than the Government target would be required to provide the feed grain necessary to meet output targets for livestock and poultry.

27. Industrial and Specialty Crops. With the significant exception of cotton, national average yields and per capita production of industrial crops (oilseeds, fibers, sugar crops, tobacco, tea) on the whole appear to be lower in China than in a number of comparator countries. The demand for these crops as well as for specialty crops such as fruits and vegetables is expected to grow rapidly as incomes rise. In the case of cotton, special encouragement given to production by price and procurement reforms and the planting of improved varieties stimulated a 22% expansion of cropped area and a 72% increase in yields during 1978-83. As a result of these area and yield gains, China has moved from being a large importer of cotton to basic self-sufficiency. Prospects seem good for further yield increases.

28. Production of oilseed crops (including rape seed, peanuts, sesame and sunflower seeds, but excluding soybeans and cottonseed) more than doubled during 1978-82 due to both increased area and yield. Soybean production has grown by about 5.2% p.a. since 1978, largely due to increased yields, but still is the only major crop grown in China in which the reported national average yield is less than that for developing countries as a whole. A steady increase in soybean yields will be required if China is to meet future needs for high quality protein meal for livestock feeding. Prospects for tea are clouded because of possible marketing constraints at home and abroad. Production of tobacco is likely to be increasingly influenced by the public perception in China of the health dangers inherent in its use. Caution may be required also with other crops in this category - e.g., sugar cane and sugar beets - for which China may have little overall comparative advantage and domestic procurement prices exceed world prices by substantial margins. For these crops the primary emphasis probably should be to improve yields through better cultural practices, improved planting materials and careful choice of planting location.

29. Forestry. Development plans call for the area under forest to increase from the present 13% of China's total land area to about 20% by the year 2000 to meet expected rapid growth in demand for forest products. Annual per capita wood consumption is about 0.05 cu m (excluding fuelwood), compared to about 0.02 cu m in India and 1.5 cu m in the US. Reflecting local shortages and increased demand from population and income growth, imports of forestry products rose from US$242 million in 1976 to peak figures of US$642 million in 1980 and about US$540 million in 1981. Major thrusts of future development include afforestation, increased exploitation of mature and over-mature forests, expansion of forest industries and strengthening of forest research, education and extension. Investment programs by the state forest farms, of which there are some 3,900, have been hampered by the relatively low price they receive for industrial round wood sold to the Government. Despite recent increases, state procurement prices for timber are only about one-half negotiated prices.

30. Livestock. By the year 2000, the share of the livestock sector in GVAO is projected by the Government to rise from the present 15% to 25%, with meat consumption more than doubling. Achievement of targets will depend heavily on use of animals with higher genetic potential, better production and management systems, improved veterinary services and the availability of much larger supplies of grass, grain and protein supplements. Low grain feeding systems and seriously inadequate levels of protein supplementation are major factors contributing to present technical inefficiencies in China's livestock sector. Solution of the toxicity problems in China's rape seed and cottonseed meals would greatly enlarge potential supplies of protein meal, although soybean meal is still the most appropriate meal for poultry and swine rations because of its amino acid balance. In the absence of adequate local supplies, the development of a capacity to produce synthetic amino acids warrants consideration.

31. China's extensive grazing areas of the North are viewed as a potential source of much of the large incremental supplies of beef, mutton and wool in future years. However, overgrazing problems in areas such as Nei Monggol and northern Hebei have been exacerbated by policies since 1979 which have stressed expansion in herd numbers and the rapid introduction of the PRS. While the PRS has encouraged individual care of animals, with the result that mortality rates in some areas are down, it also appears to have destroyed the mechanism by which collectives formerly were able to control animal numbers and to implement pasture management systems. The combination of privately managed herds on a common grazing resource has added pressure to an already overburdened range land. The most important immediate requirement is to match livestock numbers with carrying capacity through herd reduction and improved range management. Although the focus of ruminant livestock development in China has been on the pastoral areas of the North and Northwest, more than 40% of the large animal population, including about half of China's cattle, is located in 12 southern provinces. While these areas may be technically suitable for pasture development, the financial and economic viability of ruminant development in South China also needs careful assessment.

32. Several different production systems are being tried in the livestock subsector. Official policy increasingly favors animal production by

specialized households (SH), although most of the dairy development heretofore has been on state-owned enterprises. The term SH refers to small-scale commercial animal farms, which differ from state or collective enterprises in their household management and/or ownership of animals and use of private funds and capital saving production techniques. A major problem faced by the SH system is ensuring adequate supplies of balanced feeds. In some areas, authorities have encouraged SH animal producers to subcontract their land to other farmers who serve as SH feed producers. This form of specialization avoids some of the costs of transporting feed grains, though it is not a fully reliable mechanism for providing adequate feed supplies. China also has a growing number of large-scale, commercialized pig and poultry operations, mostly in the suburbs of major cities, to serve urban or export markets. These operations employ confined feeding systems and modern production technology with varying degrees of success. Local management in some cases is inexperienced and a few joint ventures with overseas interests are being organized.

33. China's dairy development policy is to promote production initially near large cities, stressing production by collectives and individual households and using state farms as sources of improved animals and modern technology. With high investment and operating costs, many of the larger dairy enterprises which are already operational do not appear to be financially viable, despite local prices for dairy products which exceed world prices by a substantial margin. Viability of some operations has been improved by integrating dairying with more profitable activities such as fish farming or fruit growing which use the manure as feed or fertilizer. But pig or poultry raising is likely to be a less costly source of nutrients for these operations. The economics of large-scale dairy operations in suburban areas warrants careful study. Smaller production units owned by SH and located closer to cheap forage supplies may be preferable. For the inland areas, higher productivity from improved breeds and better pastures may establish the basis for economic expansion of dairy production.

34. Aquatic Products. China's aquatic products sector (marine and freshwater) accounts for only about 1.5% of GVAO. China's fisheries rank third internationally in total production, but one hundredth in per capita production. Production in 1983 totalled about 5.3 million tons, of which more than two-thirds was accounted for by marine capture fisheries. The Government plans to expand aquatic products output to 11 million tons by the year 2000 by emphasizing intensive fish cultivation, particularly in freshwater ponds. There is good potential to increase fish yields in many of the fish farming areas. Factors which have contributed to low yields include poorly designed pond layout, inappropriate breeds of fish or stocking rates and poor feeding systems. With regard to the marine resource, additional consideration should be given to the production of fish meal for the livestock and poultry industries by expanding the collection and processing of fish species now considered to have little economic value.

Options and Issues

35. Between the present and the turn of the century, China's agriculture will be required to feed at better nutritional levels a population growing by

at least 10 million per year and to supply the raw materials to meet rapid growth in industrial demand. This will be a challenging task. At best, the land area under cultivation will not increase and the sown area is likely to remain at present levels as land reclamation and irrigation are approximately offset by lands converted to nonfarm uses. Competition for available water in some parts of China between agriculture, industry and human consumption will increase and make agricultural expansion more difficult. Most of the production gains will have to come from increased yields on presently cultivated land. The general direction of development is clear, viz., the shifting of more resources into activities (1) which are less constrained by fixed resources (land and water); (2) for which improvement of management and labor skills has a high payoff (specialty crops, modernization of livestock and poultry production); and (3) for which the gap between existing and advanced technology is greatest (agro-industrial production).

36. It may be suggested that two decades (1980-2000) is too short a time to bring about major structural change in the sector, but examples exist and some lessons may be learned from them. Structural change in Korean and Japanese agriculture has been striking over a roughly similar period of time (1960-80) and began from levels of development in some respects comparable to China today. These structural shifts were not "planned," but were largely the response of agricultural sectors in those countries to high rates of industrial growth and the attraction of agricultural labor to nonfarm employment. The comparison clearly suggests that rapid growth of the nonfarm economy is a requisite to rapid structural change in agriculture.

37. Projections of Agricultural Growth. Preliminary planning by the Government calls for rapid growth in livestock, poultry and sideline production and a relative decline in the crop share of GVAO by 2000. The farm labor force would decline sharply, while the rural nonfarm work force would rise extremely rapidly. The area sown to grain would remain unchanged, although wheat and rice production would grow slightly less rapidly than coarse grains. No significant increases are planned for areas planted to nongrain crop, although yields are expected to increase.

38. If the present generally favorable policies in agriculture continue, agricultural growth to the year 2000 is likely to be more rapid than long-run historical growth rates and structural change would be more rapid. However, this change may not be as rapid as indicated by Government supply targets or consumption demands under targeted income growth. Growth of crop production value is unlikely to greatly exceed the 3.7% p.a. achieved in 1965-83. Potential annual growth rates of grain production would be about 2.4% and nongrain crops 6.8%. Among grains, the MAAF target growth rates for fine grains seem feasible, but corn and soybean production would have to grow more rapidly to provide the feedstuff required to meet targets for the production of livestock and poultry. Nongrain crops would be required to grow at annual rates exceeding historical rates by 1-2 percentage points. Other components of GVAOR (excluding sidelines) are less subject to diminishing returns because of the land constraint and their growth rates will be determined more by the extent of Government and private investment, including that for agricultural support services.

39. Though a wide range of alternatives is possible, under one set of reasonable assumptions regarding technical progress, agricultural investment, use of industrial inputs and prices, GVAOR would expand by about 4.4% per annum while NVAOR would increase at a rate of about 3.8% yearly. If the farm labor force expands by about 0.6% p.a., these increases in output would translate into an approximate doubling of gross labor productivity in agriculture by the year 2000. The share of crops in GVAOR would decline by about eight percentage points and the livestock share would increase from 18% in 1980-82 to 24% by 2000. While this projection of potential growth is slightly higher than the growth rate of total supply needed to satisfy consumption requirements in 2000, the structure of potential production is quite different from that projected for consumption. The value of potential crop production would significantly exceed consumption requirements (particularly of rice), while that of livestock and fisheries would fall short of requirements. Faced with such potential imbalances, the options could include measures to (1) adjust price and area for the crops in surplus, (2) encourage the production of feedgrains in the rice areas; (3) attempt to develop export markets for crops in surplus; (4) trade them for products in short supply (livestock products, forest products, etc.) or (5) import sizeable quantities of feedgrain and high protein meals to support livestock production. A challenge to Government policy would be to convert China's potential for rice and nongrain crop production into increased feed supply either through external trade or a major restructuring of domestic cropping patterns.

40. International Trade. Planning in China continues to be premissed on basic self-sufficiency in agriculture, although it is acknowledged that trade will continue to play a role in balancing supply and demand for farm products and in generating foreign exchange. However, a self-sufficiency orientation may well conflict with satisfaction of future consumption patterns and raises the question of the extent to which international trade could balance supply and demand at lower cost to the economy. Global supply and demand considerations suggest that in the next decade overall world trade in grains is not likely to grow as rapidly as in the 1970s. With generally abundant supplies, world prices for the major grains in real terms are expected to decline about 10% from 1976-82 levels. Because of the large volume of world trade in feed grains, it seems unlikely that a gradual increase in imports of these grains by China to support rapid growth of the livestock and poultry industries would have a significant effect on world prices. China's potential impact on the world rice market could be much larger because of the "thinness" of that market relative to the quantities which China could supply. The best export prospects in agriculture are likely to be for a wide variety of labor-intensive, high-value products for which international income elasticities of demand are high. But the successful production, processing and marketing of them in world markets would require strengthened support services in research, extension, market infrastructure and market development.

41. Adjustments in Production. Reflecting expected changes in domestic consumption patterns and world markets, the needed adjustment in cropping patterns might involve some reduction in the area planted to rice and expansion of the area under crops such as corn and soybeans required by a much larger livestock program. This might well include conversion of some of the uplands of the south from the production of low-yielding rainfed rice to feedgrains and oilseeds. Such a shift would allow peri-urban areas to plant higher value crops on lands now under grain and forage crops and provide a basis for more diversified production systems in the low income upland areas where rainfed rice is a major source of income. For the nongrain crops, bottlenecks in transport, storage and processing are major constraints to expanded production. For the oilseeds, the most urgent tasks, in addition to expanding production of high quality protein meals, are to improve varieties and processing technology so as to increase the suitability of these meals (particularly from rapeseed and cottonseed) as livestock and poultry feeds. China seems likely to maintain its position of basic self-sufficiency in cotton and may have supplies for export. Study is needed to compare the relative economic merits of further expansion of cotton for export or use of the land to, e.g., increase production of animal feedstuffs. For high value fruits and vegetables, the major challenges lie in expanding production to meet the expected sharp increase in domestic demand and exploiting possible export markets. It is in the processing, packaging and marketing of semi-perishables such as these that China's existing systems are most deficient. This appears to be an area where joint ventures with established foreign firms would be useful as a source of both technology and market access.

42. Central planners have posed ambitious targets for meat, dairy and egg production. Beef, mutton and wool production from the northern grasslands are likely to grow no faster than in the recent past, and possibly slower, because of serious overgrazing and deterioration of range lands. Shortage of feed and forage are also likely to limit livestock production in the southern grasslands and the agricultural areas. A solid technological base exists to expand pork production, but the rate of growth will depend heavily on the adequacy of high quality energy feeds and protein. China's poultry industry should be accorded high priority because (1) poultry meat and eggs are preferred products among Chinese consumers, (2) modern production systems are efficient converters of plant materials to animal protein, and (3) technology to substantially improve production efficiency is available internationally and readily transferable. In light of the high investment costs, the objectives and means in China's proposed dairy development program should be reconsidered. Production by state enterprises in suburban areas is increasingly handicapped by high economic costs of land and scarcity of abundant forage. In the medium term, increased milk supplies for urban consumers might well be provided at lower economic costs through the importation and reconstitution of relatively low cost milk powder. Greater emphasis on specialized households and smaller-scale production units would be expected to improve efficiency in the dairy industry. This would require improved access by these groups to better milking stock, good veterinary services and high protein feed sources to supplement local feed supplies. The technology to double the output of aquatic products is available, particularly for freshwater fish cultivation, but realization of that target will depend heavily on whether adequate supplies of feeds (manure, grass, some grain) can be made available at suitable prices.

43. Income Distribution. Recent rural reforms have significantly narrowed urban-rural income differentials, although in 1982 average per capita income in urban areas continued to be about twice that in rural areas. In the 1978-82 period, interpersonal income differentials in the rural areas almost certainly increased as a consequence of policies to improve production incentives and foster entrepreneurship. Interregional income differences originate in differences in land and water availability, access to markets for inputs and outputs, and tax, procurement and price policies of the Government. In 1979-82, some of the poorest areas were among the first to introduce the BGDH system and consequently realized the earliest benefits from the reforms in crop production (e.g., Anhui, Sichuan, Guangxi and Guizhou). Some of the better endowed areas (e.g., parts of Jiangsu and Guangdong) benefitted from expanded production from sideline industries and access to free market and export prices. Relative poverty remains characteristic of much of the northwest and parts of the north and southwest - areas with poorer soils, little irrigation and difficult access to modern inputs such as fertilizers or to urban or export markets. Although one element of Government policy is to provide special assistance to the poorer areas, significant results may be difficult to achieve. The Central Government controls directly only about 20% of chemical fertilizer production and current plans for water resource development continue to emphasize the better endowed provinces. On the other hand, pricing policy for farm products and production inputs has tended to favor the poorer, more isolated areas and criteria for assessing returns to irrigation in such areas are frequently less rigorous than elsewhere. The emphasis on dairy and poultry production around urban centers probably tends to widen interregional income differences, as does rural industrial development which is faster near major urban areas.

44. Policy options which would substantially change these general trends are difficult to identify. The areas of extreme poverty are typically resource poor; investments to substantially alleviate this situation may not be justified on economic grounds alone. In some of the poorest areas, outmigration is certain to be one of the required policy measures. Elsewhere, improved transport and access to markets for agricultural products and inputs are likely to be among the most important measures needed to address the relative poverty issue. But to be effective, these must be buttressed by stronger agricultural research and extension oriented to difficult agro-climatic circumstances. Issues related to inter-regional income distribution are likely to remain important in China.

45. Prices. The budgetary cost of the continuing upward drift of average procurement prices has encouraged changes in the multi-tier pricing system. An approach, currently applied to oilseeds and cotton and soon to be introduced for grain, is a system whereby fixed proportions of farm sales receive quota and above quota prices. Marginal prices received by farmers for additional sales are reduced to a weighted average of quota and above quota prices, and state procurement agencies cease to serve as buyers of last resort. With this approach, incentives to sell to the state and to use purchased inputs might decline and budgetary costs would be little affected unless the system were applied to reduce average procurement prices as well. A preferable alternative might be to replace this system with a single market price structure, with government intervention as necessary to maintain price

stability. The indirect tax resulting from low procurement prices could be replaced with direct taxes based on the productivity of land and other resources. Procurement agencies would purchase only the quantities needed to meet urban and rural resale requirements and to maintain emergency reserves and price buffer stocks.

46. Some changes in relative prices for specific farm products and inputs seem to be required in order to enhance incentives and encourage efficiency. Some of the required changes emerge from the fact that much larger output of, e.g., livestock products, requires new production technologies (e.g., more intensive grain feeding) which are not profitable if grain is priced at current market (or marginal) prices. In pork production, for example, the policy has been to subsidize grain and other costs for producers who use grain intensive systems. A more efficient alternative would be to allow both product and input prices to rise and employ direct taxes as necessary to meet efficiency and equity objectives.

47. To stimulate necessary investment, comprehensive price reforms in agriculture are likely to require price increases for livestock, forestry and fisheries relative to most crops. This selective increase in farm prices might permit an increase in interest rates on agricultural loans and in the rates paid on deposits, thereby helping to mobilize more savings for productive investment. While non-Government funds are likely to be the major source of investment in the sector, an increase in Government resources also will be required.

1. Performance Since 1979

Introduction

1.01 China's agricultural sector has undergone substantial change since the visit of the World Bank's first Economic Mission in November 1980. The introduction of the "production responsibility system" (PRS), price reforms and other changes in the organization and management of production units and support services have had very positive effects on the performance of the sector in recent years. This chapter of the annex describes these changes in some detail and examines agriculture's performance since 1979. The second chapter explores future demands for food and other agricultural products, while the third and fourth chapters look at determinants of future growth and production prospects for major products, respectively. A concluding chapter considers some of the issues and options which face the sector over the next 15-20 years.

1.02 The basic objective of this report is to bring together the material available to the Bank which bears most directly on future development of China's agriculture and, from that base, to discuss development prospects and options. The size and diversity of the agricultural sector makes this a formidable task. The work has been made somewhat easier by extensive discussions with authorities in Beijing and through visits by the Economic Mission to Hubei, Jiangsu and Gansu Provinces during the first four months of 1984. The Bank's ongoing agricultural project work also has deepened our knowledge of the sector. The material which follows should be viewed as part of the World Bank's continuing effort to understand and assist an agricultural economy which provides basic sustenance to more than one billion people and livelihoods for some 800 million individuals.

The Changing Policy Environment

1.03 Institutional Reforms. Beginning with the experimental abolition of collective farming in the more impoverished areas, the Chinese Government has moved swiftly since 1979 to implement a comprehensive restructuring of rural institutions. The reforms, a major feature of which is implementation of the PRS, were designed to improve incentives and management at all levels of the agricultural economy. By 1983 the farm household had become the fundamental unit of management and production in the agricultural sector, within a framework of collective or state ownership of land and major fixed assets. The continuing process of reform is directed at shoring up the new structure, dismantling redundant collective institutions, and facilitating a higher degree of commercialization and specialization.

1.04 The PRS is based on a system of contractual relationships which define the rights and responsibilities of owners (state, collective, or private) and managers of assets. The contract system is also applied to define vendor-consumer or supplier-procurer relationships. It is intended to provide scope for increased, albeit constrained, independence of decision making and encourage relationships based on negotiation rather than administrative fiat. A wide variety of contractual forms have been tried, and in agriculture one system has become nearly universal: bao gan dao hu (BGDH). This, loosely translated, means "contracting all actions to the household".

1.05 In BGDH, management of collectively-owned land is contracted to households, usually in proportion to household size or labor force. Other collective assets are divided up, sold or contracted to individuals or groups willing to manage them. The household is obligated to pay taxes, make contributions to collective welfare funds, provide its share of state procurement requirements, and contribute labor to maintain or construct public infrastructure. All remaining output may be retained by the household. Food rations and the work point system are abolished. Under this system, teams of 20-40 households function largely as administrative bodies, make periodic adjustments in the distribution of land and other assets, collect taxes, procure production quotas on behalf of the Government, and implement family planning activities. Teams may continue to promote the development of service or subsidiary production activities, but this is done usually through subcontracting rather than direct management.

1.06 Some teams have retained less radical forms of the PRS and continue to play a major role in management or distribution. Usually these are teams in areas where extensive indivisible collective assets exist. The state farm system initially tied bonuses to contractual performance of individual workers on fixed basic wages, but has now begun to implement a scheme similar to BGDH.

1.07 As part of the trend toward a reduced role for administrative bodies in economic management, higher level institutions are also undergoing restructuring. The commune is being transformed into the township (xiang) with its economic role confined largely to fostering commune and brigade enterprise (CBE) development. The brigade is being renamed the village (cun) and is losing much of its managerial and technical staff. The Supply and Marketing Cooperatives are being restored to their initial role as dividend-paying, shareholder-managed institutions owned largely by farm households. At higher levels, Jiangsu Province is experimenting with the integration of cities, towns and surrounding countryside into single administrative units in order to reduce administrative obstacles to commercial development. State farm reforms include the establishment at provincial level of semi-autonomous Agriculture, Industry and Trade Corporations which will be responsible for, inter alia, interprovincial and international trade in products from state farms. These corporations also will be permitted to engage in construction work outside of the state farm system.

1.08 BGDH has provided substantial rewards to those farmers who are able to increase production. Tax, welfare fund contributions, and quota procurement obligations have been fixed in absolute terms, rather than on a

percentage basis, although amounts vary with the productivity of assigned land. The total obligation to the collective and the Government, counting the underpricing of procurements, appears to be in the range of 20-30% of gross value of output.[1/]

1.09 A State Council regulation of early 1984 permits the transportation and marketing of most agricultural products by collectives and individual producers after quota and above quota deliveries have been made.[2/] After licensing by local commercial bureaus, producers may transport agricultural products, including livestock, aquatic products and processed foods, for sale across county and provincial lines. Similarly, private merchants in urban areas may cross jurisdictional boundaries to purchase eligible products directly from producers. Prices are to be established through negotiations and may vary within the bounds, if any, specified by local or national policy. In the case of inter-county or inter-provincial movements of goods, itineraries of transport vehicles must be approved by authorities at county level or above.

1.10 The shift in control over resources from collectives to individuals has created new policy issues, among them how to sustain a high rate of investment in the farm sector. Perhaps reflecting uncertainty over the duration of the PRS policies, households were initially inclined to devote their new surpluses to housing construction and the accumulation of consumer durables or commodity stocks. The Government has responded with policy changes designed to encourage private investment, notably by lengthening land contracts to up to 15 years in the case of annual crops and 50 years for tree crops, machinery and equipment. Since the inception of the PRS some 1.2 million households have purchased pedestrian tractors.

1.11 Part of the new policy environment is to encourage specialization and commercialization, thereby reversing the self-sufficiency orientation of Chinese collective agriculture. This requires better functioning markets in labor, purchased inputs, services and output. These have begun to develop with official sanction. A clear example relates to labor and land. It is widely held that about one-third of the rural labor force is not required in agricultural production with existing technology. To encourage more efficient use of rural labor, recent Government decisions have allowed farmers to hire labor at negotiated wage rates and to surrender or subcontract land use rights in order to engage in off-farm activities.

1/ Assuming that 50-60% of total sales are at quota prices and the "market equilibrium price" is perhaps 50% higher than the quota price.

2/ State Council, "Regulations Issued by the State Council Concerning the Transportation and Sale of Farm and Sideline Produce by Collective Commercial Units and Individuals," February 25, 1984 (World Bank translation of Xinhua release of March 8, 1984).

1.12 The growth of BGDH and the focus on farm households as production units has required new structures for agricultural extension and research. Here the Government is using new concepts such as the model farmer and is applying the contractual features of the PRS to extension work by experimenting with a fee-for-service system to provide technical assistance to producers. The farm household is the new target for support services, and the "specialized household" (SH) is considered to be the major vehicle to demonstrate improved technology. Some 14% of farm households now possess sufficient degrees of production specialization and/or commercialization to be classified as SH. The SH at present is something of a hothouse product, nurtured with subsidies and often headed by individuals with some technical training. Government policy reflects an increased awareness of the need to establish an institutional framework for agriculture which provides a "complete service structure supporting commercial production, including such requirements as technical assistance, investment, marketing, storage, processing, transport, commercial credit, and management assistance."[3/] Achievements are encouraging, but much remains to be done in each of these areas.

1.13 Rural Reforms and Investment. Spread of the PRS appears to have been accompanied by a contraction in rural investment in production infrastructure. In the past, accumulation by collectives, together with investment in kind by collective labor, represented a major part of agricultural investment. In recent years, in-kind investment by collective labor has become much less important, although this may have been offset to some extent by increased labor investment by households on lands contracted to them. The transfer of control over resources from collectives to farm families has resulted in an increase in private rural savings which now are equal to about 20% of annual income. Until recently, most of these savings had been funneled into housing construction or stock accumulation, possibly reflecting a reluctance to make long-term on-farm investments due to uncertainty about tenure arrangements or the permanence of reforms. In early 1984 the Government reacted to this problem by issuing decrees to guarantee long tenure and to encourage private investment in productive activities. The rapid increase in crop marketing in 1983 suggests that on-farm stock accumulation may have reached its limits.

1.14 The collectives now appear to be handicapped by diminished income from agriculture and growing difficulties in drafting team labor for such works as irrigation, land improvement and local road projects. Compensation for labor on large projects must be paid in cash or kind, at rates which compete with the earnings possible from private farming and sideline activities. However, an uncompensated "social labor obligation," perhaps averaging 20 work days per farmer per year, may be tapped to maintain infrastructure, construct small projects with local benefits, and fight natural disasters. Costed at about Y 2 per day, this may amount to as much as Y 12 billion in potential rural gross investment per year. In addition, rural collectives

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3/ China Farmer's News 16 (February 1984), p. 1, describing the contents of the 1984 No. 1 Party Directive.

accounted for Y 13.1 billion of fixed investment in 1982, of which about 60% was derived from the net incomes of CBEs.

1.15 State investment has been adversely affected in recent years by increased budgetary stringency, designed to reduce the central Government deficit. Investment by the state in agriculture appears to have suffered more than some other sectors. The Y 3.0 billion budget in 1982 for fixed capital investment in agriculture (including forestry, water conservancy and meteorology) represented a decline in this component to 9.7% of total Government investment in basic construction, compared to the 11-12% reached at the end of the 1970s (Table 1.1). Actual total investment in agriculture, including extra-budgetary funding by state-owned units at all levels, fell from 10.5% of the total during the Fifth Five-Year Plan to 5.8% in 1983. Much of this was absorbed by major projects receiving state support, e.g., Heilongjiang drainage and land reclamation, Tianjin municipal water supply, and various projects in Guangdong, some of which appeared to be only indirectly related to agriculture. The source of financing of water conservancy projects has shifted away from state budgets to provincial and local funds. In 1983 only about a quarter of expenditure for this purpose originated in the state budget.

1.16 The agricultural credit system also may have been used to restrain investment. Available data suggest that increased rural deposits exceeded the net increase in rural lending in recent years (although more rapid loan repayment due to good harvests may account for this phenomenon). The portfolio of rural lending institutions also was undergoing restructuring, as individual farmers received a growing proportion of new loans and the financing of state farms shifted increasingly from central government grants to loans by the Agricultural Bank (Appendix Table A.1).

1.17 A rough estimate of the magnitude of rural gross capital formation in 1982 is about Y 65 billion (Table 1.2). Investment by the state appears to have accounted for only 5% of this total, but represents perhaps one-fourth of directly productive investment in agriculture (Y 3.4 billion of Y 14.5 billion, the latter being the difference between the Y 26.5 billion in "other use" and the Y 12 billion for uncompensated labor). About one-half of collective investment was directed to CBE expansion from CBE profits, which also provided more than one-quarter of the financing for other collective investments (excluding "social labor"). The value of net increases in pedestrian tractors, draft animals, and pigs alone, presumably components of private investment, totalled nearly as much as state investment in agriculture.

1.18 The estimates in Table 1.2, notwithstanding their imprecision, suggest that by 1982 only a limited proportion of rural savings was being directed into investments which would contribute directly to agricultural productivity. A sizeable proportion of this investment undoubtedly was used to replace aging infrastructure or was offset by abandonment of collective assets such as large-scale farm machinery. On the other hand, the estimates suggest that private rural savings are large enough to be a major source of finance for rural development, if the savings can be mobilized without undermining the newly-established production incentives.

Table 1.1: AGRICULTURE IN THE STATE BUDGET
(Y billion) /a

	1957	1965	1975	1978	1979	1980	1981	1982
Total budgetary allocations /b	30.4	46.6	82.1	111.1	127.4	121.3	111.5	115.3
Of which: Basic construction investment /c	12.4	15.9	32.7	45.2	51.5	41.9	33.1	30.9
Budgetary allocation for agriculture, forestry, water conservancy and meteorology /c								
Basic construction investment	1.1	2.4	3.6	5.1	6.2	4.9	2.5	3.0/d
Administrative expenditure	0.9	1.7	3.3	6.1	7.9	7.0	6.5	6.2
Working capital expenditure	0.1	0.3	0.3	0.8	0.5	0.4	0.2	0.2
Subsidies to communes	-	0.1	0.9	1.6	1.1	1.2	0.9	1.0
Rural relief assistance	0.3	0.7	0.7	0.7	1.0	0.7	0.7	0.9
Total	2.4	5.1	8.9	14.3	16.8	14.2	10.8	11.3
Allocation for basic construction in agriculture as % of:								
Total budget	3.6	5.0	4.3	4.6	4.9	4.0	2.2	2.6
Total basic construction	8.8	14.8	10.9	11.3	12.1	11.6	7.4	9.7
Budget allocation for agriculture as % of total budget allocation	7.9	10.9	10.8	12.9	13.2	11.7	9.7	9.8

/a Relates to magnitudes in the unified national development plan and therefore includes those allocations by the central, provincial and local governments which are normally included in the national plan.

/b From 1982 China Statistical Yearbook, p. 449. Refers to budgeted expenditure.

/c From 1982 Yearbook, pp. 452-53.

/d Actual expenditure, which was probably higher than budgeted expenditure.

Table 1.2: ESTIMATES OF RURAL GROSS CAPITAL FORMATION, 1982

	Amount (Y billion)	Percentage (%)
By origin:		
State /a	3.4	5
Collectives /b	13.1	20
Private /c	48.5	75
(of which uncompensated labor)	(12.0)	(19)
Total	65.0	100
By use:		
Commune & brigade enterprise /d	6.8	10
Private housing /c	15.7	24
Stock accumulation /e	16.0	25
Other uses	26.5	41
Total	65.0	100

/a From Table 1.1. Includes investment by state-owned enterprises and farms outside the state budget.

/b Report in State Statistical Bureau, Outline of Chinese Statistics, 1983 (Beijing, 1983), p.57.

/c The sum of estimated components, including investments in private housing and other buildings (Y 16.9 billion, from source in note b), stock accumulation (Y 16 billion, based on difference between income and consumption in kind as reported in rural income surveys), net investments in productive assets except buildings (Y 3.5 billion, net of transfers from collective to private ownership). The increased numbers of pedestrian tractors, draft animals, and pigs alone would account for Y3.1 billion, and uncompensated "social labor" (assumed to average 20 workdays per year at Y 2/day for each of some 300 million farm workers) would have a value of about Y 12 billion.

/d The portion of retained earnings of commune and brigade enterprises which was not distributed or used to support agriculture. Includes Y 4.7 billion reinvested in CBE expansion and Y 2.1 billion for "other uses," primarily infrastructure such as roads, bridges, and housing related to CBE production as well as some "administrative expenses". As reported by the CBE Bureau, MAAF.

/e Accumulation of grain stocks and other agricultural commodities, including private working capital.

1.19 Price Reforms. The Chinese government in 1979 made major adjustments in the level and structure of farm prices because of concern that the existing structure did not provide sufficient income and incentives for the crop mix which the Government wished to encourage. Because these reforms forced sharply higher budgetary costs for consumer subsidies, the Government has indicated its unwillingness to consider further significant increases in the farm price level over the medium term. However, as seen below, this pricing system guarantees an upward drift in the weighted average price received by farmers as long as production and procurement continue to grow.

1.20 Prior to further reforms announced in late 1984, the farm price structure encompassed four distinct prices: (a) quota; (b) above quota; (c) negotiated prices; and (d) free market prices. Quota prices applied to crops sold in fulfillment of procurement quotas; above quota prices were paid for that part of crop sales in excess of quotas. Quantities to be delivered to the state at quota and above quota prices were stipulated for each producer. After fulfilling these two obligations, producers could sell remaining supplies at negotiated or free market prices. Ratios of above quota prices to quota procurement prices, which were 30% for grain prior to 1979, were increased to 50% for grains and oilseeds, 20% for bast fibers, and 30% for cotton (which previously had no above quota price premium). Procurement prices for soybeans were increased 15% in 1979 and 50% in 1981. Quantity norms or obligations for sales at above quota prices have been typically determined for a three-year period, but no penalty is attached to underfulfillment, as currently there is little differential between above-quota and free market prices. The number of agricultural commodities with state-established prices is declining and the pricing structure is being simplified. In Gansu Province, for example, the number of agricultural and sideline prices controlled by the price bureau declined from more than 100 to about 40 by early 1984 (of which 30 were for medicinal herbs). Beginning with the 1984 crop, all cotton in China was to be procured without regard to quota fulfillment under a one-price system in which a weighted average of quota and above-quota prices will apply, with weights varying by region but not over time. It is expected that a similar system would be applied to grains beginning in 1985.

1.21 Negotiated prices fluctuate at approximate parity with free market prices. They apply to sales to the state by individual farmers for production which may be legally sold on the free market. In 1980, negotiated prices were 10-20% higher than above quota prices, reflecting procurement shortages and high free market prices. Recently, negotiated prices for some grains have fallen in some areas to less than above-quota prices, reflecting bumper harvests. Overall, in 1979 the average procurement prices (each type of price weighted by the share of sales transacted at that price) rose about 25% for grains, 40% for oilseeds, 17% for cotton and 37% for pigs.

1.22 Procurement quotas for the two major commodity groups, grain and cotton, were last fixed in the early 1970s and have remained substantially unchanged. Quotas for other crops such as oilseeds varied from year to year. If no quota existed for a product, the above quota or negotiated price normally applied. As a result, increased procurements have generally taken place at higher than average prices and imparted an uptrend to the weighted average price, even with an unchanged price structure. The effect can be

sizeable. Of the total value of net procurement of agriculture and sideline output in 1983, 48% was at quota prices, 28% at above quota prices, and 13% at negotiated or market prices. Just under 11% represented free market sales to the nonfarm population. The increased volume of sales in 1983 over 1981 at quota prices was only 9%, but was 49-78% for each of the other three categories. As a result, average weighted prices in agriculture appear to have continued to grow in recent years at about 5% p.a (Appendix Table A.2). Reforms announced in late 1984 are expected to effectively abolish procurement quotas for most agricultural commodities. Under the new system Government procurement would be limited largely to contracted amounts needed for urban consumers. Excess production is to be retained by the farmer or marketed by the farmer on the free market.

1.23 Price reforms of recent years were designed to improve levels of living for farmers and to correct incentive imbalances among crops. However, there has been little public information on how these objectives were translated into specific prices. Some inferences can be drawn from post-reform surveys of farm production costs (Table 1.3). It appears that quota prices were set at levels which roughly equalized the net return (wages, rent, profit) per labor day for different crops (with the exception of sugar, where the intent apparently was to provide an incentive for expanded production), with the value of rural consumption per labor day which has been reported at about Y 1.40. This leads to significant differences among crops per sown ha, although these differences are greatly narrowed if cropping systems are considered which would typically occupy land for an entire year (e.g., rice, corn or soybeans combined with wheat or rape, and compared with crops such as cotton, jute, tobacco or sugar cane where only a single crop per year is possible).

1.24 Average quota procurement prices appear to bear a reasonable relationship to historical production costs for the "average" region or situation. However, the new price structure is based on past levels of input use which, in turn, were influenced by the previous price structure. Thus, price adjustments which restored profitability relative to past production costs tend to perpetuate any inefficiencies existing in the previous price structure. Further, average cost-price relationships mask regional variations in subsistence costs, land quality, the extent of multiple cropping, etc. Some local observers regard the new level of quota prices as too low to promote increased production and biased against grain production. However, agriculture's good performance since the 1979 price adjustments does not provide support for these assertions. Some anomalies, such as the low return per ha for soybeans (which are single cropped in the main producing region), have been corrected through subsequent price or quota adjustments.

Growth and Productivity

1.25 The period since the 1979 reforms has been characterized by exceptionally good performance of the agricultural sector. The gross value of agricultural output (GVAO) in 1983 grew by 9.5% following growth of 11.1% in 1982, 6.6% in 1981, and 3.9% in 1980. Since 1978, GVAO has grown at an annual average exceeding 7%, or more than twice the rate achieved over the previous two decades. Weather during much of this period was normal, but unusually good growing conditions in 1982 and 1983 made important contributions to high

Table 1.3: EFFECTS OF PRICE REFORM ON RETURNS TO CROP CULTIVATION /a

Crop	Net return per labor day /b	Net return per ha /b	Rate of return on cost /c
Rice	1.56	782*	47
Wheat	1.13	411*	19
Corn	1.31	500*	33
Soybean	1.37	352	39
Cotton	1.34	1,087	40
Rapeseed	1.17	491*	25
Peanuts	1.27	570*	45
Jute	1.39	1,289	42
Tobacco	1.36	1,540	36
Sugarcane	1.98	1,769	66
Sugar beet	3.37	810	106

/a Computed from survey data covering over 800 production teams and reported in the Handbook of Agrotechnical Economics (Beijing, 1983), pp. 642-57. Data refer to prices and costs which prevailed after the 1979 reforms.

/b Net return defined as gross value of main product at quota prices less material costs (net of value of byproduct); that is, rent + wages + profit. Refers to crop area, not cultivated area. An asterisk designates crops which frequently occupy land in one of two crop seasons per year.

/c Net returns exclusive of "wages," valued at Y 0.80/labor day (an accounting wage used in cost surveys since the 1950s); as a percentage of material costs + "wages."

growth in those years. During the 1979-83 period, China's cropped area declined by 3.0%. The area sown to grains fell by more than 4%, while the area under non-grains rose by 20%.

1.26 Grain production in 1983 reached a record 387.3 million tons, some 17% higher than in 1979 (Table 1.4). Grain production in 1979-83 increased at an annual average rate of 3.9%, as the steady decline in sown area was more than offset by a remarkable 22% increase in average yields. Factors contributing to yield gains included more rational selection of areas planted to grains, improved production incentives and greater use of purchased inputs. The largest production gains have been centered on the fine grains. Compared with 1979, wheat production in 1983 was up by 30%, rice output was some 17% greater, but output of coarse grains increased by only 9%. An important contributor to grain production was hybrid rice, which now accounts for about 26% of China's rice production and has a yield advantage over conventional varieties of 15-20%.

1.27 Oilseed production in 1983 (excluding soybeans and cottonseed) totalled 10.6 million tons, down 10.7% from 1982 but 66% more than production in 1979. In contrast to grains, the area planted to oilseeds increased steadily until recently, with most of the increase coming in rapeseed. The area planted to rapeseed was cut in 1983 in response to market surpluses and state prices were reduced slightly. Good harvests permitted steady gains in per capita availabilities of edible oils to about 4 kg per annum, thereby helping to alleviate scarcities of this important food item. Soybean production in 1979-83 varied markedly from year to year in response to weather conditions, but trended upward. Imports of soybeans for crushing declined while soybean exports for food use have moved up slightly. Production in 1983 was 9.8 million tons, up 7.7% from the 1982 crop.

1.28 China's cotton crop more than doubled in 1979-83, reflecting both higher yields (up 56%) and larger planted area (up 36%). The 1983 crop was up more than 28% from the 1982 level. The rapid growth in production is due in large part to specialization incentives and the introduction of new varieties. These incentives are encouraging expansion in the traditional areas well-suited to production in North China, while the planted area declined in less well-adapted areas where production had been encouraged by previous policies. The planted area in 1983 in Shandong Province, the largest producer, was 40% greater than it was in 1981, while the cotton area in Sichuan Province was down about 50% from 1981 levels. Cotton imports continued to decline and in 1983 were only about 10% of levels in the peak years of 1979 and 1980. Stocks of cotton in early 1984 were about 1.6 million tons, equivalent to nearly half a year's consumption requirements, and export markets were being sought. Rationing of cotton textiles ended in 1983 in conjunction with a price adjustment (cotton up 20%; synthetic textile prices down 30%) designed to balance supply and demand and pass on increases in raw material prices.

1.29 Sugar production increased by 52% in 1978-82, in response to attractive price incentives. Despite these gains, sugar imports continue to increase rapidly as part of the Government's efforts to improve per capita consumption levels of key commodities. Annual per capita consumption of sugar of 4.5 kg remains low by international standards (e.g. 20 kg in Thailand). In the 1979-83 period, tobacco production rose by 43%, tea by 45%, and silk cocoons by 26%.

Table 1.4: PRODUCTION CHANGES, 1979-83

Production	Unit	1979	1983	Percent change 1983/1979	% annual growth rates 1983/1979
Rice (Paddy)					
Sown area	mln ha	33.9	33.1	-2	
Yield	tons/ha	4.3	5.1	+20	
Output	mln tons	143.8	168.9	+17	4.1
Wheat					
Sown area	mln ha	29.4	29.1	-1	
Yield	tons/ha	2.1	2.8	+31	
Output	mln tons	62.7	81.4	+30	6.7
Corn					
Sown area	mln ha	20.1	18.8	-6	
Yield	tons/ha	3.0	3.6	+20	
Output	mln tons	60.0	68.2	+14	3.3
Others /a					
Sown area	mln ha	35.9	33.0	-8	
Yield	tons/ha	1.8	2.1	+15	
Output	mln tons	65.6	68.8	+5	1.2
Total Grain					
Sown area	mln ha	119.3	114.0	-4	
Yield	ton/ha	2.8	3.4	+22	
Output	mln tons	332.1	387.3	+17	3.9
Cotton					
Sown area	mln ha	4.5	6.1	+36	
Yield	kg/ha	88	763	+56	
Output (ginned weight)	mln tons	2.2	4.6	+109	20.2
Oilseeds /b					
Sown area	mln ha	7.1	8.4	+18	
Yield	kg/ha	913	1,260	+38	
Output	mln tons	6.4	10.6	+66	13.4
Sugar (refined)	mln tons	2.5	3.8	+52	11.0
Tea	'000 tons	277	401	+45	9.7
Meat /c	mln tons	10.6	14.0	+32	7.2
Tobacco (cured)	'000 tons	806	1,151	+43	9.3

/a Soybeans, pulses, sorghum, millet, barley, oats, tubers, miscellaneous grains.
/b Excludes soybeans and cottonseed.
/c Pork, beef, and mutton only.

Source: State Statistical Bureau.

1.30 Meat production (pork, beef, mutton) in 1983 was 32% greater than in 1979, with most of the gains coming in pork production. Per capita availability of meat in 1983 reached 13.7 kg. Cattle numbers have increased sharply in recent years, partly in response to the PRS which now permits farm households to own draft animals. The PRS in the grazing areas also is providing strong incentives to increase animal numbers, but thereby exacerbating the problem of overgrazing. Milk production is in the range of 1.8 million tons annually, but consumption remains low by international standards (about 1.7 kg per capita in China; 10 kg in Malaysia; 103 kg in the United States). The Government has just begun to collect statistics on poultry production. Household surveys suggest that per capita egg consumption has grown by nearly 50% since 1978. Modern enterprises for the production of eggs and poultry meat are being established near some of the larger coastal cities and are providing larger shares of total broiler and egg production.

1.31 Output of aquatic products in 1983 totalled nearly 5.5 million tons, of which the marine catch was 3.6 million tons and fresh water production 1.8 million tons. Output of fisheries products, after a decline in the late 1970s, has begun to expand as rapidly as most other subsectors of agriculture. Total fisheries production in 1983 was about 27% greater than the 1979 level. Sluggish growth of salt water fisheries is attributed to over-fishing of the marine resource. In contrast, fresh water fish culture has grown by 64% since 1979 and now accounts for about a quarter of total production.

1.32 Output from sideline activities (gross value of hunting and gathering and industries run by brigades and teams) increased by 110% since 1979 and 20% in 1983 alone. Sample surveys of households indicated that in 1983, 36% of farmers' net incomes came from private household activities. The comparable figure for 1978 was 27%. Output of commune-run industries (which are not included in GVAO) in 1983 was 87% higher than in 1978. Appendix A, Table A.3 notes the continued decline in the relative importance of crop production, the marked increase in sideline production and more modest relative gains in livestock. Chinese agriculture continues to be heavily crop oriented, with a crop:livestock ratio of about 92:8 (net value added) as compared with 52:48 in the United States and 83:17 in India.

Incomes and Consumption

1.33 Recently published household survey data provide some measure of the extent of income and consumption gains in rural China (Table 1.5). In nominal terms, per capita incomes of farmers in 1983 were 2.3 times those of 1979. Incomes of employees in state enterprises (mostly urban dwellers) rose by 66% during this period and were nominally 70% higher than rural incomes in 1983. In real terms, rural incomes may have increased by 70% while urban incomes were up by about 40%; however, the urban/rural income ratio in real terms is still well over 2:1. Consumption gains have been substantial. Between 1979 and 1983 annual per capita consumption of grain in rural China increased by only 1% while per capita consumption of vegetable oils rose by more than 48%. Consumption of red meat (excluding poultry) on a per head basis was up by more than 53%. Consumption patterns in China's rural areas continue to differ markedly from those in urban areas with rural residents consuming

Table 1.5: COMPOSITION OF RURAL INCOME AND EXPENDITURE, 1979-83

	1979	1983	Percent increase, 1979-83
Rural net income (Y/capita)	160.2	309.8	93
Composition (%):			
Collective income	64	55	
Private income	27	36	
of which from:			
Crops	10	12/a	
Livestock	12	13/a	
Other private	6	13/a	
Remittances & other	9	9	
Rural consumption expenditure (Y/capita)	134.5	248.3	85
Composition (%):			
Food	64	59	
Clothing	13	11	
Fuel	6	5	
Housing	6	11	
Other commodities	8	11	
Services	3	2	
Consumption of (kg/capita):			
Grain (unprocessed)	256.5	260.0	1
Edible vegetable oils	2.4	3.5	46
Red meat	6.5	10.0	54
Poultry	0.3	0.8	159
Fish and shrimp	0.7	1.6	128

/a 1982 figures; 1983 not yet available.

Source: State Statistical Bureau. Commodity income in 1979 valued at 1978 quota-procurement prices; in 1983 at 1983 procurement prices.

substantially more grain and less meat on a per capita basis, but the patterns have been converging.

1.34 It would be natural to expect that the PRS and associated reforms provided the incentives to accelerate agricultural growth but, in doing so, may have increased the inequality of income distribution in the sector.[4/] The rationale behind this expectation is that ability and ambition are unequally distributed in the population and the earlier rural distribution system rewarded neither. Indeed, it put a "cap" on distributed income whenever ability, effort and access to unusually productive agricultural resources would have led naturally to increased income differentials. Initial analysis of data through 1982 on the distribution of rural income suggests that the PRS in fact may not have increased the concentration of rural incomes (Appendix Table A.4). Rural income surveys suggest that between 1979 and 1982 poorer households shared more than equally in the benefits of the PRS.[5/] A possible explanation for these results is that the PRS, and in particular the BGDH version, was extended first to the poorest teams and most backward areas which therefore realized the earliest income benefits from the reforms. Only in 1982 and 1983 did the wealthiest teams and areas adopt BGDH. Improved incentives for growing cotton in the relatively poor North China Plain and sugarcane in the poorer areas of South China may also have narrowed regional differences. Moreover, BGDH was initially applied to crop production, and was of greatest benefit to families or areas with few non-crop activities. Recent reforms (1983-84) promote development of commercial sideline and CBEs, and will be of most benefit in wealthy areas. In short, the geographical reduction in inequality through 1982 may have "swamped" the effect of reforms on inter-family income differentials. On this reasoning, the full effects of BGDH on the richer areas have yet to be felt.[6/]

4/ Egalitarianism has been officially discredited. A recent article in the Beijing Review stated: "For more than two decades after the cooperative movement, China has tried to bridge the income gaps between the peasants with large-scale egalitarian collective management and egalitarian methods of distribution. By arbitrarily equalizing peasants' income, these methods only crippled the peasants' enthusiasm for work and held back the growth of agricultural production which even came to a standstill in some places". (September 19, 1983).

5/ The Gini coefficient estimated from these data declined from 0.257 in 1979 to 0.225 in 1982.

6/ A factor complicating the interpretation of these results is that size of the sample surveys more than doubled between 1978 and 1982 and composition also may have changed. Other statistical phenomena which would influence the computed coefficients include: (a) family divisions which would increase the weight of particular income groups seem more likely to occur among middle income families, rather than the poorest (who lack savings) or the richest groups (comprised mostly of young, nuclear families); and (b) migration out of the rural areas - and the rural statistics - may be highest among the poorest groups.

1.35 While the full impact of rural reforms on income growth and distribution remains to be seen, the rapid income gains of all groups clearly reduced absolute poverty. Various estimates document the decline in absolute poverty.[7/] In the 1977-79 period, about 200 counties were designated as poor. By 1982 only 42 counties were classified as in poverty. Measured somewhat differently, Appendix Table A.4 shows that families with yearly per capita incomes of less than Y 100 dropped from about 20% of the total in 1979 to less than 3% in 1982.[8/]

2. FUTURE DEMANDS ON THE SECTOR

2.01 Consumption of agricultural products in China will be strongly influenced by future trends in growth of per capita income and population. At the same time, consumption will be affected by policy measures intended to balance supply and demand. At any level of per capita income and population size, different price structures, rationing, or foreign trade patterns can be used to achieve balance at quite different levels and structures of food consumption. The projections of consumption made below are of potential demand in the particular situation where relative commodity prices are similar to those in other Asian countries at comparable income levels.

2.02 Peculiarities of the present Chinese consumption pattern, involving relatively high per capita levels of direct grain consumption, suggest that higher incomes would bring about a substantial restructuring of the Chinese food consumption pattern over the coming decades.[9/] The directions and magnitude of this restructuring are accepted in China as long-term economic goals. Broadly speaking, it involves a substantial reduction in direct per capita consumption of grain and corresponding increase in consumption of

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7/ A commune (township) is officially designated as poor if its per capita distributed collective income for three successive years is no higher than Y 50. Since the standard is not adjusted for price changes, use in intertemporal comparisons is misleading.

8/ Part of this change may reflect changes in accounting practices. In poor teams or areas, most of the distributed income is in kind. Official statistics on distributed income are very sensitive to changes in accounting prices. In 1981-82 distributed commodities were revalued upward in income surveys by about 30%. Presumably, officially-reported distributed income was similarly revalued. This may suggest that a substantial number of previously poor teams were pushed above the poverty line artificially by this change in accounting prices.

9/ Direct consumption of grain refers to consumption by humans of processed rice, wheat, corn, other minor grains and tubers (at one-fifth fresh weight). Consumption of soybeans and other pulses is excluded from this definition. Indirect consumption of grains would be grain consumed by livestock and poultry, the products of which are then eaten by man.

animal products, along with other forms of dietary diversification. This restructuring of consumption would require changes in the composition of domestic production, including its regional dimensions, and perhaps increased foreign trade in agricultural products.

Present Consumption Levels

2.03 After severe reversals and famine in 1960-61, China has made substantial progress in improving average per capita levels of available energy and protein. By 1982 the average Chinese consumed (directly) about 205 kg of cereals, 12.8 kg of red meat (pork, mutton, beef) and 4.2 kg of vegetable oil. This average diet on a daily basis provided over 2,700 kCal of food energy, 68 g of protein, and 38 g of fat (Appendix Table A.6: Food Balance Sheet, 1982). These availabilities exceed estimated requirements of food energy by 24% and of safe minimum levels of protein intake by 87%. Declines in per capita availabilities were registered in the late 1950s, the 1966-69 period, and again in the early 1970s. Generally rapid increases have occurred since the 1978 reforms.

2.04 These national average figures do not mean that nutritional levels throughout China are fully satisfactory. Interregional differences in per capita nutrient availability exist, although they are not well documented, and malnutrition is undoubtedly present in some localities from time to time. But China's food procurement and distribution system has been successful in providing basic food nutrients to most of the population most of the time. Because interprovincial shipments of food are relatively small, data on provincial meat and grain production provide crude measures of differences in per capita nutrient availabilities. These data suggest that in 1981 per capita production of grain varied from 202 kg (Guizhou) to 420 kg (Jiangsu), while in 1980 average per capita availability of protein ranged from about 38 g (Guizhou) to more than 100 g (Heilongjiang). Average per capita meat production in 1981-82 ranged from 19.3 kg in Sichuan to 5.4 kg in Ningxia.

2.05 Survey data for 1979 suggested that in most relatively high-income locations such as urban Beijing, there was virtually no malnutrition among children. Rural-urban differences were substantial, although somewhat less so in weight-for-age than in height-for-age. The data indicated that more than a third of 7-year old boys in Sichuan were stunted, as compared with less than 4% in Tianjin. The rural-urban gap in per capita energy and protein levels may have narrowed by 1982. Urban residents generally have access to more animal protein, edible oils, fruits and vegetables, whereas rural residents consume considerably more grain per capita.

2.06 At the national level, average per capita consumption levels markedly exceed those of other low income countries, but in China an unusually high proportion of calories comes from grain. Average availability of energy in China on a daily per capita basis in 1980-82 (2,580 kCal) exceeds the 1975-77 average for middle income countries (2,560 kCal) and the world (2,570 kCal). Protein availability of 66 g exceeds the average for all developing countries (57 g) and approaches the world average (69 g). However, in China only about 10% of protein intake is from animal sources, as compared to a world average of 35% and 21% for developing countries. Similarly, the

availability of animal and vegetable fat in 1980-82 was 5% below the average in developing countries and more than 40% under the world average. Direct per capita consumption of grain (about 209 kg p.a. in 1980-82) is among the world's highest and exceeds that in India by 60% and in Indonesia by more than 30%. In summary, by consuming relatively more grain and less animal products per capita, China achieves a diet substantially higher in energy and total protein content than that of countries with comparable income levels (Appendix Table A.7: Per Capita Food and Nutrient Availability in China and Other Countries).

Projections of Consumption to 2000

2.07 Assumptions. The projections of consumption discussed below assume that relative commodity prices would be similar to levels elsewhere in Asia with sizeable Chinese populations, and examine the implications of changes in real per capita incomes for future consumption patterns. Three scenarios are examined: (a) a "target growth" case, wherein present Government targets for increased per capita GNP and population growth are achieved (requiring an average annual growth of 5.5% in per capita GNP and 1% in population); (b) a "low growth" case, where annual per capita GNP growth is only 3.5% and the Government's population growth target of 1% p.a. is met; and (c) a "high growth" case, in which the Government's targeted per capita GNP growth is combined with population reaching 1.3 billion in the year 2000 (1.4% p.a. growth in 1980-2000).

2.08 Ideally, future changes in consumption resulting from these projected growth rates of per capita income could be estimated from income elasticities of demand derived from Chinese household consumption data. At present, the only data available permitting such estimates are for Beijing consumers.[10/] Analysis of this data indicates consumer behavior similar to that in other countries, viz., as per capita incomes increase from relatively low levels, preferences move sharply toward animal products, fruits, vegetable oils and nonfood consumer goods, and away from direct consumption of grain. However, the narrowness of the statistical base, its urban orientation, and possible distortions arising from rationing make these data unsuitable for projecting demand at the national level. Moreover, these data are inappropriate as the basis for projecting future demand because future incomes are expected to substantially exceed the range observed in Beijing today.

2.09 In view of the difficulties referred to above, the approach employed here assumes that consumption patterns of Chinese populations outside of the Chinese mainland at higher per capita income levels would approximate those which might be reached in China by the year 2000. For these populations the income elasticity of total grain consumption appears to have been about 0.25 over a considerable period of income growth. Applied to 1980-82 base year per capita total consumption of grain in China, this elasticity produces estimates

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10/ Basic data are from the Beijing City Offices of Statistics, "Year-end Data from the Survey on the Livelihood of Working Families, 1982;" (Beijing, 1983).

of total per capita grain consumption in the year 2000 of about 390 or 430 kg, if per capita GNP growth is 3.5% or 5.5%, respectively.[11/] The analogue Chinese population had roughly similar per capita consumption levels in 1970-72 and 1976-78 respectively. The pattern of direct consumption of a selected number of commodities at these times is examined in Table 2.1.

2.10 Per Capita Consumption. In either the target growth or low growth scenario, little or no change from average 1980-82 levels would occur in per capita consumption of energy and protein.[12/] However, compared with 1980-82, consumption of fat would roughly double, and the proportion of protein derived from animal sources would more than triple. The difference between the high and low income variants in per capita consumption in 2000 of various food items is less significant than the radical adjustment from the present dietary pattern to a more varied diet, in which meat, eggs, fish, milk, pulses, fruits, sugar and vegetable oil are larger components. Direct consumption of cereals and tubers would be expected to decline by 15-20% overall, reflecting a sharp decline in direct consumption of coarse grains and tubers and a slight increase in consumption of fine grains (rice and wheat) in the low growth case or during a transition period in the target growth case (Table 2.1).

2.11 Within the fine grains category, there is a question of how per capita consumption of wheat and rice in China will change in response to higher incomes. In developing countries, higher incomes typically lead to a significant shift toward wheat consumption relative to rice. In India, for

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11/ Projections of total grain consumption per capita are:

Assumed annual growth in GNP/capita 1980-2000 (%)	Growth in per capita grain requirements 1980-2000 /a (%)	Total grain consumption per capita in 2000 /b (kg)	Analogue years /c
3.5	18.7	394	1970-72
5.5	30.9	434	1976/78

/a Based on an income elasticity of demand for total grain of 0.25.
/b In terms of unprocessed grain; excludes tubers and pulses. The comparable figure in 1980-82 was about 332 kg/capita.
/c Years in which analogue Chinese populations had similar levels of total per capita grain consumption.

12/ Compared to SSB estimates of daily nutrient intake in 1982, the high income growth projection would involve equal per capita energy intake and a slight decrease in protein intake. SSB, Statistical Yearbook of China, 1983, p. 509.

Table 2.1: PROJECTED DEMAND AND CONSUMPTION TARGETS FOR SELECTED AGRICULTURAL PRODUCTS, 2000
(kg per capita per year)

	1980-82	Consumption in 2000 with per capita GNP growth of:/a 3.5%	5.5%	CAAS /b 2000
Crops				
Cereals /c	193.0	164.8	153.1	132.0
Fine grain	146.0	160.1	144.8	-
Coarse grain	47.0	4.7	8.3	-
Tubers /d	16.0	4.1	2.1	7.2
Pulses /e	11.3	15.3	15.5	18.0
Sugar	4.1	12.4	19.4	6.0
Fruit	5.7	44.2	58.0	48.0
Vegetables	92.0	89.1	118.6	120.0
Vegetable oil	3.2	5.7	7.0	6.0
Cotton /f	3.4	4.1	4.5	3.1/g
Synthetics /f	0.8	1.3	1.8	-
Animal Products				
Red meat	12.7	19.8	24.1	24.0
Pork	12.0	19.2	22.8	-
Beef	0.3	0.5	1.1	-
Mutton	0.5	0.1	0.1	-
Poultry	0.9	6.5	10.3	-
Eggs	2.1	4.3	6.6	12.0
Fish	4.5	34.6	35.6	6.0
Milk	1.5	14.4	27.6	24.0
Grain Requirements /h	340	404	445	440

/a Consumption patterns of analogue Chinese population in 1970-72 and 1976-78 respectively.

/b Figures represent the most optimistic of targets considered by MAAF. From Wu Daxin, "Briefing on Agriculture of the PRC", in E. M. Reisch ed., Agricultura Sinica (Berlin: Duncker and Humboldt, 1982).

/c In terms of milled rice, whole grain wheat, maize and other miscellaneous coarse grains.

/d Tubers at one fifth wet weight.

/e Pulses include soybeans, soybean products, peanuts and other pulses.

/f Estimates from the income elasticities of demand projections, based on the Beijing consumption survey.

/g Derived from the CAAS production target of 3.75 million tons of cotton, assuming a population of 1.196 billion. Cotton imports of 0.74 million tons (i.e., the average annual imports for 1979-81) have been included to facilitate comparison with the figures for cotton consumption 1979-81.

/h On Chinese definitions, viz. unprocessed weight, including tubers at one fifth wet weight, soybeans and pulses other than peanuts.

example, wheat's share in total grain consumption rose from about 20% in 1960 to 30% in 1980. In Indonesia, which grows no wheat, the share of consumption accounted for by wheat rose from about 1% to 5% during that period. In the Chinese analogue population, per capita consumption of wheat increased very rapidly until recently, when consumption of both rice and wheat declined. In Japan per capita consumption of milled rice fell from 118 kg to 76 kg p.a. in the 1962-82 period. It is likely that per capita consumption of wheat, in China's cities in particular, will rise steadily in response to higher incomes and preferences for more convenience foods.

2.12 These projections of per capita consumption are compared in Table 2.1 with a projection by CAAS (the most optimistic of three sets of projections for the year 2000). The CAAS projection is based on total grain supply (unprocessed weight) of 440 kg/capita (including tubers, soybeans and pulses other than peanuts). Even though the CAAS number for total grain supply available for direct and indirect consumption is only slightly below our high estimate of consumption, the CAAS estimates assume smaller direct consumption of grain as well as less fat and animal protein. One result is 14% less energy in the average diet. In part this is explained by CAAS' assumptions of less efficient conversion of feedgrain into animal products and rapid growth of nonfood requirements. Equally important, the CAAS estimates derive from international standards of nutritional "requirements", rather than the preferences of Chinese consumers.[13/] Judging by the consumption patterns of the analogue Chinese population, it is unlikely, ceteris paribus, that Chinese consumers at GNP levels of US$800 per capita would be satisfied with direct consumption of grain 30% below present levels if this would result in the significant decline in total food energy intake implied by the CAAS figures.

2.13 Feed Requirements. The estimated per capita consumption demands, in combination with the alternative population growth estimates, are used to estimate total supply requirements in the year 2000. In addition to direct consumption requirements, it is necessary to add indirect consumption via conversion of grain to animal products, as well as industrial and other demands. The amount of indirect grain consumption depends heavily on the

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13/ The CAAS targets are reportedly based on the concept of "objective" nutritional needs, taking into account resource availability and production efficiency. Underlying the CAAS targets is a daily nutritional standard for an average adult of 2,400 kCal and 50 g of protein, below nutrient availabilities already attained in China.

efficiency of production in the animal husbandry and food industry sectors.[14/] At one extreme, one could suppose that production efficiency would be as high as that of the analogue Chinese economy used here to estimate direct consumption requirements. In that case, the per capita direct and indirect requirements shown in Footnote 11 could be used to estimate total needs.

2.14 Alternatively, we could examine the effects on grain requirements of different efficiencies in livestock feeding as measured by FCRs. Little detailed information is available on FCRs in China and available data must be interpreted cautiously. In these circumstances, a reasonable approach to estimating additional concentrate required for additional meat production is to employ alternative FCRs, representing modern, efficient production systems on the one hand (low FCRs) and less efficient production practices (high FCRs)

14/ The largest additions to the per capita requirements for direct grain consumption are the agricultural products used in feeding of animals. The major components of animal feeds, together defined as concentrates, include feedgrains, by-products of grain milling and high protein meal or cake from oilseeds. The efficiency with which concentrates are converted into meat, milk and eggs can be measured crudely by feed conversion ratios, defined in this analysis as the kilograms of concentrate per kg of animal product (dressed carcass weight, eggs, etc.), with dressed weight assumed to be 72% of liveweight in the case of pigs. FCRs depend on: (a) the amount and quality of concentrate and, in particular, the amount and quality of protein meal; (b) the genetic potential of the animals being fed; and (c) general standards of animal husbandry in these production systems and, in particular, the quality of disease control measures. Little detailed information is available on FCRs in China and available data must be interpreted cautiously. Information does not always distinguish live weight from dressed weight, and marginal from average quantities, nor clearly specify whether, and how much, nonconcentrates are being fed.

on the other.[15/] Neither necessarily reflects China's existing household production systems, which typically minimize grain and protein meal use, but may apply to specialized households or state enterprises which together are expected to supply a large part of incremental production (Chapter 4).

2.15 The implications of alternative feeding systems for concentrate demand in the year 2000 are explored in Table 2.2. The contrasts in grain requirements between high and low efficiency systems of livestock production are striking. Under the high growth scenario the difference between added feedgrain requirements under efficient versus inefficient livestock production systems would be about 89 m tons of feedgrain. However, an efficient livestock system would itself require more than 30 million tons of high protein meal, as contrasted with about four million tons used annually in livestock feeding in recent years. Despite the imprecision of these estimates, they clearly indicate that high future demand for livestock products would require correspondingly large increments of feed grains and protein meals for livestock feeding. Furthermore, increased protein meal availability could lead to improved FCRs and large potential savings of feedgrains.

2.16 Total Requirements. Grain requirements for direct and indirect consumption may be added to projected requirements of other products to provide indicative estimates of total agricultural requirements in the future. These requirements for the year 2000 are shown (Table 2.3) under the most optimistic assumption of efficient animal production systems (FCRs as defined in footnote 15), and with the three income and population scenarios defined in para. 2.07. If the Government's income and population growth targets were met, total grain supply in 2000 would have to increase by about 50% from 1980-82 levels (2.2% p.a.) and more than a third of supply would be committed to livestock feeding (as contrasted with perhaps 10% at present). Supply of red meat would have to grow at 4.6% p.a., poultry at 14% and eggs at 7%. Very high growth rates would also be registered for sugar, fruit, fish and milk. A

15/ This analysis assumes an FCR (grain to meat) in pork production of 8:1 as the lower efficiency bound characterizing traditional systems and 5.1:1 as the higher efficiency FCR indicative of modern production systems. The 8:1 FCR is considered typical of traditional pork production systems in developing countries; the 5.1:1 figures represents a high standard of feeding efficiency somewhere between average commercial results (5.3:1) and "best practice" in the United States (4.1:1). An FCR of about 6:1 is reported for Japan's pork industry. Alternative FCRs assumed for incremental production of poultry meat are 5:1 and 2.9:1. For incremental production of beef and eggs only modern system FCRs are assumed viz., 10:1 and 3.5:1, respectively. The FCR assumed for milk (converted to powder at one-tenth fresh weight) is 5.0:1 (modern) and 10:1 (traditional). On these assumptions, a "composite modern system FCR" for the year 2000, estimated by weighting FCRs for individual livestock product shares by projected shares of livestock products consumed in 2000 under the low GNP/capita growth assumptions (3.5%), would be about 4.2:1. Similarly estimated, the "composite traditional system FCR" in 2000 would be about 6.5:1.

Table 2.2: ESTIMATED REQUIREMENTS IN THE YEAR 2000 FOR CONCENTRATES AND FEED GRAINS
(Million metric tons except where noted)

		Requirements under assumed feed conversion rates in feeding systems which are:			
		Modern		Less efficient	
	Average 1980-82	Per capita GNP growth 3.5%	Per capita GNP growth 5.5%	Per capita GNP growth 3.5%	Per capita GNP growth 5.5%
Output Requirements of Livestock Products					
Pork	12.0	23.7	28.1	23.7	28.1
Mutton	0.5	0.1	0.1	0.1	0.1
Beef	0.3	0.6	1.4	0.6	1.4
Subtotal (red meats)	12.7	24.5	29.7	24.5	29.7
Poultry meat	1.0	8.2	12.9	8.2	12.9
Subtotal (all meats)	13.7	32.6	42.6	32.6	42.6
Eggs	2.3	5.4	8.3	5.4	8.3
Milk	1.6	18.2	34.7	18.2	34.7
Concentrate requirement	65	169	231	226	320
Of which: high protein meal	4	22	33	-	-
Availability of grain milling byproducts and oilseed cake	32	45	49	45	49
Feed grain requirement	33	124	183	182	271
Total cereal requirement	288	431	473	494	571
Feed grain as a % of cereal production	12	29	39	37	47

Notes: An average population growth of 1% p.a. is assumed for 1980-2000. Figures include a waste coefficient of 3% for pork, beef and mutton, and 5% for poultry, eggs and milk. Concentrate requirements for 1980-82 calculated as 10% of total grain production plus grain milling byproducts and oilseed cake. (Only 40% of oilseed assumed available as animal feed.) Concentrate requirements for the year 2000 are estimated as the sum of 1980-82 concentrate requirements plus incremental requirements calculated as the product of incremental meat production and meat conversion rates. Feed conversion rates are as defined in Footnote 15. Seventy percent of oilseed cake production is assumed available as animal feed in the year 2000. Total cereal requirements are the sum of rice, wheat and coarse grain for direct human consumption and indirect consumption as animal feed. Figures are expressed in unprocessed form and include seed and manufacturing requirements plus an allowance for waste.

Table 2.3: NATIONAL SUPPLY REQUIREMENTS IN 2000 AND COMPARISONS WITH HISTORIC RATES OF PRODUCTION GROWTH

	1980/82 (actual) (mil t)	Target growth scenario (Inc. 5.5%; Pop. 1.0%) mil t	% growth p.a.	Low growth scenario (Inc. 3.5%; Pop. 1.0%) mil t	% growth p.a.	High growth scenario (Inc. 5.5%; Pop. 1.4%) mil t	% growth p.a.	CAAS target for 2000 mil t	% growth p.a.	Actual average annual growth, 1955-57 to 1980-82
Crop Product Requirements										
Grain /a										
Cereal /b	291.0	473.0	2.6	431.0	2.1	509.0	3.0			2.7
Fine grain	208.0	259.0	1.2	287.0	1.7	278.0	1.5			1.8
Coarse grain /d	83.0	215.0	5.1	144.0	2.9	232.0	5.6			
(Feedgrain)	(33.0)	(183.0)	(9.4)	(124.0)	(7.2)	(198.0)	(9.9)	(293.0)	(12.2)	
Tubers /e	26.0	3.0	-10.7	6.0	-7.4	3.0	-10.7			0.9
Pulses /f	15.0	22.0	2.0	22.0	2.0	23.0	2.3			1.7
Subtotal, Grain	332.0	498.0	2.2	459.0	1.7	536.0	2.6	530.0	2.5	2.2
Sugar /g	2.8	23.7	11.9	15.1	9.3	25.4	12.3	7.2	5.1	6.4
Fruit	6.8	77.0	13.6	58.7	12.0	82.6	14.0	57.6	11.9	3.4
Vegetables	101.0	157.6	2.4	118.4	0.8	168.9	2.7	144.0	1.9	
Vegetable oil /h	3.6	9.1	5.0	7.5	3.9	9.8	5.4	8.0	4.3	3.0
Cotton	3.5	5.9	2.8	5.3	2.2	6.3	3.1	3.8	0.4	3.4
Synthetic fibers	0.8/i	2.3	5.7	1.7	4.0	2.5	6.2			
Animal Product Requirements										
Pork	12.0	28.1	4.6	23.7	3.6	30.1	5.0			
Beef	0.3	1.4	8.4	0.6	3.7	1.5	8.8			
Mutton	0.5	0.1	-8.1	0.1	-8.1	0.2	-4.7			
Subtotal, Red Meat	12.7	29.7	4.6	24.5	3.5	31.8	4.9	31.4	4.9	4.7
Poultry	1.0	12.7	14.3	8.0	11.6	13.6	14.7			
Subtotal, All Meat	13.7	42.4	6.1	32.5	4.7	45.4	6.5			
Eggs	2.3	8.3	7.0	5.4	4.6	8.9	7.4	14.4	10.1	
Fish	4.8	44.8	12.5	43.6	12.3	48.0	12.9	8.5	3.1	3.8
Milk	1.6	34.7	17.6	18.2	13.7	37.1	18.0	28.8	16.4	

/a Total grain requirements correspond to China's "total grain production" figures which include fine and coarse grains, tubers, soybeans and pulses.
/b Cereals include rice, wheat, corn and other coarse grains, but exclude tubers and pulse production.
/c Wheat and rice. The 1955-57 - 1980-82 growth rate is for rice.
/d Corn, sorghum, millet and other minor grains.
/e At one-fifth fresh wet.
/f Soybeans and other pulses. The historic growth rate is for soybeans.
/g Historic growth rate is for sugarcane.
/h Historic growth rate is for oilseeds.
/i Figures are for average availability, 1977-81.

lower income growth rate would lead to more modest changes in grain requirements (1.7% per year) and use of grain as feed (to 27% of total supply), but high growth rates would still be required for sugar, fruit, poultry, fish and milk to reach a pattern of consumption commensurate with consumer demands at higher per capita income levels.

2.17 The assumption of both high income (5.5% p.a.) and high population (1.4% p.a.) growth rates adds some 38 million tons to total grain requirements over and above the Government target scenario, and raises the necessary growth rate of supply to 2.6% p.a. Feed grain requirements would be about 198 million tons. This scenario approximates the CAAS "optimistic" estimates for total grain and red meat supply (although the latter presumes a lower population growth rate). However, the CAAS estimate assumes a doubling in the number of draft animals, a substantial increase in industrial food demand, and less efficient feed conversion rates, so that more grain is required for feed and nonfood uses and less remains for direct human consumption.

2.18 Each of the three projections based on consumption patterns of the analogue Chinese population reflects much higher consumption levels of sugar, fruit and fish than might reasonably be expected in China (as is apparent from the CAAS projections). These food items account for substantial fractions of total energy and protein supply. To maintain the same energy and protein levels in China with much lower consumption of these products, direct or indirect grain consumption would have to be increased relative to the projected levels.

2.19 Grain requirements above those projected in these scenarios also would result if China were not able to increase the efficiency of feed conversion as livestock production expands. As noted in Table 2.3, the difference in feed grain requirements between high and low efficiency feeding systems is in the range of 60-90 m tons annually by 2000. This is some 35-50% greater than the projections by MAAF's Planning Bureau for grain production excluding rice and wheat. Improvements in FCRs will depend largely on supplies of high-energy and high-protein feedstuffs, which in turn are likely to require changes in future cropping patterns, increased transport of feed and/or livestock among regions, and greater dependence on international trade.

2.20 This analysis has not taken into account the requirements of the industrial sector for nonfood products or any additional demands which might be placed on the sector to generate export earnings in support of overall economic growth. There are many opportunities for substitution of industrial intermediate products for agricultural raw materials, notably fibers and oils, which makes it difficult to project future requirements of these materials. China is now an exporter of both animal products and a variety of agricultural specialty products, and the potential for expansion of these exports will be considered below. Both industrialization and foreign trade policy could either augment or diminish net requirements fo the agricultural sector.

2.21 The overall potential for increasing the production of various types of agricultural products will be examined more closely in Chapters 3 and 4. The analysis of this Chapter suggests that future domestic supply potential may be insufficient for the radical restructuring of consumption implied by

projections based on consumption patterns of analogue Chinese populations. The opinion of MAAF's Planning Bureau is that growth of grain production will be more modest than assumed by CAAS' optimistic projections and will reach a level of about 480 million tons by the year 2000. Within this total, the 300 million tons projected for fine grains (rice and wheat) would exceed estimated requirements for direct consumption in all scenarios above. On the other hand, domestic supplies of coarse grains would be deficit relative to projected requirements. At best, availability of feed grains would be sufficient for the low growth projection. Under the high growth scenario at least 30 m tons of high protein meal would be required to meet projected consumption of livestock products (Table 2.3). If 70% of oil meal production was fed to livestock in 2000, China's oilseed meal supplies for livestock might equal about 15 m tons. Another 15 m tons of imports at 1984 prices would cost some US$3.3 billion.

2.22 The question emerges of how to reconcile possible future imbalances between domestic supply of agricultural products and consumption patterns which reflect likely income and population growth. Policy measures which both constrain demand and encourage supply are likely to be required. On the demand side, the instruments of price and foreign trade restrictions can be used to shape consumption patterns to better conform with available production. Other countries, both developed and developing, have used these measures to hold food consumption to levels below those expected or "normal" for a given level of GNP per capita.[16/] Present Chinese price policy has probably had the reverse effect, because food prices have been kept low relative to prices of industrial consumer goods and the supply of urban services (including housing) has been subsidized and restricted. Because basic nutritional requirements have already been met on the average in China, some restraint of consumption may be acceptable from a nutritional point of view. On the supply side a key consideration may involve the nutritional and resource tradeoffs between direct consumption of grain as opposed to its use in livestock feeding, the products of which are then consumed by the human population. If consumed directly, the cereals or pulses from one ha in China yield at least five times as many calories and two and one-half times as much protein (albeit of lower quality) as if those grains were first fed to animals or poultry and the products then consumed by humans.[17/] The amount of China's agricultural resources committed to livestock and poultry production is likely to be a key consideration in balancing future supply and demand for farm products.

16/ Among developed countries, Japan is a good example of how price and trade policy influence consumption patterns. Despite income levels roughly similar to those in the United States, per capita consumption of red meat, poultry and fish in Japan is only about half as high. Reflecting high food prices, 32% of consumer expenditure goes for food. The comparable figure in the US is 20%.

17/ Assume the 1982 mix of grain crops with a weighted average yield (rice on a milled weight basis) of about 2,800 kg and each kg containing 3,550 kCal and 95 grams of protein. With an FCR of 4.2:1, this grain mix is adequate to produce some 670 kg of animal products (assume largely pork and poultry) with 2,700 kCal/kg and 97 kg of protein.

3. DETERMINANTS OF FUTURE GROWTH

3.01 This section discusses those factors considered to be the most important determinants of growth of Chinese agriculture through 2000. They include the availability of key production inputs such as agricultural land, irrigation, fertilizers, and improved seeds, as well as less tangible institutional factors related to the sector's research and extension, rural credit and transportation, storage and marketing services. Perhaps the most important determinant of agriculture's future performance is the economic environment in which China's farmers will operate. As agriculture's rapid growth since 1979 graphically illustrates, Chinese farmers respond positively to a favorable economic environment characterized by attractive input-output price ratios, assured access to land and markets and stable policies upon which to base production and investment decisions.

Land and Water Development

3.02 The unique features of China's agriculture include the relatively small portion of the total land area which is cultivated (about 10% as compared with 57% in India) and the large portion of the total cultivated area which is irrigated (45%, as compared with 23% in India). At present more than a quarter of China's cultivated lands of just under 100 m ha is classified as high and stable yield areas, with average grain yields in excess of 2.2 tons per ha per crop. Another 40 m ha are medium yield lands with grain yields in the range of 1.2 to 2.2 tons per ha. One third of the cultivated area is considered low-yielding (less than 1.1 tons per ha) and subject to drought, waterlogging or flooding. Because of past efforts in irrigation, drainage and flood control, adverse weather now affects agricultural production to a smaller extent than it did in the years immediately after 1949.

3.03 There is considerable uncertainty regarding the actual cultivated area in China. Although official figures of just under 100 m ha continue to be used, considerable evidence, based on satellite imagery and a cadastral survey in progress, suggests that the true cultivated area is substantially higher. In 1981 the State Agricultural Commission provisionally revised the cultivated area to 133 m ha. A general view within the Government is that the actual cultivated area is a quarter to a third greater than the official figure. The largest discrepancies between official and actual cultivated areas appear to be in North and Northwestern China where crop yields are considerably lower than in the eastern and southern areas. Assuming that total output figures are accurate, a larger cultivated area would imply significantly lower yields than official figures and lower per ha usage levels of key inputs such as fertilizer. Notwithstanding, this analysis uses official production, yield and input data unless otherwise specified.

3.04 Official figures indicate that the cultivated area increased rapidly during the 1950s, but declined marginally in recent years. The reported area of cultivated land in 1983 (98.4 in ha) was only about half a million ha larger than it was in 1949. The irrigated area grew rapidly through about 1973, but has shown no significant increase since that time. The Government assumes that China's cultivated area will remain essentially unchanged over

the next 15-20 years, as land lost to roads, urbanization and industrial development is approximately offset by newly-reclaimed land. The national multiple cropping index (MCI) is projected by MAAF to increase from about 1.47 at present to 1.60 in 2000 in response to irrigation development, although the MWREP considers this to be optimistic. The major questions determining future availability of agricultural land include: (a) the extent to which reclamation will offset land lost to non-agricultural uses; and (b) the extent and effectiveness of future irrigation development. The MCI appears to have declined marginally in 1979-83, reflecting a reduction in triple cropping in the South and double cropping in the North. This seems likely to continue.

3.05 Land reclamation. Bringing into cultivation unused or underutilized land has been a major thrust of China's agricultural development effort over the past 25 years. In the 1957-77 period, the reported gross loss in cultivated area of some 33 m ha of generally high quality land was partially offset by some 21 m ha reported of newly-reclaimed land, much of which was located in less favorable agro-climatic areas. Chinese sources suggest that about 33 m ha of "waste land" are "reclaimable" for some type of agricultural use, with perhaps 60% (20 m ha) of this suited primarily for pasture.[18/] Of the remaining 12-13 m ha, about 6 m ha are in the Northeast, 5 m ha in Xinjiang and the balance is in Nei Monggol and elsewhere. Much of the area in Xinjiang may be of questionable quality and land use conflicts with herdsmen are important in other places. In short, perhaps 3-5 m ha are suitable for development in the medium-term for sustained production of annual crops. These figures may be compared with the reported loss of about one m ha annually to non-agricultural uses in 1959-78. Annual losses at present are not known, but outside major municipalities, there are few legal restrictions on conversion of farm land to nonagricultural uses. The current surge of rural housing construction suggests that losses of agricultural land will continue to be substantial, notwithstanding government efforts to restrict conversions of this type. In Jiangsu Province, where pressure to convert agricultural land to nonfarm use has been particularly intense, the cultivated area declined by about 1% p.a. in 1979-83. A national average figure half as high would imply losses of about half a million ha annually. Although some conversions may be economically justified, institutional reforms might be devised which would make disincentives for land conversion as costly as the economic loss to society. For example, if a land tax were to replace the agricultural tax and quota system, it should apply with at least equal incidence to land in agricultural and non-agricultural use.

18/ Kang Qingi, "Problems of Rationally Developing China's Wastelands Suitable for Cultivation," NYJJLC, 5 (1984), pp. 259-262.

Table 3.1: CULTIVATED AND IRRIGATED LAND, 1970, 1975, 1977-82

	(1) Cultivated land	(2) Crop area	(3) Irrigated land /a	(4)=(2)÷(1) Multiple cropping index
	million ha			
1970	101.1	143.5	36.0	1.42
1975	99.7	149.5	43.3	1.50
1977	99.3	149.5	45.0	1.50
1978	99.3	150.1	45.0	1.51
1979	99.6	148.5	45.0	1.49
1980	99.3	146.4	44.9	1.47
1981	99.0	145.2	44.6	1.47
1982	98.4	144.7	44.2	1.47
1983	98.4	144.0	44.6	1.46

/a Figures for irrigated areas refer to "effective irrigation," i.e., command areas with adequate water and engineering structures to permit irrigation appropriate to crop requirements.

Source: Various official sources.

3.06 Grain bases. Much of the reclamation emphasis of recent years has been on the relatively productive areas designated as national or provincial commercial food grain bases (Appendix Table A.8 and Map 4). The 15 national grain bases (NGBs) together account for more than a quarter of total grain production and about 40% of the grain procured by the state. The southern grain bases typically are densely-populated, have high and stable yields from good water control and benefit from high levels of input use and good management. Most of these lands are double cropped and potential for expansion of the sown area appears to be limited. The grain bases in the North have lower yields, but are sparsely-populated and thereby serve as important sources of commercial grain. The new NGBs, located mostly in the north, have benefitted from large-scale water conservancy works and land development efforts in recent years and are important producers of commercial grain.

3.07 Another 15-20 areas are designated as provincial grain bases because of their potential for commercial grain production to meet intra-provincial

needs. Further development of these national and provincial grain bases would allow other areas to increase their specialization in industrial crops. Based on incomplete data, it appears that another 3 m ha could be developed in the NGBs. All of this is located in the Northeast or Northwest where only single cropping is possible.

3.08 The loess plateau. The loess soils, covering some 50 m ha in North and Northwest China are uniform and generally fertile, with a pH level of 8.0-8.5 which permits establishment of soil renewing crops such as legumes. Most of these areas are now used in cropping or livestock, but at low levels of productivity. Rainfall, if carefully husbanded, can sustain annual cropping at low yields over a large part of the plateau. Precipitation varies from about 500 mm in the southeast, through a 400 mm zone of former grassland to a northern desert zone of 200 mm or less. In the southern parts of the plateau rainfall and irrigation permit two crops per year, but in much of the region the short growing season precludes double-cropping and deep water tables make irrigation from groundwater uneconomic. The rationale to rehabilitate these lands includes the need to reduce erosion and the transport of sediments to reservoirs and canals below, and to increase the productive capacity of these lands which continue to support, albeit at low levels, a sizeable human population.

3.09 In some parts of the plateau where labor is abundant, conventional soil conservation measures have been used successfully. In the more rugged and sparsely-populated areas, new technology involving, e.g aerial seeding of grasses and legumes show considerable promise. With available technologies it seems possible that productivity of up to 20 m ha of loess soils might be substantially improved. Major elements in the improvement of such lands include the conversion of the most erosion-prone croplands to grass and trees, control of grazing particularly by sheep and goats, and the planting of better adapted crop varieties. Sizeable production gains within a relatively short period seem possible (Table 3.2). Whether such development would be economically justified is a matter deserving further study.

Table 3.2: SELECTED DATA FROM TWO GULLIES ON THE LOESS PLATEAU, SHAANXI PROVINCE, UNDERGOING TREATMENT FOR EROSION CONTROL

	1979 (before treatment)	1983 a/
Chuen Jia Gully		
Cultivated area (ha)	234	163
Grass land (ha)	16	79
Forested area (ha)	60	100
Livestock numbers		
Large animals	51	89
Sheep	72	257
Swine	169	172
Goats	280	9
Income from livestock (yuan)	8,500	21,300
Crop production b/ (tons)	249.5	337.4
Crop yield (tons/ha)	1.1	2.1
Ratio of cropland:trees:grass	15:3.8:1	2:1.5:1
Gao Jia Gully		
Cultivated area (ha)	168	147
Grassland area (ha)	12	50
Forested area (ha)	31	43
Crop production b/ (tons)	169	241
Crop yield (tons/ha)	1.0	1.6
Agricultural income (yuan)	65,000	119,000
Ratio of cropland:trees:grass	14:2.6:1	2.9:1:1

a/ Some data for Chuen Jia gully refer to 1981 or 1982.
b/ Assumed to be largely grain and oil seeds.

Source: Reports from Comprehensive Control Experiment Station, Mizhi County, Shaanxi Province

3.10 The red soils. Another group of problem soils widely regarded to have some development potential are the red and yellow soils in the warm, humid regions of South and Southwest China. Most of these soils are acidic, of low fertility and, although originally forested, some of these areas now support little more than shrubbery. About 8 million ha are under cultivation at low levels of productivity and perhaps 2-3 million ha more can be reclaimed for agricultural purposes. The challenge of the red soils is to find a range of cultural practices which permit sustainable crop, tree crop or livestock production systems which are economically viable. The necessary technology is

available and has been practiced with good results in parts of the southeastern United States, Brazil and Peru. Success in these instances is highly dependent on sophisticated soil testing, fertilization, soil management and plant protection measures, all guided by skilled scientists supported by adequate laboratory equipment. Terracing of sloped lands, crop rotations including legumes, general applications of lime and other chemical fertilizers and careful monitoring and treatment for deficiencies of soil micronutrients are components in rehabilitation. The possibilities seem sufficiently promising to warrant the beginning of development efforts.

3.11 Irrigation and Drainage. In China's environment of land scarcity, irrigation and drainage take on particular significance as means to increase the sown area. The MWREP assumes that future irrigation development will permit an increase in the total irrigated area from the present level of about 45 million ha to something over 53 million ha by 2000. Other estimates are somewhat higher. These differences reflect different assessments of trends in conversion of irrigated area to nonagricultural use, availability of budgetary funds for water conservancy, and investment requirements for rehabilitation of aging existing works. Expanded irrigated area is not necessarily more important than improved water management in existing installations, a high proportion of which lack adequate facilities for distribution to the farm level. Under present average standards, the area actually irrigable falls short of official total area in one year out of four, due to water shortage.

3.12 Over half (4.3 m ha) of MWREP's planned expansion of irrigated area would fall in the rice region south of the Huai River, largely through upgrading of existing facilities. Another large component (1.6 m ha) would occur in the North China Plain, primarily through the project to divert Yangtze River water northward, which ultimately could add 2.5 m ha of newly irrigated area and supplementary water for 1.8 million ha now under irrigation.[19/] The remainder would be split between the Northeast (1.0 m ha, including Nei Monggol) and the arid areas of the Northwest Loess region (0.6 m ha) as well as the two provinces of Xinjiang and Gansu (0.7 m ha). Additions to irrigated area will generally be costly, even in the South where improvements would come in hilly or mountainous areas. MWREP estimates total costs to average Y 4,500-6,000 per ha where new reservoirs or major drainage works are not required, and Y 6,000-15,000 along the upper reaches of the Yellow River, where a lift of 100-300 m is usually required. The economics of such development may be questioned.

19/ Data from MWREP and the Yangtze River Basin Commission indicate that some 4.3 m ha would benefit from the project. Of the 2.5 m ha to be newly irrigated, most is in Hebei, Henan and Shandong Provinces. Hebei and Jiangsu would benefit most through the supplementary irrigation of already-cropped areas. Beneficiaries of the first stage of the water transfer project would be northern Jiangsu and southern Shandong. The middle diversion, which is not included in the present project but which might be developed at a later date, involves another 3.8 m ha of newly irrigable land.

3.13 It is estimated that about 23 m ha of cultivated area require drainage facilities to prevent waterlogging and, often associated with these areas, there exist some 7 m ha of salinized land, including 3.3 m ha in the North China Plain. Over several decades, some drainage improvement has been made to 18 m ha (including 4 m ha subject to salinity), of which 10 m ha now meets a protection standard of 1:5 years. Government ojectives for 2000 call for increasing the area thus protected to nearly 17 m ha, eliminating salinization problems in the North China Plain, and making on-farm drainage improvements to an additional 1-2 m ha of low-yield fields. Areas benefiting would include the North China Plain, the Jiang-Han Plain, Northeast and South China. However, failure to combine irrigation with on-farm and higher level drainage works is a persistent problem in North China, and frequently leads to further salinization. The shortage of investment funds has contributed to the problem of inadequate drainage.

Fertilizers and Seeds

3.14 Present use. Improved irrigation, better crop varieties and higher levels of chemical fertilizer use have been the most important material inputs behind China's good agricultural performance in recent years. Application rates for chemical fertilizer doubled between 1977 and 1981 and by 1983 averaged 169 kg of nutrients per cultivated ha (equivalent to about 115 kg per sown ha). About 70% of available fertilizer is used on grains and 30% on other crops. Consumption growth rates of over 11% p.a. in the 1970-80 decade are among the fastest registered for any developing country over a similar period of time. Current levels are more than three times those in India, about equal to levels in the United States, but a third those in Japan or South Korea, where price subsidies encourage use in excess of economic levels (Table 3.3). Fertilizer use has been stimulated by greater availability and improved fertilizer: product price ratios growing out of the 1979 price reforms.[20/] The N:P:K ratio for China (1981) of 100:31:4 may be compared with a world average of 100:52:10. This serious nutrient imbalance reduces synergism and the benefits from the relatively high levels of nitrogen use.

20/ In 1976 the ratio of the price of nitrogen from urea to the price of paddy was about 4.4: 1, the highest of any major rice producing country in Asia. The average price for rice in 1981 was about 40% higher, reflecting a higher quota price, an above quota premium, and larger average deliveries to the state at these higher prices. This increase in the price of paddy was a major factor behind the decline in the nitrogen:rice price ratio to about 3.2:1. N. Lardy, Agricultural Prices in China, World Bank Staff Working Papers No. 606, 1983.

Table 3.3: A COMPARISON OF APPLICATION RATES FOR CHEMICAL FERTILIZER, 1980

Country	Kg/ha of arable land /a				N:P:K ratio
	N	P_2O_5	K_2O	Total	
China	87	27	2	116	100:31:2
India	21	6	4	31	100:29:19
United States	56	26	30	112	100:46:54
Japan	126	141	105	372	100:112:83
South Korea	204	89	83	378	100:44:41

/a Includes cultivated area under temporary crops, temporary meadows for hay or pasturing, land under market and kitchen gardens, land temporarily fallow and land under tree crops.

Source: FAO for all countries except China. Estimates for China were calculated from application and sown area data from MAAF and SSB.

3.15 China has a long history of using organic fertilizers and, until very recently, organics probably supplied a major share of total nutrients from fertilizers. Estimates of nutrients from organics must be interpreted with some caution, since quantities, particularly of nitrogen, available for plant use depend heavily on the type of raw material and methods of storage and handling, etc. Estimates in China of the amount of N supplied by organics in 1980 range from 5-10 m tons. Possibly 4-5 m tons of P_2O_5 and 5-6 m tons of K_2O came from this source. On this basis, total nutrients from organics (14-21 m tons) would have accounted for at least 40% of all nutrients applied in 1980. While these estimates may exaggerate the importance of organics, organic fertilizers continue to be important sources of nutrients in China, particularly for P, K, and some trace elements.[21/] MAAF estimates that only half of nutrient offtake will come from chemical sources by 2000.

3.16 Production and imports. About 85% of China's total consumption of chemical fertilizer is produced domestically (89% for N, 72% for P and 6%

21/ Based on the results of Chinese experiments comparing plant offtake of nutrients from chemical and organic sources applied during the same crop season, the Mission estimates that chemical fertilizers accounted for 71%, 24% and 4% of 1981 total offtake of N, P and K respectively. The remainder came from either organic fertilizers or mining the soil, and soil mining of P and K may be significant at present offtake levels.

for K). In 1983 some 2,200 plants in China produced 13.8 m tons of fertilizer (nutrients), of which 11.1 m tons were N, 2.7 m tons were P_2O_5 and about 29,000 tons were K_2O. Domestic production is characterized by a small number of product types and low nutrient content. Nitrogenous fertilizer production is about 60% ammonium bicarbonate (16-0-0) and aqueous ammonia; 33% is in the form of urea (46-0-0) and the balance is largely ammonium nitrate. About 70% of P production is single superphosphate (12-20% P_2O_5) and 30% is calcium magnesium phosphate (14-18% P_2O_5). Users of local products complain of low quality, lack of uniformity and, occasionally, poor bagging. Urea and diammonium phosphate (18-46-0) are commonly preferred products on quality and price grounds. Imports of fertilizer have averaged 10 million product tons (2-3 m nutrient tons) in recent years at a foreign exchange cost of more than US$1 billion p.a.

3.17 Distribution and use. Farm sales of chemical fertilizer are made by the Agricultural Means of Production Corporation, although the local distribution network is essentially that of the National Federation of Supply and Marketing Cooperatives which handled the job until 1982. Most imports are handled by SINOCHEM, but small amounts are brought in directly by provincial trading companies. About 20% of domestic production is from relatively large plants owned by the central and provincial Governments and is usually distributed through the state system at centrally-established prices. In the 1973-79 period, the portion of chemical fertilizer distributed through the state system declined from 48% to 23%. That portion has probably continued to decline. A substantial share of state supplies is allocated as rewards or exchange for items procured by the state and typically goes to intensively cultivated areas where application rates and yields are high. Fertilizer produced by county owned or lower level units is allocated locally under a state-recommended pricing system which is not always honored if market imbalances exist. This distribution system, and the use of fertilizer as rewards in pursuit of production objectives, has spawned a complex bureaucracy. In 1982 some 16 government agencies at state level, and more than twice this number at lower levels, were involved in the production and distribution of

chemical fertilizer. The system is cumbersome and seems likely to result in high marketing costs and, commonly, delayed deliveries.[22/]

3.18 The state system of allocating fertilizer has been used as a policy instrument to encourage production and marketing of key commodities. Fragmentary information suggests that the allocation process in the past has favored food crops relative to feed grains and pulses; the high, stable yield areas relative to lands of lower quality; irrigated areas relative to non-irrigated areas; and the state farms relative to the collective sector. Surveys of crop production expenses (1981) indicate that per ha costs of chemical fertilizer applications averaged about Y 150 for paddy rice, Y 120 for wheat and corn, Y 50-75 for other grains and tubers, Y30-85 for soybean and major oilseeds, Y 175 for cotton, Y 160 for other fiber crops, Y 250 for sugar cane, and Y 45 for sugar beet. Differences in application rates among crops have narrowed considerably since the mid-1970s. Regionally, application levels of nutrients per sown ha (Map 3) ranged from less than 50 kg (Xinjiang, Gansu, Nei Monggol, Heilongjiang) to over 150 kg per ha (Fujian, Jiangsu, Shandong and Liaoning).

3.19 Consumption and supply prospects. Fertilizer, both chemical and organic, will obviously continue to be a major factor contributing to future agricultural growth within an environment of unchanged cultivated area. The question is whether inability to increase supplies rapidly enough can be anticipated to be a major constraint on growth. Based on crop offtake of nutrient at production levels projected for 2000, MAAF expects consumption of chemical fertilizers to reach 30 m tons of nutrients, equivalent to about 240 kg per cultivated ha (adjusted for underreporting) - or more than twice current US levels, yet well below those of Japan and South Korea. This projection assumes, perhaps optimistically, that use of organic fertilizer would continue to grow, so that only half of total nutrient requirements need be supplied from chemical sources. If the targeted N:P:K ratio of 100:50:40 were achieved, chemical fertilizer applications would consist of about 16 m tons of N, 9 m tons of P_2O_5 and 5 m tons of K_{2O}.

3.20 Unofficial production targets for 1990 by the Ministry of Chemical Industry place total nutrient production at 17.1 m tons, of which 13.0 m tons are N, 4 m tons are P and 0.1 m tons are K. Thus, growth rates of N production would slightly exceed 2% p.a., while P would grow by 6% p.a. and output

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22/ These factors are costly in economic terms. Delayed delivery and application reduces potential benefits from fertilizers. Multiple handling increases physical loss and raises distribution costs. The International Fertilizer Development Center (IFDC) estimates average physical loss in developing countries at 10% each time fertilizer is warehoused. Marketing costs are often 50% or more of the retail price in these countries. China appears to be no exception. Price data for 1979 indicate factory to farmgate markups of about 30% for urea and 40% for ammonium nitrate. These logistical difficulties explain in part the continued popularity of fertilizers from smaller plants outside the state system, despite their problems with product quality and process inefficiencies.

of K would quadruple by 1990. MAAF assumes domestic production of 24 m tons of nutrient by 2000, elimination of imports of nitrogenous fertilizers, but continued imports of P and K to meet large domestic shortfalls. If the chemical industry were to accept these goals, they might aim to produce 16 m tons N, 7 m tons P and 0.6 m tons K by 2000. This would leave a supply shortfall of 2 m tons P and 4.4 m tons K which could be imported at a projected cost of about $1.7 billion (1983 dollars). As this only exceeds the current bill for fertilizer imports by 50%, the projected burden on foreign trade is not large.

3.21 Adjustments in organic fertilizer use are also warranted. Due to the scarcity of rural fuel supplies, a high proportion of crop residues are burned for heat and cooking. In the south, straw from the early rice crop is commonly burned in the fields even in areas where the soil is short of organic material, while oilseed meal is often used as fertilizer where feedstuffs lack protein. While there are usually technical or economic reasons why such practices are difficult to change, the situation could be improved through, for example, development of alternative rural fuel sources, including coal, fuel wood, and biogas (in association with commercial livestock production); and chemical replacements for nutrients and microelements supplied by oilseed meal fertilizers.

3.22 China has developed a capacity to design and construct efficient, large-scale plants for the production of nitrogenous fertilizers. Two new nitrogen production facilities began trials late in 1983, each with an annual capacity of 220,000 tons of N. Two additional nitrogen plants are planned to come into production before 1990. Total increased capacity in all four plants would be less than a million tons by 1990. If raw material supplies are made available (coal, fuel oil or gas), the rather modest production targets for N would seem realizable. The higher growth rates for P and K raise more questions, although they are from a low base production level. Existing phosphate deposits are located in the central south and the mountainous southwest, in areas where transportation facilities are poor. Plans are to establish phosphate fertilizer plants near mines and produce high analysis products (such as TSP or DAP) for shipment to distant markets. Because China has limited expertise in the design and construction of large plants for these materials, it expects to rely on foreign technology and advice. Domestic deposits of potash are limited to the Qaidam Basin, where a 1 m ton potassium chloride plant will eventually be constructed. For both P and K production, achieving year 2000 targets demands an early commitment of funds and manpower to a process requiring mastery of new technologies.

3.23 Questions remain regarding the availability of the 30 m tons of nutrients projected annually from organic sources by 2000. If the projected increase in organic fertilizer use does not occur, proportionately more foreign exchange will have to be committed to chemical fertilizer purchase, or else fertilizer availability will be inadequate to meet requirements of targeted production. Assuming that organic fertilizer on average contains about one percent nutrients by weight, these targets imply the need to collect, store, transport and apply some 3 billion tons of organic materials annually. Although these materials may be available if high growth rates of livestock are achieved, would the use of such large quantities of labor be

economically desirable? It would almost certainly not be consistent with declines in the farm labor force projected by MAAF. Willingness of sufficient labor to undertake these frequently onerous tasks is also a consideration, as indicated by experience in other countries where commercialization of agriculture and growing opportunities for labor have resulted in steady declines in the use of organic fertilizers. Much depends on the future opportunity cost of labor. If projected increases in labor productivity in the rural economy materialize, through opportunities for slack season and non-agricultural employment, it should be asked whether farmers in the year 2000 would be willing to put in the work time required to apply organic fertilizers at a rate approaching 25 t per ha. If alternatively, this were forced by, for example, tying chemical fertilizer distribution to organic fertilizer use, it would have undesireable consequences to the efficiency of fertilizer distribution.

3.24 Adjustments in policy and practice regarding fertilizer use and distribution seem warranted. To favor particular commodities (food grains) or production systems (state farms) or agro-ecological zones (high, stable yield areas) may have been more economically rational when fertilizer application rates were relatively low. This pattern of allocation appears much less efficient today.[23/] At the new higher levels of application, marginal yield responses in the high yielding localities are frequently below marginal yield responses in the low yield areas. CAAS studies suggest that marginal yield responses in some high yield areas on average declined from 15-25 kg of grain per kg of nitrogen in the 1960s to 5-10 kg of grain today. These results would imply a decline in the incremental benefit-cost ratio from nitrogen application (urea derived) from about 3.4:1 to 2.3:1.[24/] The decline in incremental return in the high yield areas is reported to have stimulated illegal resales of fertilizer to areas where marginal returns are higher.

3.25 The general objective for fertilizer distribution is to facilitate the use of economically-optimum quantities in a timely manner. In the past, with general scarcity of chemical fertilizers and only nitrogenous fertilizers to distribute, a system of rationed distribution was easier to administer and could serve efficiency objectives. Today, with more abundant nitrogen but continuing scarcities of P, K and microelements, there is strong reason to allow the market to play a large role in allocating fertilizers. The most critical task for Government is to develop fertilizer testing programs and related extension work, involving both economic and technical considerations, which could guide the processes of production, distribution and utilization.

23/ Guo Jinju and Lin Bao, "A Study of China's Chemical Fertilizer Problems," Turan Tong Bao (Soils Bulletin), No. 2, April 6, 1983, pp. 25-27.

24/ Assume an average farmgate price for paddy of about Y0.17 per kg in 1965. By 1981 the paddy price had increased to about Y0.31 per kg (Y0.20 as the 1973 average quota price for japonica and indica rice, adjusted for 20% price increase on quota price received by producers in 1981). The price of nitrogen from urea at farmgate is estimated at about Y0.98 (Y450 per ton of product @ 46% N.).

Fertilizer import priorities should be closely aligned with the nutrient needs established by research.

3.26 Seed supplies. Good quality seeds in adequate quantity are critical inputs in high-yield agriculture. At the central level, MAAF's National Seed Corporation (NSC) is responsible for national seed policy and planning. The NSC regulates international trade in seeds, coordinates domestic seed production and distribution, and provides technical guidance to provincial and county seed companies. The 2,300 local companies are responsible for the multiplication, processing, storage, certification and distribution of stock and certified seed.[25/] The breeding and development of pure strains is carried out primarily by provincial agricultural research institutes. Multiplication of stock and certified seed is done by seed farms operated by local seed companies. Special contracting arrangements also exist where brigades, teams and households, under supervision of center technicians, produce certified seed which is then returned to the company for processing and ultimate distribution to users. The Central General Bureau of State Farms also operates a system of seed companies and farms which produce seeds for both state farms and collectives. The 2,600 seed farms under both NSC and GBSF serve about 90% of all counties.

3.27 Although basic mechanisms are in place, the national seed system has a number of shortcomings. Supervision and technical services are inadequate and storage and processing facilities are in short supply. The national supply of seed produced under NSC supervision totals about 2.5 m tons and meets less than 12.5% of total seed requirements. Less than one third of this supply has received proper treatment and certification. Most farmers therefore continue to rely mainly on retained seed of uncertain quality and parentage. In recognition of these shortcomings, the NSC has established pilot projects in 120 counties, and the provincial governments in 200 counties, to improve seed processing, storage, and distribution. The national target is to produce up to 10 million tons of seed under NSC supervision by the year 2000. The government is also considering developing a system of seed testing centers, independent of NSC control, which would certify seed quality.

The Policy Environment

3.28 The policy environment refers to the economic circumstances in which Chinese agriculture will operate and includes a wide range of policy measures which influence levels of work effort, production, consumption, savings and investment by farm families. The prospects for agricultural growth in any country are strongly influenced by both the structure of production incentives and the level and form of investment in the agricultural sector. The promulgation of the PRS has significantly improved agricultural production incentives, and can share credit with price adjustments for the outstanding growth record of Chinese agriculture since 1979. Its benefits have been

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25/ Stock seeds are progeny of genetically pure strains. Certified seeds are improved seeds available for distribution to farmers and conform to specified purity and quality standards.

manifested primarily in greater labor effort and improved production management. Additional benefits might be gained by improved allocation of resources among productive activities, often associated with various forms of specialization. The Government recognizes this, and is conscious of the need to develop markets in productive resources to facilitate specialization. As noted in Chapter 1, recent directives open the way for development of a labor market and allow subcontracting of land.

3.29 China still relies to a considerable degree on administrative measures to distribute production inputs and assign land to major crop categories. Despite considerable loosening of the system through recent reforms, the Government continues to circumscribe the decision-making freedom of farmers beyond the requirements for efficient use of common infrastructure. Further measures to permit an enlarged role for prices and the market were announced in late 1984 and should provide an enhanced environment for agricultural development. However, there appears to be a continuing concern within the Government that the present price system may not provide appropriate signals which would lead a farm sector, composed of a very large number of independent decision makers, to grow and market the quantities and mix of crops needed to meet national requirements. Thus, quotas for sown area of some crops are reportedly being retained in order to prevent farmers from switching a larger portion of land under their control from grain to more profitable industrial crops.

3.30 Production incentives. Despite substantial increases since 1979, average procurement prices appear to be lower than the level required to induce voluntary sales of an equivalent amount of produce and therefore involve a tax on the farm sector. However, since in theory the procurement quota is fixed in absolute amount but varies among teams in proportion to land productivity and cultivated land per capita, it satisfies the criteria which economists have set for the ideal land tax. Eliminating the quota procurement system without instituting some alternative tax scheme would reduce revenues available to the Government, either directly through increased procurement costs or indirectly, as an increased urban cost of living forced compensating wage increases, leading to decreased profits from state enterprises.

3.31 It may be asked whether the new farm price structure provides an appropriate set of incentives to encourage efficient production. In reviewing the price structure, the marginal price received or paid deserves attention, because adjustments in cropping patterns and input use are influenced by relationships between marginal revenues and marginal costs. Because many of China's agricultural products and modern inputs are internationally traded goods, domestic prices for these items can usefully be compared to border prices (world prices adjusted for transport, trade and processing margins to the farmgate level). The comparisons may suggest needed price adjustments to encourage efficiency. If the ratios of marginal domestic prices of outputs to input prices differ from the corresponding relative border prices, the total supply of a product from domestic and international sources could be increased without increasing its procurement costs. For example, as long as the domestic pig:feedgrain price ratio is lower than the border price ratio, it should be possible to increase the domestic pig price, exchange part of the induced additional pig procurement for imported feedstuffs, and increase national

income in the process. Since quotas are based on levels of local production which have been attained in the past, crop producers can normally expect that any increments in production can be sold at above-quota prices or higher, or else (in part) retained, in which case the product may be sold at negotiated prices or on the free market. Hence, marginal prices are not quota procurement prices, but are some average of the other three prices. Table 3.4 therefore compares the full range of 1982 domestic price levels for major agricultural products and inputs with farmgate border prices.[26/]

3.32 It was suggested in Chapter 1 that China's farm price structure is designed largely on the basis of internal considerations, viz., to give a reasonable return to labor or land above domestic material costs. Therefore, it is not surprising that the relationship of marginal domestic prices to border prices shows little uniformity, although domestic prices for a number of crops and inputs do not seem far out of line with border prices. Some important products appear to be underpriced relative to international prices. These include rice, timber, pork and fish which together undoubtedly account for a high proportion of agricultural procurement. Three of these (rice, timber, fish) are products for which one would expect production cost as defined in China to be a poor guide to pricing, because it does not reflect rent or returns to past investment in, e.g., paddy fields or fishpond construction and water control systems, or depletion allowances for forests. Underpricing of pork may reflect the grain-saving nature of traditional Chinese production methods compared to grain-intensive production systems abroad and the fact that pig manure in China is a valuable product, the benefits of which accrue to the pig producer.

3.33 On the other hand, certain products seem relatively overpriced, including edible oil, sugar crops, natural rubber and milk. For some of these, climate or natural resources may put China at a comparative cost disadvantage, yet the Government has sought to stimulate domestic production. The overpricing of edible oils does not extend to all oilseeds. The implicit subsidy may accrue to the processing enterprises rather than the farmers. Oilseed meals in China tend to be priced well below international prices for similar products.

3.34 Pricing of industrial inputs has been generally influenced by a Government policy of maintaining a modest profitability of manufacturing and passing along cost reductions to farmers through reduced input prices. Thus fertilizer prices, which benefit from underpricing of energy and raw materials used in the manufacturing process, have fallen to levels which approximate

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26/ Exported or imported products may differ in quality from average domestic production. For this reason, as well as possible estimation errors in conversion to farmgate and unit weight equivalencies, conclusions drawn from comparison of border and domestic prices should be taken as indicative rather than definitive. Moreover, absolute values of indices, which would change nearly proportionately if other than the official yuan-to-US$ exchange rates were used, are less meaningful than price ratios between products.

Table 3.4: COMPARISON OF 1982 BORDER PRICES WITH DOMESTIC PROCUREMENT PRICES /a

Product	Farmgate border price (Y/ton)	Percentage of farmgate border price			
		Quota price	Above-quota price	Free market price	Average price
Crops					
Paddy rice	435	53	80		
Wheat	411	77	115	122-170	
Corn	316	68	102	114-152	
Soybean	590	117	117	119-136	
Lint cotton	2,817	105	136	177-199	115
Oilseeds					
Rapeseed	927	77	116		
Peanuts	738	131	196		
Edible oil	1,046			374	265
Jute	660	56	67		73
Tobacco (smoked)	2,927	59			52
Vegetables	460				
Sugar cane	26	162			191
Tree Crops					
Fresh fruit					
Apples	571			79	68
Mandarin orange	671			92	72
Tea (processed)	3,720			345	95
Natural rubber	1,637				372
Timber	211	41			
Animal Husbandry					
Pork	3,562	50		47	56
Beef	2,435			67	120
Chicken	1,942	113		185	
Eggs	1,755			173	106
Milk	213				282
Wool	6,378				56
Honey	1,417				133
Fisheries					
Fresh fish	3,151	22		67	29
Inputs					
Urea	428	117/b			
Ammonium sulphate	213	119/b			
Phosphate (P205)	898	104/b			
Potassium chloride	255	103/b			
Soybean meal	501	66/b			

/a From Annex, Table 3.3.
/b State fixed price.

international prices for equivalent products, but could turn sharply upwards if price reform increases production costs. Farm machinery remains costly by international standards, but diesel fuel is relatively cheap. On the other hand, the price of electric power for irrigation pumping and fees for surface irrigation water both reflect substantial Government subsidies and would have to be tripled to cover average costs (including operations and maintenance costs but not depreciation for the irrigation system).

3.35 Additional evidence on the appropriateness of the present price structure can be derived from comparisons of ratios of prices of output to major inputs. The ratio of the farm-level prices of nitrogen to crop prices is a commonly used indicator of incentives for high input use (Table 3.5).[27/] Assuming that above-quota prices approximate marginal prices in China, this ratio for Chinese wheat production is identical to the border price ratio and more favorable than in several other major wheat producing countries. The ratio for rice is substantially less favorable, although not worse than those of some other Asian producers (with lower crop yields and fertilizer use rates). This is significant in view of the high crop yields and levels of fertilizer use, and diminished response to incremental nitrogen applications which appears to characterize much of Chinese rice production.

3.36 Not all producers in China face price signals which are as attractive as those considered above. Quota prices appear to vary considerably among geographical areas, as suggested by the considerable differences between reported national averages and local survey data. Quota levels appear to discriminate against areas which had achieved high productivity before introduction of the PRS, and this may be inducing sizeable conversions of cropland to non-agricultural use as in, e.g., Southern Jiangsu. Farmers who normally cannot meet their procurement quotas face quota procurement prices at the margin, and, hence, rather unfavorable incentives to increased input use. Domestically-produced nitrogenous fertilizer varies widely in price per unit of nutrient, and farmers who depend heavily on high-priced fertilizers are penalized. Solutions to these problems might include adjustment of fertilizer prices to reflect quality, nutrient content and transport costs, and reduction of excessive quotas.

3.37 A similar comparison can be made of the ratios of animal product prices to prices of feed input, assuming use of a balanced feed concentrate (Table 3.6). The price ratios may be compared with FCRs which relate concentrate input to resulting meat output: production systems using concentrate-intensive techniques are only profitable when product:feed price ratios substantially exceed conversion rates. In terms of border prices, this favorable relationship exists for pork, chicken and eggs. Border price ratios for beef and milk appear to be below levels necessary for profitable production with concentrate-intensive technologies, possibly because international prices are influenced by exports from subsidized production.

27/ It should not be taken to indicate absolute profitability, as low procurement pricing may be a substitute for taxes, which are ignored in the comparison.

Table 3.5: RATIOS OF FARM LEVEL PRICES FOR NITROGEN AND GRAIN, SELECTED COUNTRIES

Selected wheat producers	Price ratio of nitrogen to wheat/a	Selected rice producers	Price ratio of nitrogen to rice /b
Mexico	1.3	Japan	0.5
Bangladesh	1.5	Korea, Rep	0.7
Egypt	1.6	(Border price)	1.5
China: above-quota price	2.3	Indonesia	1.6
(Border price)	2.3	Sri Lanka	1.7
Canada	2.4	Bangladesh	2.1
Pakistan	2.6	Nepal	2.2
USA	2.6	China: above-quota price	3.1
Turkey	2.7	Malaysia	3.1
France	3.0	Philippines	3.2
Brazil	3.1	Thailand	3.4
China: quota price	3.5	Pakistan	3.6
India	3.6	India (Orissa)	4.3
Australia	5.4	China: quota price	4.7

/a International statistics from CIMMYT, 1983 World Wheat Facts and Trends, Report Two (Mexico, 1983), Table 6, p. 18. Chinese statistics are from Annex Table 3.3.

/b International statistics for 1979 or 1980 are from IBRD-EAPD, Rice Handbook, February 1981, Table VII-B1. Chinese statistics are from Annex Table 3.3.

3.38 Domestic product:feed price ratios appear to exceed border price ratios for all products except pork. Aside from pork and beef, they are also more than adequate to make concentrate-intensive production financially attractive. Indeed, they may be too attractive to encourage efficiency. For poultry products, where most sales are at free market prices, this high ratio may be a combined reflection of strong consumer demand and low-productivity domestic production systems. The data suggest a need to increase pig procurement prices if increases in production are to come from a concentrate-intensive production system. Because of low domestic productivity, the profitability of beef cattle raising and dairy production seems questionable in China even at output price ratios more favorable than border prices. Further study of these price relationships is necessary: given China's agricultural diversity and size, it is important to examine price relationships location-by-location.

Table 3.6: COMPARISON OF PRICE RATIOS OF ANIMAL PRODUCTS TO FEED WITH EFFICIENT FEED CONVERSION RATES

	Ratios of product prices to feed prices /a		
	Border prices	Domestic prices	Kg feed per kg product /b
Pork	10.1	6.2	4.7-5.8
Beef	6.9	9.0	10.8
Chicken	5.5	11.1	2.5-3.9
Eggs	5.0	5.8	3.5-3.7
Milk	0.6	1.9	0.4

/a Product prices are border or average procurement prices per ton of dressed weight. Feed prices are a weighted average of maize (80%) and soymeal (20%). The above-quota price is taken to be the domestic price of maize.

/b Conversion rates shown (kg feed:kg dressed weight) are averages for countries with efficient production systems.

3.39 Though some agricultural products appear relatively overpriced, the marginal procurement prices of other products may be too low to elicit expanded production. As together these represent a sizeable proportion of total agricultural procurement, increases in average procurement prices would be costly to the government budget or to urban consumers. Higher prices would create larger profits for existing efficient producers and would improve incomes most in areas which are already well off, as the presence of rice and pigs on the list would imply. These effects could be minimized if, e.g. (1) the entire price structure, including quota prices, were adjusted upward, but income effects were offset by quota adjustments and/or resource-based taxes; or (2) if the tiered pricing structure were retained, only the above-quota price was increased.

3.40 Agricultural Investment. In every country the linkage between agricultural investment and growth of the sector is obscure. And, as the Chinese experience since 1980 demonstrates, agricultural growth may accelerate while public sector investment declines as long as production incentives remain strong. But this phenomenon of rapid growth in the presence of declining public investment poses the question of whether productive investment in the sector is adequate to sustain agricultural growth at rates needed to achieve national growth and income targets. As noted in Chapter 1, available information on agricultural investment in recent years relates largely to budgeted funds at the state and provincial levels. Little is known of public sector investment outside the state budget or on-farm investment by individual households. Yet it is at these lower levels that investable savings are growing most rapidly. At the national level, little analysis appears to have

been done which estimates the size and type of investment in agriculture required to achieve specific production and income targets. Ministries have reached a general consensus on the size of technically-feasible programs in agriculture to 2000 and have rough figures on unit development costs. But the major analytical effort relates to five-year plans which ultimately determine the allocation of central Government funds among ministries.

3.41 In these circumstances, the present analysis is limited largely to a consideration of investment in capital construction required for major development programs noted by Government agencies in discussions with World Bank staff. Because these programs have been developed by separate agencies and have not necessarily been approved at higher levels, they should not be construed as an integrated investment program for agriculture to 2000. Rather, they provide the basis for developing the annual estimates of public investment in agriculture in several development activities accorded priority by the Central Government. As provincial and local governments have different, more localized sets of priorities, and control over investment resources is shared among governmental levels, an all-inclusive program listing might require investment funds which are substantially larger. Moreover, these estimates are partial in the sense that they relate largely to capital construction in the public sector and exclude most capital expenditure for critical support services such as agricultural education, research, extension, marketing infrastructure and transport. Further, they exclude increased working capital requirements for agriculture. The estimates in Table 3.7 should therefore be regarded as illustrative only and as reflecting assumptions which are not necessarily shared by all ministries concerned.

3.42 The subsectoral structure of this "program" differs greatly from present sectoral shares of output. The share of investment primarily benefitting crop cultivation (about 30%) is less than half of the crop share in GVAOR (about 75%), whereas the other subsectors' shares are at the least twice their present product shares.[28/] While these investment "weights" are generally consistent with the structural change sought in agriculture by the Government, an investment pattern of this nature may not necessarily be desirable from an economic viewpoint, or be an effective means of achieving production and income objectives. More than half of total investment would be absorbed by dairy and forestry development. The advisability of massive investment in dairy development will be questioned below. And while forestry development in general warrants priority on need and environmental grounds, expenditure on afforestation will add relatively little to annual product in the next several years.

28/ Chinese statistical convention defines the gross value of agricultural output (GVAO) to include the value of output from production of crops, livestock, fisheries, forestry and "sidelines." Sidelines include industries operated by brigades and teams, as well as hunting and gathering activities. In keeping with more conventional accounting definitions, this analysis defines GVAOR to include only the gross value of production from crops, livestock, fisheries and forestry.

Table 3.7: ANNUAL INVESTMENT IN CAPITAL CONSTRUCTION FOR AGRICULTURAL DEVELOPMENT (1984-2000) /a

Purpose	Total area affected (ha '000)	Annual expenditure (Y millions, 1982 prices)
Crop cultivation		
Irrigation	6,900	2,264
Drainage, desalinization	11,000	688
Land reclamation	5,970	1,594
Red and yellow soils	3,000	1,042
Subtotal		5,588
Forestry		
Afforestation	60,000	1,408
Maintenance of immature plantings	60,000	4,388
Subtotal		5,796
Animal Husbandry		
Pasture improvement	33,330	816
Feed processing facilities		666
Dairy development		5,008
Poultry development		530
Subtotal		7,020
Fisheries		
Fishpond construction	585	562
Fishpond improvement	800	482
Subtotal		1,044
Grand total		19,448

/a The projected expansion in irrigation is closer to the opinions of MWREP than to those of MAAF, but land reclamation on the scale envisioned by MAAF would often further enlarge irrigated area (investment included in reclamation costs). Pasture improvement investment excludes costs of wells or cultivated pasture. Development of feed processing is assumed to emphasize dispersed, small-scale facilities in order to minimize investment costs. For most other animal and fisheries investments, requirements derive from MAAF production targets for the year 2000. See Appendix Table A.11 for additional detail.

Source: Mission estimates, based on information provided by various agencies.

3.43 The rate of long term growth will depend heavily on the adequacy of agricultural support services, including the agricultural research and extension systems. Because yield increases will be the source of most of agricultural growth, a strong research program aimed at improving production technology is of particular importance in China. Although it is very difficult to estimate an optimum level of investment in research, a study of international experience has recommended an amount up to about 2% of the value of agricultural output.[29/] For China, this would imply annual expenditure (capital and recurrent) of up to Y 4 billion. Comprehensive information is not available on research expenditure in China, but available evidence suggests current levels are considerably less than this amount.[30/]

3.44 Suppose that the Y 20 billion average annual fixed investment level of Table 3.7, which could mean something like Y 11-12 billion at present, rising to Y 33 billion by 2000, may be taken as a minimum requirement: how easily could this investment level be financed? Although at first glance, estimated 1982 rural investment levels of Y 65 billion (Table 1.2) seem ample, a part of the former would be absorbed by replacement investment and working capital requirements. Moreover, only Y 16.5 billion of this total represents investment resources in public hands (excluding obligatory public service labor), of which Y 6.8 billion is now being committed to CBE development. The opinion in China is that state investment in agriculture will not be increased in the short run by more than Y 1-2 billion annually and collective investment (excluding that in CBEs) may continue to decline. Therefore, the ability to effectively tap private savings for productive investment is likely to be a critical determinant of the adequacy of agricultural investment.

3.45 Several approaches could be taken to capture a larger proportion of private savings for productive investment: (1) by bringing more types of developmental activity within the scope of the private sector through the granting of private use rights over collective or state property; (2) by inducing more private direct investment by ensuring stable tenure for families which invest in resource development, assuring access to production inputs, adjusting price levels where necessary, and by offering loans to supplement private investments; (3) by making time deposits attractive through higher interest rates; or (4) by imposing additional taxes on idle assets, offset with tax credits for the productive use of assets. As noted in Chapter 1, the Government has made a start on some of these measures in recent months. But even in the best of circumstances, it will take time for rural institutions to completely abandon preferential treatment for collective or state-sponsored activities and for farmers to become convinced that the present favorable climate for private investment will remain.

29/ World Bank, Agricultural Research: Sector Policy Paper, (June, 1981), pp. 102-106.

30/ As noted below in 1982 expenditure by agricultural research institutes at provincial levels and above was Y206 million, of which Y45 m was for constructing and equipping of research facilities.

3.46 The banking system will need to expand its role in directing investment to more productive uses. In particular, rural credit institutions should be encouraged to devote a larger proportion of credit to long-term lending, which could bid resources away from consumption or nonproductive use and finance use of rural labor for productive investments. The present trend towards an increasing proportion of lending to individuals seems desirable as a means to support the development of specialized household production. Consideration also should be given to, e.g., a higher interest rate structure and the strict repayment policy necessary to ration credit, supported by measures to improve management of credit institutions.

Agricultural Support Services

3.47 The restoration of a farming system organized around individual households has placed new demands on agricultural support services. Previously, the various levels of collective organization could serve as major nodes in the delivery of production inputs and technical assistance, with direction below the production team level left to team cadres. At present the support system requires direct links to nearly 200 million production units which increasingly operate like small family-managed farms elsewhere. In response to this requirement, the system has begun to undergo a restructuring based in part on an innovative extension of PRS concepts. The future development of Chinese agriculture will depend to a large extent on the success of this restructuring in providing small-scale farms with the full range of support services needed by production systems which are increasingly complex technologically and more closely linked to markets for production inputs and outputs.

3.48 Agricultural Research. Of critical importance will be the continued generation of yield-augmenting production technology. Much of the agricultural research in China today is carried out in the 390 agricultural research institutes at provincial level and above which operate under the general professional guidance of the Chinese Academy of Agricultural Sciences (CAAS) within MAAF. The MAAF also supports other smaller research agencies such as the China Aquatic Sciences Research Institute (under the general guidance of the Aquatic Products Bureau) and the South China Tropical Crops Research Institute (under the General Bureau of State Farms). The Ministry of Forestry is the parent agency for the Academy of Forestry Sciences which provides professional guidance for provincial forestry research institutes. The Ministry of Water Resources and Electric Power oversees 33 affiliated research organizations which carry out some research related to water use in agriculture.

3.49 The various provincial research institutes under CAAS guidance are staffed by some 18,800 research personnel, along with support staff and workers. The CAAS itself has about 3,500 research scientists. This network has available about 13,000 ha of land for research and demonstration work. Another 49 crop and livestock research institutes operate at province level or below, are staffed by some 15,300 scientists, and are under provincial leadership. The Chinese Academy of Sciences (CAS) supervises the work of more than 100 research institutes, some of which carry out research in the agricultural sciences. About 11% of the research conducted by institutes

under the guidance of CAAS is classified as basic research, while the balance is designated as applied (71%) or development research (18%). The distinction among these categories is not always clear, although the latter two generally relate to specific problems encountered in agricultural production and processing. In 1982 expenditures by agriculture research institutes at provincial level and above were about Y206 million, of which Y45 million were for construction and equipping of facilities[31/].

3.50 China's agricultural research system continues to suffer from the effects of the Cultural Revolution when many major research institutions were closed and staff dispersed to the countryside. Work at many research institutes is hampered by inadequately qualified staff and poor research facilities. Experimental fields and greenhouses need to be established or upgraded and there is a general need for better housing and educational, health and recreational facilities, particularly for research centers in isolated areas. Qualified staff, especially at the middle and senior levels, are in short supply. Of the total research staff noted above, less than 3% hold graduate degrees and more than 35% have not earned a college degree. A large part of the intellectual leadership for agricultural research in China is provided by research staff who are more than 60 years of age.

3.51 Linkages between research institutes and the agricultural colleges and universities tend to be weak. At the ministry level there is some interaction between bureaus of science and technology responsible for research institutions and bureaus of education which oversee higher educational institutions. At the provincial level, the ties between teaching and research institutions are commonly based on personal contacts and ad hoc arrangements for joint work on specific projects. Cooperative research arrangements are being increasingly encouraged by central funding agencies which may respond to bids on research projects submitted by colleges and research institutes by making joint awards. Linkages between research and extension are to be improved through the work of extension committees which are being established at the provincial level.

3.52 Agricultural Education. China has some 85 institutions of higher education in agriculture and related fields with a total student enrollment (1981/82) of about 100,000. This represents only 8% of the 1.2 million students enrolled in China's 715 institutions of higher education. At the secondary level, some 740 institutions provide training in agriculture in 2-4

31/ Among the agricultural research achievements of international acclaim in China were the early development of stiff-strawed, fertilizer-responsive wheat and rice varieties, the development of hybrid rice varieties, methods to control stripe rust in wheat and, more recently, the development of high-yielding or shorter season cotton varieties. In 1983 the State Scientific and Technological Commission granted a number of awards for outstanding research achievements by the CAAS system, including the development of a vaccine against equine infectious anemia, the development of wilt-resistant cotton varieties, and the development of an effective vaccine against swine fever.

year programs. About 185,000 students were enrolled in these programs in 1981/82. At the university level, agriculture is not generally the first choice of candidates and those admitted to the agricultural colleges and universities frequently have lower scores on admissions tests than candidates entering other fields. There is also a problem of retaining agricultural students after training is completed. Since the early 1950s, some 500,000 of the technicians trained in agriculture have left the countryside for jobs in urban areas. Through new policies - a special quota system for admissions of rural students to agricultural colleges and secondary schools and salary incentives to encourage graduates to return to the countryside to work - the Government hopes to develop a much larger group of committed agricultural professionals and technicians.

3.53 Although the precise dimensions of the skilled manpower needs in agriculture must await further detailed studies,[32/] recent projections indicate shortages of appropriately-trained personnel at both the professional and technical levels. Training institutions are striving to overcome such shortages, but efforts are hampered by limited enrollment capacity and inadequate quality of instruction and range of curricula. Based on present enrollments of postgraduates in the agricultural sciences totaling about 1,200, the Government estimates that requirements between 1983-90 for personnel with advanced degrees will exceed availability by more than 15,000. At the college graduate and technical levels, shortages are most acute in specialized fields such as forestry and meteorology where the present flow of 5,000-6,000 graduates per year can satisfy only half of the requirements over the decade. Overall, it is estimated that there are currently about four agricultural technicians per 10,000 agricultural workers.

3.54 There is a further need to upgrade the qualifications of already-employed personnel, both professionals and technicians. Extension personnel number about 170,000 of whom 35% are graduates of colleges or technical schools and 65% are experienced farmers with no formal technical training. According to MAAF/FAO data, 80,000 of the technicians in the extension network are in need of skill upgrading, as are most of those in the animal husbandry and veterinary service stations. The demand for in-service training in agriculture for secondary school teachers is also of growing concern as the Government seeks to strengthen the agricultural curriculum in the secondary schools.

32/ Manpower requirements in agriculture and implications for educational planning are being examined in a pilot study in Jiangsu Province launched in 1982 as part of the World Bank-assisted Agricultural Education and Research Project (CR 1297-CHA). One of the preliminary results is that the present deployment at the ratio of about 1:1 between college-trained personnel and technicians trained at the secondary level makes inappropriate use of higher level personnel. This investigation, some version of which may be undertaken in other provinces as part of a nationwide agricultural manpower survey, is to be completed in 1985.

3.55 Agricultural Extension. China's past agricultural successes in such areas as the rapid expansion of hybrid rice production can be attributed in large part to the working of a well-structured extension network. Organizational reforms in the rural areas, and the sharply diminished roles for brigades and teams in agricultural production decisions, have necessitated new approaches to extension. In 1982 a decision was taken to convert the existing county research institutes into county agro-technical extension centers (ATECs) which combine the formerly-separate extension, research, plant protection, seed production, fertilizer distribution and soil analysis, farm machinery and animal husbandry stations. Each ATEC is expected to include 10-15 agricultural technicians and support staff. Physical facilities may include some 3-5 ha of land for experimentation and demonstration, 2,000-6,000 sq m of floor space for laboratories, class rooms, audiovisual materials and exhibitions. More than 300 such centers have been established, generally in the better developed agricultural areas. About a third of these have been created with MAAF funding, while costs of the other centers were met from provincial, prefectural or county sources. The Government intends to establish ATECs in each of the country's 2,300 counties over the next 10 years.

3.56 The ATECs' major functions include training and demonstration and the provision of several support services to farmers such as plant protection, machinery services, soil analysis, weather forecasting and supplies of seeds, fertilizers and irrigation water. Training is provided through a variety of courses offered to farmers and technicians at county and township levels and ranges from field days for farmers to short courses of two weeks' duration to two-year courses for farmer and township technicians. Demonstrations may relate to fertilizer and variety trials, pest and disease control measures and irrigation practices. Higher level technical support to the ATECs in the form of, e.g., more basic research, development of improved crop varieties, and production of teaching materials is provided by agricultural colleges or provincial academies of agricultural science.

3.57 Contracts between the center (or a subcenter thereof) and individual households are other means of providing agronomic advice, plant protection or machinery services. While farm machinery is typically owned by the machinery subcenter, it may be operated under contract by a farm machinery team which provides services to farmers on a fee basis. The system specifies bonuses to be received (or penalties paid) by technical assistance teams in the case of over (under) achievement of yield or production targets. The specialized households or "keypoint" households (similar to model farmers in other extension systems) also are expected to be important means of extending improved technologies to producers.

3.58 The new arrangements to provide agro-technical services vary widely among locations and continue to evolve. Although not yet adequately tested through operation, they are likely to foster greater coordination among units which provide agricultural support services. The close integration of training, demonstration and the provision of production inputs such as seeds and fertilizers should be particularly beneficial to the increasingly complex production systems which are emerging in Chinese agriculture. The consolidation of services also should improve the means of ensuring a two-way flow of information between the research institutes and agricultural colleges on the

one hand and the farmers on the other. MAAF's recently-created Leading Group on Extension has the responsibility to coordinate at the national level all agricultural education, research and extension activities.

3.59 Machine services. Since 1979, Government policy has changed from active promotion of agricultural mechanization to a market-oriented approach in which the future rate of mechanization will depend largely on farmer demand and farmer investments. Following the development of BGDH management systems, the reductions in field size, as well as farmer desire to obtain maximum control over timing of farm operations and to minimize cash expenditures, have caused a decline in demand for large and medium-scale machinery, and a corresponding rise in demand for draft animals. The demand for small-scale pedestrian tractors continues to be high. Excluding the 10% of tractors owned by state farms, about one-third of tractors are now privately owned, another one-third privately operated, and the rest collectively owned and operated under contract to mechanization teams or service companies. Mechanization continues to be important in irrigation, pest protection, processing and transport, as well as on state farms, where low labor/land ratios and short growing seasons typically militate against labor-intensive techniques.

3.60 The emerging organizational form for provision of machine services involves private or collective custom land preparation by specialized operators or teams, whose earnings are supplemented by short-haul transport work. The provision of transport services which normally accounts for 40-60% of farm labor input, is far more profitable than custom land preparation for regulated fees. This may contribute to the decline in mechanized plowing and increased demand for draft animals. Tractor hauling is reportedly as efficient as truck transport on poorly maintained farm roads, but contributes to clogging of the rural road system. In the long run, the introduction of fuel-efficient, small scale trucks to replace off-farm tractor hauling, would produce important savings in fuel and transport time. In the medium-term draft animals, which now consume over 20 million tons of concentrate per year, are likely to continue to grow in importance. In view of the competition this poses for limited concentrate supplies, successful development of custom machine services would help free resources for production of livestock products for human consumption.

3.61 Marketing and transport. One of the most important constraints to the restructuring of Chinese agriculture and increased specialization is the limited capacity of the rural transportation, processing, storage and distribution system. Most options for accelerating agricultural growth and increasing productivity have as prerequisites investments and organizational improvements in this area. Efforts should be made to both expand the capacity of the rural marketing system and increase its operational efficiency. The system could be improved by policy measures which simplify pricing and procurement, reduce administrative barriers to the flow of farm output and production inputs, curtail the number of public intermediaries in the marketing chain, and encourage larger roles for individuals or small groups in the management and ownership of purchasing and selling points, processing and storage plants and transportation equipment. The demand for marketing services (transportation, storage, processing) will grow rapidly as commercialization of agriculture expands. Experience in other countries

demonstrates that individuals and small groups can provide these services efficiently and can usefully complement the Government's role in these activities.

3.62 There appears to be inadequate linkage between the work of the agricultural planners in China and agencies responsible for transportation, with a resulting tendency to consider such bottlenecks as largely insuperable constraints. With improved transportation, agricultural specialization could expand to more fully exploit comparative advantage and facilitate the transition to a more commercialized agriculture. For an extreme example, Gansu's Hexi Corridor is less distant from China's Northeastern provinces than California is from the east coast of the United States and shares with some areas in California the dry, sunny climate and fertile soil which provide the basis for high value crop production. At present, melons and deciduous fruit from Gansu sell at high prices in Hong Kong and Chinese cabbage procured in Hexi for Y 0.02-0.04 per kg sells in Northeastern cities for more than Y 0.20 per kg. These price differentials suggest that a reliable system of refrigerated rail transport might well generate enough revenue to more than cover the cost of supplying additional grain to horticultural producers in Gansu. More generally, there will be little increase in the average national per capita consumption of high value, perishable foods such as dairy products, fruits, vegetables and fish if their commercial production and distribution are confined largely to the vicinity of major municipalities as at present. Improved transportation would permit more rational use of suburban land, reduce input supply problems, distribute perishable products more widely and improve the income distribution effect of high value agricultural production.

3.63 Recent policy decisions to permit individual ownership of trucks and provide for the relatively free movement of privately-owned farm products across jurisdictional boundaries are major contributions toward solving the rural transport problem. More transport vehicles will put additional stress on China's rural road system which is already over-burdened. Because of past policies emphasizing local self-sufficiency and relative neglect of local transportation networks, the problems of rural transport in China may be more acute than in many other developing countries[33/]. Improvement of the rural road network is essential to a better marketing system. A substantial amount of internal trade in agricultural commodities could probably be moved advantageously by barge in terms of cost per ton km, particularly if the cost of new rail or road lines is considered.

3.64 At the production level, the stress on holding local grain reserves, the lack of adequate investment in the past for storage, and the surge in production in recent years is creating an increasingly serious grain storage

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33/ The Sahelian countries of West Africa have more trucks per capita than do the rural areas of China. In Northwest India expansion of the rural road network was a major factor behind the farmers' adoption of new production technology and the five-fold increase in commercial grain supplies. These roads, which reduced marketing distances by half, were financed in part by levies on grain sales.

problem. Reliable measurements of post harvest grain losses are not readily available in China, but post harvest losses in grain in the range of 5-10% of production have been reported and storage problems are likely to be even larger for the more perishable fruits, vegetables and animal products. Cold storage capacity will have to grow very rapidly if the changing pattern of consumer preferences is to be accommodated. Chinese sources suggest that cold storage capacity in the whole of rural China is less than that available in Northwest India which has a total population of only about 50 m. To ensure their efficient use, these cold stores would have to be integrated into retail arrangements for the commodities being handled and would require similar investments in urban areas.

3.65 At the national level, a major problem is an inadequate physical infrastructure for trade in agricultural products, particularly bulky products such as grain. Without major improvements, existing port facilities appear to be capable of handling not more than 16-18 m tons per year. This assumes that improvements at Dalien, Zhanjiang and Qingdao are completed. Little of the unloading appears to be handled by continuous flow equipment and none of the ports can accommodate the largest and most efficient bulk grain carriers. Shipping charges for these carriers from North American ports are $4-5 per ton below those of the smaller vessels which can be accommodated in Chinese ports. Some idea of the grain handling problem at the major ports may be indicated by demurrage charges which have been estimated at nearly $30 per ton in 1982 for those grain imports which were carried on non-Chinese bottoms (about 20% of total grain imports).

3.66 Agro-processing. Improved inland transportation and storage facilities would provide a basis for agro-industrial development which requires assured deliveries of high-quality, uniform raw materials. For cereals and oilseeds, the investment priorities include: (1) improved oilseed milling facilities to increase extraction rates and provide processes to reduce toxic substances in processed products; (2) feed milling and mixing facilities to provide balanced feeds for poultry and livestock; and (3) improved wheat milling and processing facilities, including equipment for the manufacture of convenience foods.

3.67 Substantial investment will be needed to establish a feed milling industry which meets China's requirements. In the rural areas, where transport of large volumes of raw materials will continue to be difficult, livestock producers are likely to grow substantial quantities of their feed. In this setting, large scale feed mills would be less appropriate than an industry organized around the manufacture of feed premixes (vitamins, minerals, some high protein supplements) which are relatively low volume materials and can be purchased and transported by small- and medium-scale producers to be mixed with their supplies of grains. For the large-scale animal or poultry production systems, well served by roads and located near major urban markets, the modern, high capacity feed mill using large volumes of grains, protein supplements and feed additives, is likely to be the most efficient.

3.68 A viable feed milling industry can only be established if the product is demonstrably superior to current feeding materials and justifies the higher cost. In China measures which would contribute to this objective

include development (or expanded production) of synthetic amino acids, fish and bone meal, and vitamin, mineral and antibiotic supplements. The oilseed processing industry will have to increasingly regard the production of oilseed meal as of equal importance with edible oil. The quality and price of feed concentrates will have to be adjusted to the point where production is profitable and the use of protein meals as fertilizer becomes uneconomic.

3.69 To provide adequate services, China's agricultural processing and distribution system will have to be much more specialized, technically complex and more closely integrated than is the existing system. This modern system will require a high level of technical and managerial skills. Much of this expertise, or necessary training facilities, is not currently available in China. The experience of other countries in developing modern food distribution and agro-industries would be useful and an active program of information exchange and study tours should be encouraged to permit China to benefit from this experience. Foreign technology, including managerial expertise, could make a large contribution to meeting these skill requirements.

3.70 Local management capacity can be augmented through joint-venture contracts with foreign agro-industrial firms. In addition to facilitating the transfer of improved technology, joint ventures often provide the means to break into a competitive export market. The advantages of such links in terms of market access, packaging technology, quality control and assured delivery, often are more important in the export market than being the low price supplier.

4. PROSPECTS FOR MAJOR AGRICULTURAL PRODUCTS

Food Crops

4.01 Grain production in China increased by 3.9% annually in 1979-83 as the annual yield increases of 5.1% more than offset the decline in sown area of 1.1% per year. The most rapid growth rates were reported for wheat (6.7% p.a.) and rice (4.1%). Corn production rose by 3.2% per year while output of other grains (pulses, soybean, tubers, other coarse grains) rose by only 1.2% per year. Looking forward, the Planning Bureau within MAAF has targeted grain production to grow by about 2% annually from the average 1980-82 base while the area sown to grains would continue to decline marginally by about 0.1% p.a. This would require average yield gains of 2.1% yearly over the two decades, with individual rates ranging from 1.3% annually for grains other than rice, wheat and corn to 2.8% annually for corn (Table 4.1). Rice yields would increase by only 1.8%.

Table 4.1: PROJECTIONS OF GRAIN PRODUCTION, AREA AND YIELDS BY THE PLANNING BUREAU, MAAF

	1980-82 average (actual)	1983 (actual)	Pro-jections 2000	Average annual growth rate (%) 1980-82 to 2000	1979-83
Sown Area (million ha)					
Rice	33	33	33	0.0	-0.5
Wheat	28	29	28	-0.1	-0.3
Corn	19	19	19	-0.2	-1.7
Others	34	33	33	-0.1	-2.1
Total	115	114	113	-0.1	-1.1
Yields (tons/ha)					
Rice (paddy)	4.4	5.1	6.2	1.8	4.7
Wheat	2.1	2.8	3.5	2.6	7.0
Corn	3.1	3.6	5.3	2.8	5.0
Others	1.8	2.1	2.3	1.3	3.3
Total	2.9	3.4	4.2	2.1	5.1
Production (million tons)					
Rice (paddy)	148	169	208	1.8	4.1
Wheat	61	81	99	2.6	6.7
Corn	61	68	98	2.6	3.2
Others	59	69	75	1.2	1.2
Total	329	387	480	2.0	3.9

Source: Derived from projections of aggregate growth rates provided by the Planning Bureau, MAAF. Other grain includes soybean, lentils, and tubers. As noted in Chapter 3, these figures are considered to understate the actual sown area and overstate yields.

4.02 Rice. MAAF's Planning Bureau assumes that the area sown to rice would remain virtually unchanged from current levels, with the roughly 40% production increase (2000 over the 1980-82 average) coming entirely from higher yields. A major factor expected to contribute to increased yields is the projected expansion in the area planted to hybrids from the 1983 level of nearly 6.8 m ha to 13.3 m ha in 2000. With a net yield advantage (taking into account the larger areas required for seed production) of about 20% over conventional varieties, an increase from current levels of the hybrid area by the implied 7.7 m ha (wihout yield increases from 1982 levels for all rice), would generate nearly a third of the projected increment in rice production by 2000. The Government also plans to stress measures to improve rice yields in low-yield areas where considerable potential seems to exist.

4.03 The major constraint to area expansion for hybrids is the relatively long maturation period for current hybrid varieties in China (at least 135

days), a fact which limits hybrid rice largely to the second crop in rice-rice sequences or the single rice crop in wheat-rice sequences in the South. Although not yet in commercial production, promising materials are being tested in China which have maturities of 110 days or less. The successful introduction of these varieties in China over the next few years, which seems possible from technical and organizational perspectives, would permit extension of the hybrid rice area and possibly a cropping system which includes two crops per year of hybrids. China's hybrid rice varieties were developed from a narrow genetic base, and remain somewhat vulnerable to pests and disease, but research efforts in recent years have successfully incorporated much greater resistance in the newer varieties.

4.04 Progress also has been made in reducing hybrid seed costs by improving production technology. Hybrid seed yields in China have been increased on average from about 500 kg per ha in the mid-1970s to 1.0 ton at present. Yields of up to 1.5 tons have been reported in the better areas and genetic materials are available with physical characteristics (long stigmas and anthers, shorter flag leaves) which should permit further increaes in seed set and yields. The cost of hybrid seed in China is up to ten times the cost of conventional seed, although seeding rates are less than 20% of the non-hybrid types. Thus, hybrid rice cultivators spend somewhat more on seed than do cultivators of other conventional varieties. Because conventional seeds are usually produced by the farmer, cash costs for users of hybrid seed are substantially increased. With a yield advantage for hybrids of 0.75-1.0 ton per ha (valued at $100-120), the incremental benefit-cost ratio of about 5:1 (abstracting from incremenal costs of labor and other purchased inputs, which also would be expected to rise), suggests that hybrid rice is economically attractive to producers. Consumers appear to respond less positively. In markets where both hybrid and non-hybrid varieties are available, hybrid rice sells for about 10% less than traditional varieties.

4.05 China's rice yield in 1983 of 5.1 tons (paddy) per sown ha (about 4.1 t/ha if adjusted for acreage underreporting) lies about halfway between the average for all developing countries and yields in developed countries, but yields are constrained by the need to use short maturity varieties in double cropping systems. Water control in most of China's rice-growing areas is already quite good and fertilizer levels are at relatively high levels. Cultural practices, such as weed control, are outstanding. A major determinant of future yield gains is likely to be the speed at which hybrids with shorter maturation periods can be introduced. The steadily-improving system for rice research in China augurs well in this regard. Targets for production and yield increases seem modest relative to recent achievements.

4.06 Wheat. China is among the world's largest producers of wheat. In China wheat is the second most important grain after rice and accounts for about 20% of grain production and 25% of the area sown to grain. MAAF's Planning Bureau projects both wheat and corn production to grow more rapidly (2.6% p.a.) than other major grains. With an assumed small decline in the sown area, this implies annual growth in wheat yields of 2.6% p.a. to 3.5 tons per ha. China's 1980-82 wheat yield per ha of 2.1 tons (1.7 t/ha, adjusting for underreported acreage) is close to the average yield for all developing countries and well-below yields in developed countries. Among developing

countries, Mexico, South Korea and Egypt have yields higher than China, due in in part to the fact that virtually all of the wheat area in those countries is irrigated, as contrasted with a figure of perhaps 50% in China.

4.07 About 60% of China's wheat area is double-cropped, generally with corn (in the North) or rice (in the South).[34/] Nearly all winter habit wheat on the North China Plain has been double cropped with corn. Most intermediate habit wheats in the Yangtze Valley and spring wheats south of the Yangtze are double-cropped with rice. The spring wheats of the Northeast, Northwest and Southwest are mostly single-cropped.[35/] Although the area sown to wheat is projected to decline marginally, some increase in the double-cropped area can be expected if the Government's efforts are successful to increase the intensity of land use through expansion of the irrigated area.

4.08 Development of early maturing varieties is changing these double-cropping patterns and has important implications for production. A case in point is the cropping system in parts of the Yellow River where, prior to the 1980s, available varieties of cotton were of a duration which required early spring planting, thereby precluding double-cropping with winter wheat. Cotton breeders recently introduced cotton varieties for that area with maturation periods of less than 120 days, or a duration sufficiently short to permit double-cropping with winter wheat. One planning estimate suggests that short season cotton varieties can be combined with winter wheat on up to 1.7 m ha previously idle during the winter months. At yields of about 3.0 tons per ha, this development could add 5 million tons of wheat (6% of 1983 production) with no increase in cultivated area.

34/ Multiple cropping refers to three practices: (a) sequential cropping--the sequential growing of two or more crops on the same land in the same year; (b) relay cropping--a form of double-cropping in which a second crop is planted between rows of the preceeding crop. In China this is widely practiced in a wheat-maize cropping system in which maize is seeded between the wheat rows about 30 days before wheat harvest; and (c) intercropping--two or more crops planted in the same field at the same time, but in alternating strips. Intercropping is widely practiced in Northeast China for various crops, including wheat.

35/ Wheat breeders define winter wheats as varieties which require a resting period induced by cold weather to flower and set seed. Spring wheats require no resting period and are generally planted in late winter after the last killing frost. Intermediate wheats must demonstrate cold tolerance, but require no resting period. About 60% of China's wheat crop is of the winter growth habit; 20% is of the spring habit; and 20% is intermediate-type wheat. In contrast to these definitions, the SSB defines winter wheat as that which is in the ground during the winter months, thereby including wheats grown near Beijing as well as in Guangdong. Wheat breeders would define the varities grown in the South as intermediate types.

4.09 Cultural practices in wheat are generally of high standard, although a number of improvements seem possible. Weeds are controlled by hand pulling and the measure of control is quite high. Little is known of the rate of fertilizer applied to wheat, but for this crop, like others in China, application levels for phosphorus and potassium are likely to be well below economically-optimum levels, thereby losing some of the benefits from applied nitrogen. The degree of water control and the efficiency of water use could be improved in many of China's wheat growing areas. Seed quality also could be improved. Mechanization plays only a small part in soil preparation, seeding, fertilizing, threshing and transportation to storage or market. While this system employs abundant labor, it bears the disadvantage of slow turn around time between the June harvest (North China Plain) and the planting of corn, cotton or other warm weather crops. To speed these operations and avoid damage from summer rains, some mechanization of harvesting, threshing and hauling may be needed.

4.10 Work by Chinese wheat breeders has produced notable results in such areas as earliness (the best winter wheats in the Beijing area ripen by June 10, i.e. several days ahead of foreign winter wheats), successful spring X winter wheat crosses, and high yields (the world record wheat yield of 15 tons per ha was realized under optimum conditions at the Qinghai Plateau Institute of Botany in 1977). All varieties released for commercial production since 1965 have yield potential of five tons or more and two varieties released in Shandong Province have a yield potential of about 9 tons per ha. However, the gap between average provincial yields and yields realized in experimental and demonstration trials remains large. Provincial yields are generally less than half the yields achieved in trials, suggesting both the need and opportunity for improved practices relating to disease and pest control, irrigation and fertilization and timeliness of seeding, weeding, irrigation and harvest.

4.11 A particular concern for the future relates to wheat diseases, especially scab which may cause annual losses of 10-15% in the Yangtze Valley and losses of up to 25% in that area in two years out of ten. The most severe losses seem to be associated with heavy spring rainfall in localities with poor drainage. Through joint efforts between Chinese scientists and the international agricultural research centers (IARCs), scab resistant varieties are being identified or developed, but the process may require five to ten years to produce results of economic importance. It is possible that wheat research in China has not paid sufficient attention to developing disease resistance. Wheat losses due to disease may be higher than is commonly recognized in China. Good progress has been reported in dealing with the problem of stripe rust.

4.12 The target wheat yield for 2000 of at least 3.5 tons per ha is likely to require progress on several fronts. Breeding programs might usefully stress greater disease resistance, using local and exotic germ plasm available from IARCs. Some wheat varieties in China lack plumpness of kernels, a characteristic which is manifested in lower yields, but which can be ameliorated through careful selection of parent materials. Lodging also remains a problem, especially in areas with high levels of fertilizer use. It

may be necessary for wheat breeders in China to make larger number of crosses each year to identify a few outstanding progeny with stiff-strawed attributes.36/

Table 4.2: GAPS BETWEEN PROVINCIAL AND TRIAL YIELDS OF WHEAT

Trials at provincial research institutes	Year	Yield (t/ha)	Provincial average yield (t/ha)	Minimum gap (t/ha)	Provincial average as % of trial yield (t/ha)
Shijiazhuang, Hebei	1977	5-7	2.2	2.8	44
Jinan, Shandong	1977	7-9	2.6	4.4	40
Nanjing, Jiangsu	1977	5-7	3.6	1.4	72
Gongzhuling, Jilin	1977	5	1.0	4.0	20
Guangzhou, Guangdong	1981	4	0.9	3.1	23
Taigu, Shanxi	1981	5	1.7	3.3	34
Wugong, Shaanxi	1983	4-5	2.3	1.7	42

Source: SSB and reports by visiting scientists.

4.13 Agronomic research, particularly that related to fertilizer and water use, has been undervalued and, hence underemphasized in China. It would seem useful to undertake more complete fertilizer trials to examine production and economic effects of using alternative types of nitrogenous, phosphatic and potassic fertilizers and of varying the timing and quantity of applications. Further applied research would be useful on effects of alternative timing, amounts of water applied and number of irrigations. As part of the Government's emphasis on crop development in rainfed areas, more research

36/ Visiting scientists have stated that the germ plasm base in Chinese wheat varieties is unduly narrow. This may be incorrect. Through the IARCs, China has access to the world's germ plasm collections, but breeders may not be using effectively the full genetic range of this material.

seems needed in the semi-arid areas of the Northwest, including moisture conserving techniques such as minimum tillage.[37/]

4.14 Corn and other coarse grains. Corn production accounts for about three-quarters of coarse grain output and 18% of total grain output. Production since 1979 expanded at 3.2% p.a., or about one-half as fast as wheat. The Government projects virtually no change in the cropped area to 2000, but yields are to grow by about 70%, or 2.8% p.a., 1979-81 to 2000. China's corn yields (adjusted for acreage underreporting) are slightly higher than average yields in developing countries, but less than half those in developed countries. Much the same pattern holds for other coarse grains. In comparing wheat, rice and corn yields in China with those achieved in developed countries, the largest difference is in corn. One explanation is that corn in China is usually relay cropped following wheat and therefore may suffer from a shorter growing season and initial competition with wheat for nutrients and moisture. Other factors restraining yields of coarse grains include poor seed quality, inadequate irrigation during times of moisture stress, low application of chemical fertilizer and poorer cultural practices compared with e.g., wheat and rice which, as principal food crops, benefit from greater care by producers. Although hybrid corn accounts for about 70% of total corn area, quality of much of this seed is questionable. Deficiencies of nitrogen and phosphorous are commonly observed in growing corn.

4.15 Growth of total coarse grain production at a substantially higher rate than the Government target would be required to provide the feed grain necessary to meet output targets for livestock and poultry. Much of China's development effort in grain has focused on the high-yield irrigated areas. One of the major challenges of the future is to raise crop productivity and farmer incomes in upland areas. Much can be done with the traditional grain crops, but other crops such as cassava also have great potential in some of these less-favored areas. Cassava's potential lies in its multiple-use character and its efficiency as a converter of soil nutrients, sunlight and moisture to carbohydrate energy. With proper inputs, further expansion of this crop may be possible on lower-quality tropical soils not suitable for sustained cropping of annual food crops. Output could be used to meet energy requirements in the local market for mixed feeds. Exports also may be possible to net importers of feed grains, starches and sweeteners.

4.16 Regional Trends. The 6.4% overall increase in grain production in 1979-82 reflects rapid rates of increase in east and south China and near-stagnation in the north (Annex A, Table A.5). There was a modest production increase in the northwest, a significant crop loss in the northeast due to flooding in Heilongjiang, and a decline in acreage in low-yielding coarse grains in the north offset by increased yields for fine grains. Southern and eastern production increases extended to most types of cereals, tubers and

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37/ Some countries such as Turkey have been very successful in expanding dryland production of wheat. Wheat production in Turkey expanded by 3.9% p.a. over the past 20 years. The experience of Turkey may be useful to China.

soybean. Reportedly, 80% of the 1983 grain production increase averaging 7.5% was attributable to provinces in the north, restoring regional balance to the growth pattern.

4.17 The Government does not project any major changes in the regional pattern of the area sown to grain. At present, only the northwest has an overall grain deficit, which the Government hopes to reduce by developing commercial grain bases within the region (Map 4). Lower projected growth rates for rice relative to wheat and corn would imply higher growth rates for grain production in the north. Within the south, there may be a decline in tuber and rainfed rice area and corresponding increase in corn and soybean area, mostly in the hilly or mountainous sections. Broadcast (rather than paddy) rice is expected to expand in the north and two-crop paddy rice area in the south.

Industrial and Specialty Crops

4.18 Measured by percent of sown area, national average yields and per capita production, the industrial crops (oilseeds, fibers, sugar crops, tobacco, tea) on the whole appear to be less well developed in China than in a number of comparator countries (Appendix B, Tables B.1 and B.2). Cotton is a significant exception. The demand for most of these crops tends to grow rapidly as incomes rise. Some of the specialty crops, such as fruit and vegetables, bring high returns to producers and typically become more important as agriculture modernizes. Long-term Government plans stress improvement of yields of these crops, in part by careful selection of planting location to take advantage of suitable environmental conditions, but do not call for significant expansion of the planted area.

4.19 One of the issues in a longer term perspective is the extent to which expansion of these crops in China could be economically justified. An international comparison of average yields of these crops relative to grain yields may provide a rough measure of comparative advantage (see Appendix B for details). If average yields are indexed to cereal yields and compared, the most important producing areas in China typically appear to be at least as efficient as comparator countries in the production of oilseeds, fibers and tobacco. Chinese producers appear to be less efficient in, e.g., the sugar crops. These indices may also be taken as rough measures of production inefficiencies in these crops and, therefore, of potential for improvement.

Table 4.3: INTERNATIONAL COMPARISON OF INDUSTRIAL CROP YIELDS (1979-81, t/ha)

	Cereals	Peanut	Rape seed	Seed cotton	Jute	Tea	Tobacco	Sugar beet	Sugar cane
China /a	3.0	1.5	0.9	1.3	3.5	0.3	1.9	12.8	47.8
Korea	4.8	1.5	2.1	0.9	9.0	0.3	2.1	-	-
Japan	5.3	1.9	1.7	-	1.5	1.5	2.4	52.2	64.6
India	1.3	0.8	0.5	0.5	1.2	1.5	1.1	26.1	51.8
Pakistan	1.6	1.2	0.6	1.0	0.8	-	1.5	-	37.9
Thailand	1.9	1.1	-	1.4	1.1	-	0.6	-	37.0
Indonesia	2.9	1.6	-	0.7	2.9	1.1	0.5	-	98.7
Egypt	4.0	1.6	-	2.7	2.3	-	-	-	83.9
Index of Yields Relative to Cereals:									
China	100	50	30	44	177	10	63	427	1,593
(Leading province) /b	100	73	43	68	160	N/A	104	836	1,896
Korea	100	31	44	19	0	6	44	0	0
Japan	100	36	32	0	28	28	45	985	1,219
India	100	62	38	38	92	115	85	2,008	3,985
(Leading state) /c	100	87	37	10	66	101	64	N/A	3,644
Pakistan	100	75	38	63	50	0	94	0	2,369
Thailand	100	58	0	74	58	0	32	0	1,947
Indonesia	100	55	0	24	100	38	17	0	3,403
Egypt	100	40	0	68	58	0	0	0	2,098

/a Cereals yield according to FAO definition (excluding tubers and pulses). Chinese yields are likely to be overestimates due to underreported acreage.
/b In 1981, province with largest acreage in each crop.
/c In 1977/78, yields of rice adjusted to those of paddy.

4.20 Cotton and other fiber crops. Special encouragement given to cotton production by price and procurement reforms, the increased freedom to determine cropping patterns under the PRS, and the planting of improved varieties stimulated a 22% expansion of cropped area and a 72% increase in yields during 1978-83. In Shandong Province, the leading producer, the area planted to cotton rose by 150% between 1979 and 1983 and stimulated some concern of increased grain deficits for the province. As a result of these area and yield gains, the cotton production and trade situation has undergone a remarkable transformation. China has moved from being a large importer to basic self-sufficiency (Table 4.4). With cotton consumption presently below

production, imports have declined sharply to less than 100,000 tons per year and stocks may be approaching two million tons (equal to about half a year's consumption).

Table 4.4: COTTON PRODUCTION, CONSUMPTION AND TRADE, 1980-83

Year	Production	Imports	Con-sumption	End of year stocks
	mil tons			
1980	2.7	0.7	3.3	0.6
1981	3.0	0.5	3.5	0.6
1982	3.6	0.2	3.6	0.7
1983	4.6	0.1	3.6	1.6

Source: 1980-82 data are from SSB. The 1983 figures are from the United States Department of Agriculture.

4.21 Prospects for continued yield increases for this crop seem good for several reasons. First, the yield gap between average and best practice production is large. In Shandong, where yields of seed cotton have reached an average 2.0 tons per ha, cotton specialists believe that a further 50% yield increase could be obtained with existing varieties through extension of improved cultivation practices and better pest control. Second, cotton, along with vegetables and peanuts, is benefiting from the use of plastic sheet (93,000 ha in 1982), a technology which permits earlier planting, conserves moisture and facilitates weed control. This technique, which reportedly leads to cotton yield gains of more than 50%, appears profitable in labor-surplus regions, although the required cash outlay is a limiting factor. Finally, the CAAS Cotton Research Institute recently released a new early maturing (112-114 days) variety of summer-sown cotton which can be sequentially-cropped with winter wheat. Although yields and quality of this variety are likely to be less than those of longer-maturity varieties, introduction of wheat-cotton double cropping in both the Huanghe and Yangtze River basins may help ease the fear of grain deficits associated with increased cotton acreage. This variety is targeted in the near term for nearly 30% of the total cotton area.

4.22 Future consumption of cotton will depend increasingly on the size of the local market for textiles. In 1983 sales of textile products declined and cotton rationing was abolished. Exports of cotton textiles, which provide a market for less than 10% of production, are likely to depend on China's ability to improve quality and styles. Competition with synthetic textiles also may become increasingly keen as the large new capacity for synthetic textile production comes on stream. Some exports of raw cotton may be possible and have been included in trade agreements with East European countries.

4.23 In China the demand for bast fibers such as jute and hemp has declined rapidly due to the availability of cheaper and more serviceable synthetic substitutes. Following a 50% yield increase in 1978-82, domestic consumption requirements have been met and sown area has declined sharply. Prospects are that the area sown to these crops will continue to decline as China's synthetic fiber industries mature.

4.24 Oilseeds. During 1978-82 production of oilseed crops (including rapeseed, peanuts, sesame and sunflower seeds, but excluding soybeans and cottonseed) more than doubled, due about equally to increased area and yield. Area expansion was partly due to resumption of specialization patterns abandoned in the 1960's during the drive for local grain self-sufficiency. New patterns also emerged such as the rapid adoption of sunflower in the well suited areas of the Northeast. There is also evidence that oilseeds received larger supplies of chemical fertilizers. As a consequence of these developments, the previous extreme shortage of edible oils was eliminated and rapeseed oil grew rapidly to nearly one-half of edible oil supplies.

4.25 Soybean production has grown by about 5.2% p.a. since 1978, largely due to increased yields. Acreage has shown a small uptrend. Variable weather in major production zones resulted in sharp inter-year fluctuations in output. Soybeans appear to have been benefited less than the major grains from research and relatively small amounts of chemical fertilizers are allocated to this crop. Soybeans are the only major crop grown in China in which the reported national average yield was less than that for developing countries as a whole. Chinese yields (adjusted for acreage underreporting) are at least 20% below average yields in developing countries and 40% below those in developed countries. A steady increase in soybean yields would be required if future needs for high quality protein meal for livestock feeding are to be met.[38/]

4.26 Processing of oilseeds could be much improved. Most existing facilities are small-scale operations using inefficient machanical presses and are characterized by low extraction rates, high levels of impurity in the product, and inability to remove toxic substances in rapeseed and cottonseed oil and meal. Less than 20% of China's oil seed processing capacity uses the more efficient solvent extraction methods.

38/ Soybeans originated in the temperate areas of Northeast China and most of the world's production takes place at latitudes more than 30 degrees from the equator. Efforts to develop tropical soybeans have been underway for a number of years in various countries. Researchers in Brazil recently released for commercial production three varieties of tropical soybeans suitable for planting within 15 degrees of the equator. Yields may average about 1,850 kg per ha, compared to about 1,100 in China, or 2,000 kg in the United States. Adaptation and introduction of soybeans into China which perform well at lower latitudes could improve the outlook for high quality protein meal and, indirectly, the livestock industry.

4.27 Other industrial and specialty crops. These include sugar cane and beets, vegetables, fruits, tobacco, tea, coffee and various tree crops. Per capita production of these crops as a group is low in China relative to most comparator countries. Income elasticities of demand typically are high.[39/] Although the projected growth rate of demand suggests that the area sown to several of these crops should expand over the next several years, caution may be required with crops such as sugar cane and sugar beets where the evidence noted earlier suggests that China has little overall comparative advantage and domestic procurement prices exceed world prices by substantial margins. For these crops the primary emphasis probably should be to improve yields through better cultural practices, improved planting materials and careful choice of planting location. It may be that overall efficiency gains can be made by replacing these crops in some areas with crops more suited to the environment.

4.28 Prospects for tea are clouded because of possible marketing constraints at home and abroad. Tea production in 1983 declined by 3.8% from 1982 levels, the first decline in 20 years, reflecting smaller sales at home and abroad. In the major producing province of Zhejiang, 1,000 ha of tea reportedly were converted to other crops because of a difficulty in selling the output. Proposals in China to decentralize tea marketing and permit free market sales would probably encourage larger domestic consumption. Average tea consumption in China of about 150 gm per capita per year is the lowest among tea producing countries and far behind the world average of 430 gm. The World Bank projects the world price of tea to show no change in real terms between the present and 1995 (Appendix Table A.12).

4.29 Production of tobacco is likely to be increasingly influenced by public perception in China of the health dangers inherent in its use. Chinese authorities in the past have been reluctant to acknowledge that increased cigarette smoking may be linked to lung cancer. More recently, smoking has been increasingly recognized as a health hazard, although trends continue to show very rapid growth in tobacco consumption. In 1981 the retail price of cigarettes was increased by about 30% and limits were placed on the land allocated to production in response to the emergence of surplus leaf supplies. Tobacco production rose rapidly in 1981 and 1982 (to about 2.08 m tons) but declined in 1983.

4.30 Increased production of vegetables and fruit present special problems because of their perishability. A primary constraint in the development of these products is the weakness of the processing, transport and

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39/ Vegetables at first glance appear to be an exception. Beijing consumption surveys suggest an elasticity as low as 0.20. Meat and fish are substitutes for vegetables in Chinese consumption habits. Replacement of lower quality vegetables such as cabbage or mustard greens with higher quality vegetables and greater consumption during the off season also is associated with increased incomes. Both trends are associated with decreased crop yields. Hence, if the income elasticity for vegetables were defined in terms of value of expenditure, rather than quantities consumed, it would be more meaningful and also probably quite high.

marketing system. Particularly critical are the shortages of modern processing facilities and the lack of refrigerated transport and cold storage. Development of commercial production of perishable products (livestock products, fruits and vegetables) has been largely confined to the peri-urban areas partly in response to the transport and storage problems. However, the high and rising economic value for land near urban areas makes this a less viable solution. This concentration of production also contributes to income inequality within the agricultural sector, inasmuch as suburban producers reap the major benefits from high value production. With improved processing and transport facilities, production of perishable commodities could expand outside municipal boundaries.

4.31 Government plans give considerable emphasis to development of fruit and other tree crop production on lands too steep for annual crop cultivation. The lag between planting of tree crops and first harvest implies that much of the supply of fruit between the present and 1990 has already been determined. Tree crop investment programs in the next few years will largely determine supply after 1990.

4.32 Potential for further specialization. Recent agricultural planning in China has been influenced by the view that a higher degree of specialization, based on economic incentives and careful land use planning, is feasible and promises continued economic gains. Provincial statistics on sown area indicate the expansion of industrial crops since 1979, with the largest increases in provinces with relative comparative advantage. However, these increases in the industrial crop areas have come primarily at the expense of the area sown to grain. Few examples have been found of declining plantings in areas lacking comparative advantage in industrial crops. This may be related to marketing and transport deficiencies, which encourage self-sufficiency, and to a unified price structure which shifts much of the burden of differential transport costs from the producer to the marketing organizations and, ultimately, to the Government.

4.33 Without special studies or access to highly disaggregated data, it is difficult to draw conclusions about whether significant efficiency improvements are to be gained from further specialization. This discussion is therefore limited to suggestive evidence from provincial data in the context of international comparisons. Appendix B examines the extent to which provincial cropping patterns are related to comparative advantage in China and India. Because provinces are large geographic entities with diverse micro-environments, and because transport costs inevitably encourage local production, considerable production diversity is to be expected, and indeed is found, at the provincial level in both countries. However, the statistics suggest that provincial specialization in particular industrial crops according to comparative advantage is more characteristic of China (1981) than India (1977-78), even though overall China devotes a smaller proportion of the sown area to such crops. This finding may be explained in part by the observation that many of India's farmers are closer to subsistence and such producers tend to use diversification as a measure to reduce risk. Further, China's rural production and welfare systems continue to reduce risk to the individual producer, permitting a higher degree of specialization. Unfortunately, the analysis provides no firm guidelines as to how far specialization could go if the

weaknesses of China's transport and marketing system were remedied and the residual concerns for regional self-sufficiency in basic foods were relaxed.

4.34 Regional Trends. Increased production of industrial crops in the last few years has come primarily from specialized, commercial production bases (Map 4). Thus Shandong and Hebei Provinces account for 76% of increased cotton production in 1979-82, with traditional producing areas in provinces such as Xinjiang, Shanxi and Jiangsu accounting for smaller increases and southern area declining. Growth of oilseed crops has been broadly based, including rapeseed in all the provinces crossed by the Yangtze River, peanuts in Shandong, Guangdong and other provinces with areas of sandy soil, and sunflower in the northeast. Expansion of sugar cane and beet have also centered on commercial production bases.

4.35 In the Government's view, any further adjustments of industrial crop area should be marginal. Because southern cotton is of higher quality, only slight decreases in acreage should occur, whereas acreage in Xinjiang would further expand if transportation conditions permit. Emphasis in the north will be on quality improvement. Future locational trends for oilseeds are not expected to differ from those of recent years. Additional expansion of sugar cane is to be limited to that permitted by grain yield increases; sugar beet area would be increased, primarily in Neimonggol, Xinjiang and Gansu, in areas in which grain yields are low. Sugar beet, like sunflower, is especially targeted for areas with saline soils. In short, past patterns of industrial crop specialization have been largely restored, and future stability is expected.

Forestry

4.36 Output and employment. Forestry's share in GVAO remains relatively small, but has increased steadily from about 1% in the early 1950s to just over 4% at present. Employment in forestry and forest industries totals 2.2 m (less than 1% of the rural work force), with 60% in wood processing, 30% in land preparation and planting and 10% in nursery operations, logging, etc. Industrial roundwood harvested and marketed within the state plan in 1982 was 50 million cu m, an increase of 2% over the 1981 level, but below the peak figure of 54 million cu m in 1979. (Appendix Table A.10: Timber Production, 1981). A volume of about the same magnitude was produced outside of the plan. Production of timber products includes sawn timber (2 million cu m in 1981), plywood (0.35 million cu m), fiberboard (0.57 million cu m) and particleboard (76,700 cu m). Paper and paperboard output was about 5.7 m tons in 1982.

4.37 The resource base. About 120 m ha, or 13%, of China's land area is under forest cover, with about a third of this in virgin forest, nearly half in secondary (natural) forest and the balance under replanted forest. Since 1949 some 86 m ha have been afforested but plantings on only about one-third of that area are reported to have survived. Survival rates in recent years have been higher. Total growing stock is estimated to be 9.5 billion cu m of which 55% is in coniferous species and 45% is in broadleaved types. About 21% of the forested area is in Heilongjiang Province alone and five provinces (Heilongjiang, Yunnan, Jilin, Guangdong, Sichuan) account for 48% of the total. In contrast, the five provinces with the smallest areas under forest

(Ningxia, Qinghai, Nei Monggol, Jiangsu, Shandong) make up less than 2% of the total cover. Heilongjiang accounts for 24% of the country's growing stock of timber, while three provinces (Heilongjiang, Sichuan, Xizang) together make up 54% of the total. As a percent of provincial land area, forest cover ranges from 35% (Heilongjiang) to 0.3% (Qinghai). A significant feature of China's forest resource is the high proportion of the forested area and the standing volume of timber accounted for by mature forests (more than 30% and 60% respectively). This is due in part to the inadequate network of forest roads which restricts exploitation.

4.38 Consumption and imports. Annual per capita wood consumption is about 0.05 cu m (excluding fuelwood), compared to about 0.02 cu m in India and 1.5 cu m in the US. Reflecting local shortages and increased demand from population and income growth, imports of forestry products (logs, sawn timber, veneer, plywood) rose from US$242 m (CIF basis) in 1976 to a peak of US$642 million in 1980, then declined to about US$540 m in 1981. Between 1978 and 1981, pulp and paper imports rose from less than 600,000 tons (US$150 million) to 1.4 m tons (US$630 m). Expected income gains will almost certainly result in continued rapid growth in demand for forest products.[40/]

Table 4.5: AREA AND VOLUME OF COMMERCIAL FORESTS

Age	Area		Standing volume	
	mil. ha	% of total	billion cu m	% of total
Not classified	0.2	2	0.2	2
Immature	3.8	39	0.5	7
Middle age	2.6	27	1.8	23
Mature	3.1	32	5.2	68
Total /a	9.8	100	7.7	100

/a Excludes 0.8 m ha in protective forests, 0.9 m ha in economic forests, 0.3 m ha of fuelwood forests and 0.4 m ha in bamboo and other special use forests. Data refer to 1976.

Source: Ministry of Forestry.

40/ Rural housing has been relatively neglected for much of the past 30 years. This is being corrected. Surveys suggest that the share of expenditures on housing by rural families in 1982 had tripled from 1978 levels. The housing boom resulted in a 32% increase in the average floor space per rural resident in 1978-82.

4.39 Future development. Forestry development in recent years has been accorded high priority by the Government but has been handicapped by depletion due to over-harvesting. Major thrusts of future development include afforestation, increased exploitation of mature and over-mature areas, expansion of forest industries and strengthening of forest research, education and extension. Government plans call for the land area under forest to be increased to about 20% by 2000, an increment of some 60 m ha. Annual harvesting of timber included within state plans is to increase from about 55 million cu m in 1983 to 100 million cu m by 2000. However, much of this would be accomplished by enlarging the scope of the plan to include most of an additional 50 million cu m harvested annually, mostly for self-use by collective units and private farmers (not counting about 70 million cu m of firewood). "Real" production increases are not expected to exceed a few million cu m, including under 1.5 million cu m from exploitation of mature forests and the product of some 200,000 ha to be developed as intensive tree farms. While total timber production volume would thus remain static, processing industries are to be rapidly expanded. For example, production of wood-based panels (now largely fiber board and plywood) may expand from 1.0 million cu m in 1980 to 3.5-4.0 million cu m by 2000 if the industry receives the Y 4.5 billion investment required.

4.40 The achievement of these objectives will require a very large effort by the agencies concerned. Afforestation of another 65 m ha would require planting of 5-6 m ha annually with survival rates exceeding 60%. Some 4-5 million ha have been afforested annually in recent years, although survival rates reportedly have been less than 50% on average. The application of PRS in forest management is expected to increase this figure substantially. Funding of forestry development continues to be a problem. Although stumpage fees are paid in most areas, the revenues fall well short of development costs of the timber. Efforts are being made to shift a part of afforestation costs from budgetary grants to loans, although financial institutions such as the ABC have been wary of this type of lending operation because of the long gestation period involved. Investment programs by the state forest farms, of which there are some 3,900, have been hampered by the relatively low price they receive for logs sold to the Government. Despite recent increases, state procurement prices for timber are only about one-half the negotiated price. New policies announced in late 1984 permit timber produced by collectives or on private plots to be sold at negotiated or free market prices.

Livestock

4.41 Livestock's share in GVAO was virtually unchanged during the 1979-83 period, although since 1979 growth of this sector has been faster than that of crops. Exports of live animals and livestock products exceeded $1.1 billion in 1982 and accounted for about 5% of China's total export value that year. Exports of live hogs and chilled, frozen and canned pork are in the range of Y 1 billion annually, a value 50% greater than 1982 coal exports and larger than tea and raw silk exports combined. Discussion of the livestock sector is conveniently divided into ruminants (cattle, sheep, goats, etc.) and non-ruminants (pigs and poultry). China has the largest swine population in the world (some 300 million head, or more than 40% of the total), but only about 5% of the world's cattle, 12% of its sheep and 18% of the horses. The

country's ruminant herds and flocks utilize some of the world's most extensive grasslands (Map 6), variously estimated at 319 m ha to 340 m ha (of which 225 m ha are defined as usable).[41] Less is known of poultry and dairy production, although modernization of those industries is beginning. Red meat production (pork, beef, mutton) increased by about 12% p.a. in 1978-82, permitting per capita meat availability to grow from 8.9 kg to 13.3 during the period. Poultry meat may add about another kg to annual per capita consumption. More than 90% of total meat production (including poultry) is accounted for by pork.

4.42 China's agricultural area is divided into grazing lands (55% of the total) and crop lands (45%). The grazing areas are lightly populated by humans (6% of the total), but provide about half of the mutton production and 40% of the beef output. The crop lands support more than 70% of the large animals and almost all of the poultry and pigs. Patterns of livestock ownership and management have changed sharply since 1981 as a result of the introduction of the PRS. More than 90% of all hogs and a larger share of poultry are privately owned. In the grazing areas livestock previously managed collectively have now been allocated to individuals under sometimes vague agreements which require repayment of live animals to the collective. This system continues to evolve and is resulting in a sharp increase in livestock numbers, with accelerated pressures on already over-grazed lands. In the cropped areas, most large animals also have been allocated to individual households or specialized production groups.

4.43 Management systems tend to minimize feeding of grain and emphasize use of milling by-products, other processing wastes, cut forage produced on waste or marginal lands or natural grasslands. Concentrate consumption in 1981 was probably equivalent to about 37 m t of processed grain and 58 m t of grain and oilseed milling by-products. Most of the poultry flock depends on scavenging, although confined feeding systems are beginning to appear near larger towns and cities. Low grain feeding systems and seriously inadequate levels of protein supplementation are major factors contributing to various technical inefficiencies in China's livestock sector. Dressing rates for hogs and cattle are only about 70% and 40%, respectively, of levels in the United States.[42] Slaughter rates in the United States are more than twice in China and the period from farrow to finish in China is two to three times that in the US.[43] Milk production per cow in the US exceeds the Chinese figure by a similar margin. But these production systems are not without merit. The ability of native breeds of swine to ingest and utilize large quantities of low quality roughage, aquatic plants and agricultural processing wastes should be considered when comparing production efficiencies. The swine population

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41/ The SSB gives a grassland area of 319 m ha, of which 225 m ha are "usable." These figures compare with rangelands of about 455 m ha in Australia, 370 m ha in the United States and 140 m ha in Argentina.

42/ The ratio of dressed weight to live weight.

43/ Annual slaughter as a percent of inventory numbers.

acts as a means of converting low value organic materials into meat and valuable organic fertilizer which has played a key role in maintaining soil tilth and fertility in China.

4.44 Ambitious targets have been established for livestock production as part of the Government's efforts to improve consumption patterns. By the year 2000, the contribution of the livestock sector to GVAO is projected to rise from the current level of about 15% to 25%. Meat consumption is to more than double to about 27.5 kg per capita (33 m tons) by 2000, while the share of

Table 4.6: A COMPARISON OF SELECTED ASPECTS OF LIVESTOCK PRODUCTION IN CHINA AND THE UNITED STATES, 1980

Item	China	United States
Ratio of value of livestock to crop production	18/82	48/52
Year-end inventories (million)		
Hogs	305.4	67.4
Cattle	71.4	111.2
Dairy cattle	0.6	10.9
Sheep and goats	187.3	14.2
Animal product output (million tons)		
Pork	11.3	7.5
Beef	0.3	10.0
Mutton	0.4	0.1
Poultry meat	1.0	6.6
Cow milk	1.1	58.3
Per capita consumption (kg/yr)		
Red meat	12.3	72.6
Poultry meat	1.0	27.7
Eggs	2.5-3.0	15.7
Milk	1.4	103.2
Efficiency indicators		
Farrow to finish for hogs (months)	18-24	6
Slaughter rate, hogs (%)	62	143
Slaughter weight (kg)	94	110
Dressed weight (kg)	54	79
Dressing rate (%)	57	72
Pork production/head in inventory (kg)	37	111
Milk production/cow (kg)	1,800	5,300

Source: Adapted from USDA, China: World Agriculture Regional Supplement, 1983, p. 15.

pork in the total (pork, beef, mutton) would decline to 70% (23 m tons). This implies that production of beef and mutton would increase from 680,000 tons (1979-81) to 9.9 m tons (14.2% p.a.), while pork output would expand by 3.7% annually. Production targets for other livestock products in 2000 include: eggs 13.8 kg per capita, wool about 1 kg per capita and milk 42.5 kg per capita. These figures imply a 5.5-fold increase in per capita egg consumption, a 7-fold increase in wool consumption and a more than 15-fold increase in milk consumption. Assuming these products are locally-produced, these figures imply annual growth in output ranging from more than 11% in the case of eggs and wool to more than 20% for milk.

4.45 Major means proposed to achieve the livestock production targets include more efficient production and management systems, based on higher levels of grain feeding, pasture improvement and use of animals with higher genetic potential. With these improvements, the Government projects FCRs to fall, and slaughter rates from herds and flocks to increase. Over the longer-term, slaughter rates are to increase from about 5% at present to 25% for cattle, 68% to 100% for hogs and 15% to 60% in the case of sheep.

4.46 Technical feasibility of the livestock targets depends critically upon the availability of much larger supplies of grass, grain and protein supplements. Major efforts will be required to solve the institutional and logistical problems of developing and servicing a modern livestock industry, based on nutritionally-balanced rations, comprehensive veterinary services, and sustainable systems of forage and fodder production. Supplies of coarse grains would fall short of requirements if production expands no faster than it has in recent years.

4.47 Inadequate supplies of high quality protein meals are perhaps the major causes for the low productivity levels in much of China's livestock industry. Although China produces some 8-10 m tons of oilseed cake and meal annually, at least 70% of this amount has been used as fertilizer. Factors contributing to the heavy use of these materials as fertilizers include local shortages of chemical fertilizers in situations where oilseed cakes are readily available, relatively low prices for oil cakes, transportation bottlenecks, and the presence of toxic substances in cakes which limits their use in animal feeds.[44/] Solution of the toxicity problems in China's oilseed meals would greatly enlarge potential supplies of protein meal. However, soybean

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44/ Gossypol pigments in cottonseed meal have generally limited use of this meal to feed for ruminant livestock and for fertilizer. Because of its toxicity and high fiber content, only small quantities of China's rapeseed cake can be used in feeding of non-ruminant livestock and poultry. The oil from traditional rapeseed varieties typically has an erucic acid content of at least 25% while the meal contains 6-18% of glucosinolates. Improved varieties, developed in Canada and Europe, contain no more than about 2% erucic acid in the oil and less than 2% of glucosinolates in the meal, which is therefore usable in livestock feeding. Work is underway in China and elsewhere to develop cotton varieties with lower gossypol content.

meal is the most appropriate meal for poultry and swine rations because of its amino acid balance and its relatively high content of the essential amino acid, lysine. In the absence of adequate lysine supplies for pork and poultry feeding, it may be useful for China to consider developing a capacity to produce synthetic lysine, as other countries have done in similar circumstances. Priority should also be given to strengthening research programs aimed at introducing oilseed varieties with low toxicity levels.

4.48 The grasslands of the North. China's extensive grazing areas (Map 6) are commonly viewed as underutilized resources which can be the source of much of the large incremental supplies of beef and mutton in future years. The potential value of this resource is indisputable, but the extent to which it can support larger livestock populations under present policies is open to question. Available evidence suggests that many of the grazing areas in Northern China are already seriously over grazed and in danger of progressive and perhaps irreversible degradation unless corrective measures are implemented.[45/] Pasture conditions in the southern and southwestern areas of China are generally in better condition, but productivity there also tends be low because of poor soil fertility and low feed value of natural vegetation. Inadequate forage and fodder supplies, particularly during the stressful winter months, are major factors behind low slaughter rates and winter mortality rates in the range of 7-15%.[46/] Lambing and calving rates of no more than 70-80% are reported in some of these areas.[47/] Livestock productivity in the northern grasslands is low because most of the available dry matter is required for animal maintenance and little remains for production.

4.49 Overgrazing problems in areas such as Nei Monggol and northern Hebei go back to the 1960s, but have been exacerbated by policies since 1979 which stress expansion in numbers and the rapid introduction of the PRS. Herds and flocks, formerly managed collectively, have been allocated to individual households or specialized production groups. While grasslands also are eventually to be divided up for individual use, in many areas they remain in use as commons. The PRS also has significant positive effects. It has encouraged individual care of animals, with the result that mortality rates in some areas are down. But it appears to have destroyed the mechanism by which collectives formerly were able to control animal numbers, at least to some extent, and to implement pasture management systems. The combination of privately-managed

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45/ For example, large animal numbers reportedly are growing by 4% p.a. in Gansu's grasslands and the numbers of goats and sheep, while declining, are estimated to exceed carrying capacity by at least 25%.

46/ Winter losses in the grazing lands of the American West, a region with ecological similarities to parts of China's northern grasslands, are generally less than 2% p.a.

47/ Ratio of lambs/calves to number of breeding females.

herds on a common grazing resource has added pressure to an already overburdened rangeland.[48/]

4.50 The policy of encouraging livestock numbers appears to be based on inadequate appreciation of the existing condition and potential of much of China's grassland area. The most important immediate requirement is to match livestock numbers with carrying capacity through herd reduction. Controlled grazing and the introduction of improved grasses and legumes could permit higher dry matter yields and ultimately higher meat offtake. Failing this, other elements of an improvement program may not be worthwhile. Measures to improve genetic potential of the livestock population without first increasing feed supplies will not increase animal productivity and might in fact lead to higher mortality rates for the less hardy improved breeds. The economics of introducing irrigation to pasture or forage in the short season areas of north China, or of permanent fencing of rangelands, are open to question.

4.51 Policy objectives should move from those of expanding animal numbers to increasing the output of animal products per unit of land area. Destocking is likely to be required, but herdsmen are not likely to reduce animal numbers unless they can be convinced that it is in their economic interest to do so. Demonstration farms and ranches, backed by sound technical research and management, will be required in this regard, as will successful implementation of the grassland laws which are to shift the management of grassland to individuals or groups who would benefit from better management. It also seems useful to offer price premia for younger animals to encourage destocking. Many of these required changes are socially complex and institutionally difficult. In view of these difficulties and the existing condition of much of China's grazing areas, it seems unlikely that the large targeted increments of meat from beef and mutton are likely to be achieved.

4.52 Ruminant livestock in South China. Although the focus of ruminant livestock development in China has been on the pastoral areas of the North and Northwest, more than 40% of the large animal population, including about half of China's cattle, is located in twelve southern provinces which are considered as "agricultural," rather than "pastoral." The demand for draft animals has been increasing and will remain strong for several years. As the basis for ruminant livestock development, attention has been called to the hilly and mountainous areas as the only underutilized land remaining in South China. In the past, indiscriminant clearing of forest and expansion of cropping has contributed to a serious erosion problem. Much of this cut over area is under grass and is used, or usable, for pasture.

48/ The comment of a livestock technician from Nei Monggol, after visiting the sand hills grazing areas of western Nebraska, is perhaps illustrative: "Your sand hills are covered with grass; ours are blowing sand dunes. These people are concerned first with their grass and hay for the winter; we look first to the numbers of our animals. I can remember when our plains were lush grass areas. Now we have desert. We must change our attitude and grow grass first, then get just enough animals to eat it. We are destroying ourselves."

4.53 Chinese sources (1980) indicate about 27 m ha of usable hilly or mountain pasture in South China. However, this figure is generally acknowledged to be exaggerated, and fails to take into account the quality of grasses, soils and topography, and availability of infrastructure. Aside from the low feeding value of present ground cover, a major obstacle to development is that the areas with high potential are patchy and isolated, while the largest areas are located in sparsely-populated mountain areas with poor access.

4.54 Southern pasture areas may be divided into three subareas of uncertain size, each with distinct development potential and problems. The most promising areas, the "southern mountain and hilly areas," are characterized by relatively high altitude and a mild climate, but with steep slopes. Soils are deficient in phosphorus, but are generally suitable for legumes and grasses. At higher elevations, temperate zone pastures such as clovers and ryegrass do well. At lower elevations and latitudes, the climate approaches subtropical and temperate zone legumes perform poorly. The "tropical hilly areas" have less potential because of poorer soils (also generally deficient in phosphorus) and higher temperatures. The area may be suitable for tropical legumes, although an appropriate mix of varieties is yet to be identified. The third subarea, the hill areas north and south of the Yangtze River appear to be least amenable to pasture development. High summer temperatures reduce yields of cool season grasses and legumes, whereas tropical legumes cannot survive winter temperatures. In each of these subareas, research is needed to identify suitable grasses and legumes.

4.55 Pasture development generally would be coupled with fruit and other tree crops on gentler slopes and afforestation on steeper lands. Because of the longer growing season and more adequate rainfall, dry matter yields tend to be substantially higher in these areas than in the North and Northwest. Improvement of these pastures could be carried out through hand or aerial seeding with legumes and grasses and applications of phosphate fertilizer. Costs of this technique appear to be under Y 150 per ha and, if done properly, the approach seems as effective as more costly alternatives involving soil preparation. In the southern latitudes, the long frost-free season and high dry matter yields minimize the amount of winter feeding required and make substantial investment in cattle housing unnecessary. Overgrazing is not as pervasive as in the North, although it occurs in more densely-settled localities.

4.56 While these areas may be technically-suitable for pasture development, careful study is required of the financial and economic viability of ruminant development in South China. Justification may depend on indirect benefits such as soil conservation and employment. Southern pasture development projects examined by the World Bank exhibit economic returns which are modest compared to returns in other potential projects in the agricultural

sector.[49/] Moreover, these projects have features which limit their replicability, but which are important to economic viability, viz., minimal additional requirements for infrastructure (road, buildings, electric power and agricultural support services) and the presence in the project areas of low-cost underemployed labor. Projects to develop the more remote pasture areas of South China are not likely to have these advantages.

4.57 Dairy development. China's dairy development policy is to promote production initially around large cities, stressing production by collectives and individual households and using state farms as sources of improved animals and modern technology. Producer prices of milk are attractive and production can be profitable. State farms in the Northeast report annual profits of Y 700-800 per cow, while collectives and private farms, where production costs are lower, report annual net returns of up to Y 1,000 per animal. The basis for breed improvement is in place. Every province has at least one artificial insemination station and 90% of all dairy cows are artificially bred.

4.58 Dairy production in South China is concentrated in municipal enterprises in suburban areas which are characterized by high economic costs for land and a scarcity of high quality forage. This forces heavy reliance on concentrates and contributes to high production costs. Rapid expansion of dairying has compelled import of dairy stock from Europe and Japan at costs approaching US$4,000 per head. With high investment and operating costs, many of these enterprises do not appear to be financially viable, despite local prices for dairy products which exceed world prices by a substantial margin. Viability of some operations has been improved by integrating dairying with more profitable activities such as fish farming or fruit growing which use the manure as feed or fertilizer. But pig or poultry raising would be less costly sources of nutrients for these operations. It also is possible to improve the productivity of dairying in the subtropical areas by introducing more heat-tolerant animals.[50/] Under present conditions the question remains whether significant expansion of suburban dairying in this form is economically justifiable.

4.59 In view of the low prices of powdered milk products on the international market, one of the most economical means to increase supplies for the large eastern coastal cities may be to increase imports of milk powder for reconstitution. International prices reflect subsidies provided to milk producers in exporting countries. China's economic interests are best served by utilizing these subsidies through imports, rather than subsidizing its own producers. For the inland areas, higher productivity from improved breeds may

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49/ Appraised as part of the World Bank-supported Rural Credit Project (Credit No. 1462-CH).

50/ Introduction of the Australian Milking Zebu, an animal bred for high production in subtropical conditions, has been suggested.

establish the basis for economic expansion of dairy production.[51/] Large-scale dairying in the southern mountain areas may be economic with better animals and improved pastures which permit low-grain feeding systems.[52/] The scale of farms would have to be large enough to support processing facilities to minimize transport costs. There must be reasonable proximity to a large urban market and good transport and communications. The cost of this infrastructure, as well as herd and pasture development costs, would be important determinants of whether such farms are economically justified.

4.60 In intensive agricultural areas of e.g., the Sichuan Basin, small-scale production units could have an important role. Key requirements include access to markets which offer opportunities for fresh milk sales or sales to processing plants and adequate supplies of good quality forage. Other factors would include the availability of better quality cows, access to concentrates and protein supplements, and farmer training programs in animal health and nutrition and management practices.

4.61 Pigs and Poultry. Both pig and poultry production are dominated by the household sector, which has derived most of its cash income, organic fertilizer, meat and eggs from animal production as a sideline activity. By some measures, productivity of China's pig and poultry raising is low. Chinese pigs are fed for about 19 months on average before reaching slaughter weight, compared to a world average of 12 months and about 6 months in Japan and the United States. Carcass weights are just over 60 kg in China, compared to a world figure of 70 kg and about 80 kg in the United States. Typically, most rural households keep a few chickens or ducks for egg production, which depend mostly on scavenging or household wastes, grow slowly, and have low egg productivity and slaughter weights. There also exist expanding modern pig and poultry industries with productivity norms closer to counterparts in other developing countries.

4.62 These characteristics are partly the result of a long standing government policy to minimize the use of grain as animal feed and maximize the use of byproducts, household wastes and low value feeds which have few alternative uses. In the past this policy was enforced by a tight system of grain procurement and feedgrain supply, and by procurement prices which made grain intensive production systems generally unprofitable. Under these policies, production teams set aside feedgrain, or land to produce it, which was

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51/ An example is the development of improved dual purpose animals, such as crosses of water buffalo with imported Murrah or Nili breeds. Chinese literature suggests that a dual purpose (draft and milk) animal of this type could produce some 1,000-1,500 kg per lactation. An on-going World Bank survey of the economics of small farm buffalo milk production in India may provide a basis for appraising this potential in China.

52/ One example is the Nanshan State Farm in southern Hunan. After two years of pasture and herd management improvement, Nanshan reported milk yields averaging 3,800 kg per lactation with less than 150 kg of concentrate per cow and 0.85 ha improved pasture per animal.

provided to households in return for a commitment to raise pigs and sell some proportion to the state. Deliveries of all manure to the collective were compulsory and compensated with cash or workpoints at attractive prices, but at the expense of those households which did not raise animals.

4.63 Those who sold pigs at quota procurement prices to the state received extra compensation in the form of ration coupons which entitled them to the right to purchase limited amounts of feedgrain and meat at controlled prices. Feed grains made available from collective and state sources were carefully limited to amounts well below animals' nutritional requirements, thereby forcing private households to use byproducts or surplus food grain distributions, production from private plots and as much roughage as the animal would consume. This system did not extend to poultry, which therefore competed with pigs for the "surplus" resources of the household. Until free market sales of grain and milling byproducts were restored in 1980, unrationed purchases of feed grains were virtually impossible. Up to the late 1970s, as much as 30% of pork production came from collective enterprises run by communes, brigades and teams, most frequently at a financial loss, despite privileged access to feedgrains. Most of these operations have been abandoned in the last few years, although collective operations still keep a large proportion of sows and sell weanling pigs to households.

4.64 This policy of minimizing grain feeding is not likely to be an efficient means to the large incremental meat requirements of the future. The long fattening period and low carcass weights suggest that a significant portion of total feed nutrients is being expended simply to maintain the animal. Inadequate grain, protein and mineral supplements probably result in inefficient use of that grain which is made available. The forage used to save relatively small amounts of grain usually involves some economic costs, as when land suitable for higher-valued crops is used to grow forage because of administrative restrictions on feedgrain use. More significantly, the restrictions on feedgrain trade appear to have promoted the use of high value cereals in animal feeding. For example, it is estimated that in South China as much as 10 m tons of rice are used annually as feedgrains. At current world prices, a given quantity of rice could earn twice as much feed energy if it were exported in exchange for lower priced feedgrains such as maize or grain sorghum.

4.65 Small-scale household production. The control system described above has begun to break down as a result of the growth of the PRS in agriculture. Production teams have distributed to households the land formerly set aside for feed production. That part of the grain surplus formerly controlled by the team is now largely in the control of households and therefore not available for distribution by the collective in return for pig sales. Collectives no longer have use for manure nor income to pay for it. Hence, revenues which represented about 18% of total income from collective pig production (essentially the profit margin) have been replaced by the household's valuation of manure now used by the household. As chemical fertilizer is more abundant, increased manure production appears to be less of an incentive for animal production than it once was. In the future, pig procurement price policy will have to take this into account.

4.66 Specialized households. Official policy increasingly is to promote animal production by specialized households (SH). The term SH in livestock production applies to households which raise several times more than the national average of two pigs and five chickens or rabbits per family.[53/] Scale of operations and technology frequently approximate those of production team-level operations which they replace (often by simply taking over team assets under contract). In more descriptive terminology, these are small-scale commercial animal farms, which differ from state or collective enterprises in their household management and/or ownership and use of private funds and capital saving production techniques.

4.67 A new set of policies and practices may be required to ensure the viability of the SH production systems. Of primary importance, these operations must be profitable in order to attract private capital and encourage expansion. This does not appear to be a serious problem in poultry raising, as poultry and egg procurement prices are relatively high and state intervention in the marketing system has been minimal. Production incentives seem to be less favorable in the case of pigs. To improve financial incentives, a variety of subsidies reportedly have been employed, such as procurement of pigs at higher, negotiated prices, subsidized feedgrain sales, and/or low cost rentals to SH of collective assets. A further requirement is to ensure adequate supplies of balanced feeds. The larger scale of SH production implies that these producers can no longer depend on household wastes, nor can households provide the amounts of labor required to collect the large volumes of forage needed in low-grain feeding systems. It is not likely that non-mechanized farms can simultaneously grow their own feed and raise large numbers of animals. In some areas the authorities have encouraged SH animal producers to subcontract their land to other farmers, who are to serve as SH feed producers. This form of specialization avoids some of the costs of transporting feed grains, but it cannot be expected to provide adequate quantities of balanced feed. Without the latter, concentrate-intensive animal production is likely to be relatively inefficient. Indeed, productivity statistics reported for SH poultry producers imply high FCRs.

4.68 Large-scale production systems. China has a growing number of large-scale, commercialized pig and poultry operations, mostly in the suburbs of major cities, to serve urban or export markets. These operations employ confined feeding systems and modern production technology with varying degrees of success. As relatively new enterprises, local management in some cases is inexperienced and a few joint ventures with overseas interests are being organized. One concern of the Government is that expansion of these suburban activities may not adequately tap rural savings and entrepreneurial talents.

53/ Statistics on rabbits are grouped together with poultry statistics in China. Rabbits are of growing importance, particularly in North China. Exports of rabbit fur and frozen meat totalled US$ 161 m in 1982. Growth of the export market for these products may be slowing and future expansion will require increased acceptance by consumers at home and abroad.

4.69 Each of the production systems above appears to have particular advantages and possible problems. The small-scale household production system will continue to be an important source of cash income and dietary protein in rural areas. This system can continue to utilize low value feeds and family labor in meeting household requirements of animal products. Efforts should be made to provide these households with improved breeds, protein feed and mineral supplements, veterinary services and other support services to foster efficiency. Nevertheless, this system is likely to remain essentially non-commercial in character, depending for its viability on the availability of small amounts of grain, household wastes and roughages to meet feeding requirements.

4.70 The major increase in meat production from nonruminants is likely to come from concentrate-intensive production systems, i.e. the SH and larger-scale confined feeding systems. A major factor will be the need to extend new production technologies and provide supplies of balanced feeds. This can be done more readily to relatively small number of commercial producers than to a large number of dispersed households, each with a small number of animals. Other factors may favor smaller-scale production. Although at present efficiency in the infant SH sector is less than optimal, experience in other countries suggests that private commercial operations of limited size tend to be more efficient than larger state-run enterprises.[54/] This may also be true in China. On state farms in Jiangsu Province, for example, the ratio of breeding sows per employee is low compared with many other countries and lower than in collective or individual households.

4.71 It would be useful to re-examine the incentives for producers in these production systems. Low pork:feed price ratios suggest that some adjustment in the price of live hogs relative to grain may be required, at least for SH and larger-scale producers. Consideration should be given to dismantling the present feedgrain control system and replacing it with a market-oriented system to encourage adequate supplies of grain and protein supplements. Attention could usefully focus on the transportation and distribution system for feed, the development of a modern feedmilling industry, adequate veterinary services, improved processing and cold storage facilities, and extension work to improve SH understanding of animal nutrition and management practices.

4.72 Breed improvement work also is a requirement. While local breeds of pigs and poultry are typically disease resistant and adaptable to low quality

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54/ The experience of Yugoslavia may be instructive. In that country, it is generally accepted that livestock production in the private sector is more economical than public sector production. Major reasons include: (1) substantially lower investment costs per incremental animal or bird in the private sector because of lower building costs associated with greater use of home produced materials; (2) lower feeding costs because most of the feed is home grown; and (3) lower labor costs because of overstaffing in the public sector. These differences have been confirmed by the experience of a World Bank-supported dairy project in Yugoslavia.

feeds, they are not efficient converters of balanced, high-energy rations. Among the breeding problems which require solution are the need for leaner breeds of pigs to satisfy changing consumer demands and broiler or dual purpose chickens with improved feed conversion efficiencies. Research on breed improvement in pork should develop selection criteria and procedures for genetic improvement and establish objective measurements for desirable traits. Price differentials favoring leaner pork and younger meat birds would encourage producers to expand output of these types of pigs and poultry.

4.73 Feed for Nonruminant Animals. As noted in Chapter 2, a major determinant of future production of livestock products will be the availability of adequate supplies of high quality protein for animal feeding.[55/] Protein quality refers primarily to protein sources which are high in the amino acids required for good animal nutrition and which do not contain antinutritive substances such as gossypol in cottonseed meal or glucosinolates in rapeseed meal. The rapid growth in oilseeds production in recent years has been encouraged primarily to satisfy human demand of edible oils. Production of oilseeds valuable in livestock feeding, such as soybeans, appear to have been given less emphasis. The current emphasis on livestock production requires a reconsideration of this approach.

4.74 In order to minimize FCRs, rations for pigs and poultry should contain 16-20% protein, with an appropriate amino acid balance. Lysine, methionine and cystine are the most limiting amino acids in pig and poultry nutrition. Amino acid and crude protein content of various oilseeds are indicated in Table 4.7 and compared on a per ha basis using present Chinese crop yields and oil extraction rates. Soybeans, while yielding less edible oil, provide more lysine and as much methionine and cystine per ha as other oilseeds. Moreover, the amino acid balance is close to that required by pigs. Other oilseeds compare less favorably.

4.75 Protein requirements of pigs and poultry (broilers and layers) are estimated in Table 4.8. Poultry generally require about equal amounts of lysine and methionine plus cystine, whereas optimal swine nutrition implies a lysine content about 60% higher than methionine plus cystine. Given the projected increase in demand for edible oils, pork, poultry meat and eggs between 1980-82 and 2000, the amounts and types of oilseeds can be roughly estimated which satisfy requirements for high-protein feed at least "cost", i.e., in terms of sown area required for oilseeds. Based on analysis in Chapter 2, the increments in annual demand (1980-82 to 2000) are assumed to be 2.4, 16.1, 11.7, 6.0 and 5.5 m tons, respectively, for cotton lint, pork, poultry meat, eggs, and edible oils. These incremental demands for meat and

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55/ In 1980, about 820,000 tons of mixed feeds were produced in China (2% of feed grain supplies). Of this amount, only 30,000 tons reportedly were "balanced" in the sense of containing the proper balance between energy and protein sources.

Table 4.7: FOOD AND FEED VALUE OF VARIOUS OILSEEDS, CHINA, 1981, PER HECTARE

	Rape-seed	Soy-bean	Sunflower seed	Sesame seed	Shelled peanut
Crop yield (tons)	1.07	1.16	1.28	0.62	0.99
Edible oil yield (%)	33	12	20	45	25
Yield (kg/ha) of:					
Edible oil	31	14	26	28	40
Crude protein /a	25	45	43	14	27
Lysine /a	1.5	3.0	1.7	0.4	0.9
Methionine + cystine /a	0.8	1.4	1.4	0.6	0.9

/a In oilseed meal only.

Sources: Mission estimates based on official crop yield data and international standards of oil, protein and amino acid content.

eggs translate into an increase in annual slaughter in 2000 of about 300 m pigs and production of more than 8.2 billion layers and broilers. In this analysis, the "minimum cost solution" to the feed problem is estimated to require production of about 18.6 m, 8.3 and 4.2 m tons of soybeans, rapeseed and cottonseed, respectively, to provide a feed concentrate of which 18% is made up of high protein meal and 82% is comprised of an energy source such as corn. Cottonseed is used because of its ready availability as a byproduct of cotton lint production. This also assumes that all additional supplies of cotton seed meal and rapeseed meal would be suitable for livestock feeding through, e.g. chemical treatment (e.g., adding iron sulphate to bind the gossypol in cottonseed) or plant breeding (producing nontoxic varieties of rapeseed). Soybean production in 2000 of 18.6 m tons at current yield levels would require 16-17 m ha of soybeans, as compared with 8.8 m ha in 1982. The important point is not the quantities (which are orders of magnitude at best), but the desirability of expanding soybean production as one of the most economical sources of high quality protein meal. Expanded production of soybeans, combined with greater use of rapeseed and cottonseed meals, should be considered as one of the major options for meeting the high-protein feed requirements for increased pig and poultry production. Production of appropriate types and quantities of oilseeds to satisfy incremental requirements of high protein feeds would, ipso facto, provide sufficient edible oil to meet projected demand. On the other hand, if increased oilseed is planned with only human requirements in mind, availability of high protein feeds would fall short of projected needs.

Table 4.8: APPROXIMATE PROTEIN REQUIREMENTS PER ANIMAL OR BIRD FOR EFFICIENT PRODUCTION OF PIGS, POULTRY AND EGGS /a

	Pigs	Poultry	
		Broilers	Layers
Weeks to slaughter	22	8	66
Liveweight (kg)	75	1.9	1.8
Dressed weight (kg)	56	1.4	1.4/b
Egg production (kg) /c	-	-	11.0
Total feed requirement for:			
Crude protein (kg)	30.0	0.9	6.9
Lysine (kg)	1.3	0.05	0.28
Methionine + cystine (kg)	0.8	0.05	0.24

/a These figures are rough estimates computed from recommended diets based on a combination of high-energy feed such as corn and a good protein source such as soybean meal.

/b 1.07 kg on an annualized basis, since the full production cycle is 66 weeks.

/c Assuming 50 gm/egg and 220 eggs/year.

Sources: Mission estimates based on international standards.

4.76 An alternative option involves use of commercially available synthetic amino acids, such as synthetic lysine, to permit replacement of soybean meal with oilseeds which may be available, but which have less favorable amino acid balances. The economics of importing synthetic amino acids or producing them domestically, compared to imports of soybean meal or other protein supplements, require further study. In both options, rapeseed meal also appears to be a logical candidate for increased use as a source of high protein meal. Wider use in China would require the introduction of rape varieties developed elsewhere which do not contain substances toxic in pig and poultry feeding.

4.77 Regional Trends. The regional distribution of animal production has changed as a consequence of recent price and institutional reforms (Map 5 and Annex Table A.5). In general, the poor provinces, which were first to implement the BGDH system, have a growing demand for draft animals, reflected in increased stocks of large animals and sometimes corresponding declines in numbers of sheep, goats and pigs. Better prices for pigs and poultry products may have contributed to the declining numbers of sheep and goats in all except the pastoral regions of the northeast and northwest. Only in the northeast do pasture conditions appear to permit significantly increased herds. Pig inventories have been reduced in all but the south and southwest, but faster

and heavier fattening have led to increased meat offtake. Consequently overall red meat output has increased in almost all southern and a few northern provinces. Increased poultry numbers are probably a universal phenomenon, but survey or enumeration data to document this have not yet been published.

4.78 Among livestock and poultry products, pork will continue to dominate and production is likely to be concentrated, at least in the medium-term, near consumption centers. If storage, handling and transport facilities for livestock products could be improved, more meat production would be expected to move nearer the production centers for feed grains and protein meals. Because of strong consumer demand, much of the incremental production of fish, eggs and broiler meat is likely to take place near urban areas in SH or larger-scale production systems. A similar pattern is likely for dairy products, although economic arguments favor production and processing in areas more distant from consumption centers where adequate grain and forage supplies exist. Many of China's grasslands are deteriorating from overgrazing and wind erosion. The potential for increased production of meat and wool on a sustained basis is not promising and many such areas are likely to experience declining production unless ameliorative measures are taken.

Aquatic Products

4.79 China's aquatic products sector (marine and freshwater) accounts for only about 1.5% of GVAO. China's fisheries rank third internationally in total production, but 100th in per capita production. Production in 1983 totalled about 5.3 m tons, of which, more than two-thirds was accounted for by marine capture fisheries. Between the 1950s and mid-1960s marine fisheries grew more rapidly than freshwater fisheries. However, equipment limitations confine China's fishing fleet to coastal waters which have been seriously depleted from overfishing. Expansion into deep sea fishing in competition with other Pacific fleets would require large budgetary resources which the Government seems reluctant to commit. Fresh water fish culture lately has been the most rapidly growing part of China's fisheries sector. Production of freshwater capture fisheries has stabilized at a level of about 0.3 m tons in recent years, or only about half as high as production of several decades ago. Although over fishing and water pollution have contributed to the decline, the single most important factor has been the large reduction of water surface available for capture fisheries.[56/]

56/ Much of this loss results from the drainage of shallow bodies of water and conversion to farmland. Of the three largest lakes in China, Dongting Lake has lost two-thirds of its water surface in the last two decades while Po Yang and Tai Lakes have lost about one-half and one-tenth of their surface area, respectively. These developments appear to have reduced the buffering capacity of lakes in regulating river water. Continued conversions of lakes into farm land or ponds would expose surrounding areas to increasing risks of floods.

4.80 The Government plans to expand aquatic products output from the present 5 m t to 11 m t by the year 2000 by emphasizing intensive fish cultivation, particularly in freshwater ponds. The proportion of fish cultivation (marine and freshwater) in total output is expected to increase from the present 40% to nearly 70% by 2000. With these growth rates, output from aquaculture would grow by about 250%, while capture fisheries would grow little, if at all. The Government is expected to continue to provide funds to upgrade China's ocean-going fleets, but increased shares of these resources are expected to go to freshwater and marine fish culture. Some expansion of marine fisheries is expected on the basis of joint ventures with overseas interests. Much of the investment in freshwater fish farming is likely to come from local funds.

4.81 Sources of future growth are expected to include utilization of presently unproductive water surfaces, conversion of areas of low-lying land to fish ponds, and higher yields in existing fish farms. It is reported that only about 60% of the potential freshwater area and 12% of the potential saltwater area are currently utilized in fish productin. Of the five million ha of fresh water surface considered suitable for fish farming, less than one m ha are now utilized for this purpose. Opportunities are good to narrow the gap between average yields in pond cultivation (0.8 t per ha) and those on better farms (3.8 ton per ha or more). This gap could be closed with sufficient investment, improved management, increased inputs and known technology.

4.82 In general, much of the fish farming area is not intensively managed (i.e., with appropriate levels of productive inputs). National surveys which distinguish between intensive and extensive fish farming indicate that in 1979 operations which were intensively-managed averaged 4.8 t per ha with production costs of Y 680 per ton, whereas the extensively-managed farms averaged only 0.7 ton per ha with costs of Y 590 per ton. Factors which contribute to poor economic results and low yields include: (a) poorly-designed pond layout, with a lack of water supply and control structures which would permit independent filling and draining of individual ponds; (b) overbuilding of dikes or unnecessary use of costly cemented stone walls; (c) insufficient depth of ponds; (d) inappropriate breeds of fish or stocking rates; and (e) poor feed management, such as the tendency to supply manure infrequently, in large amounts, and to localized areas of ponds.

4.83 In the past, low and fixed procurement prices for fish have provided little incentive to improve productivity. Recent price adjustments and policy changes have improved the profitability of fish farming in some areas, primarily because a higher proportion of production can be sold on the free market or at negotiated prices. Emphasis on integration of livestock or poultry production with fish farming has increased the availability of manure for fish feeding. Table 4.9 suggests the potential of fishpond improvement projects in the present economic environment, if investment is accompanied by better management. Investment costs per ha of fishpond or per ton of product are high, but these appear to be matched by high incremental returns. Loan financing of these investments, with repayment in 5-10 years, appears to be feasible.

Table 4.9: INDICATIVE COSTS AND RETURNS OF FISHPOND IMPROVEMENT /a

	Hubei	Guangxi
Investment Costs (Y)		
Per ha fishpond	6,400	12,200
Per ton increased annual product	3,500	4,900
Material Inputs		
Cut grass per ton of product (tons)	30	22
Pig manure per ton of product (tons)	8	6
Incremental net revenues per incremental ton of product (Y)	1,300	1,200

/a Estimated from World Bank appraisal of fishpond improvement subprojects as part of the Rural Credit I Project.

4.84 The feeding of concentrate to fish may not be profitable in China in most circumstances.[57/] Where possible, fish farming may be usefully combined with livestock or poultry raising in which manure from these operations and grass cut from nearby lands are the major feed sources for the fish. On average, each 1.5 tons of fish produced require approximately the manure from one pig and the grass yield of one ha. Much of this grass traditionally has come from the banks of dikes or other underutilized or waste lands. With much larger volumes required in expanded production, these sources would no longer be adequate. If all of the planned increase of 5.8 m t of aquatic products in 2000 were to come from improved yields for such freshwater fish farms, total investment requirements might be about Y 23 billion and annual input needs would absorb a season's grass/forage production of 3.9 m ha and the manure from nearly 4 m pigs.

4.85 Aside from fish farming, there may be scope for improvement in freshwater capture fisheries. Compared to fish farming, fish yields per ha are extremely low at present. But operational costs also are low and the largest part of the unexploited water surface is suitable only for capture fisheries. Problems and solutions seem similar to those of managing any common resource. It is necessary to place authority over suitable bodies of water in the hands of authorities responsible for fisheries development, strengthen control to prevent destruction of the resource (such as fish dynamiting or pollution), organize stocking, restore specialized fishing teams, establish clearly-defined fishing rights in particular areas, and provide adequate equipment (including ice for preservation and trucks for delivery to markets).

4.86 There is a clear understanding in China of the problems of marine fisheries and of the measures required to protect and develop these resources. Necessary measures include controlled exploitation, based on yet-to-be completed surveys of existing resources and the establishment of an administrative structure and facilities for enforcement; control of industrial pollution in bays and estuaries; and upgrading of fishing fleets with cold storage and processing equipment.

57/ The efficiency of feed conversion and feed costs are important considerations. With good management, an FCR of about 2.3 may be realized in freshwater fish culture. If the feed cost is Y 0.40/kg (US$200/ton), it would take 2.3 kg of feed costing Y 0.92 to produce one kg of fish. Adding the cost of fingerlings of Y 0.07-0.08 gives a total cost of Y 1.00 per kg of fish produced. If the fish price is Y 1.20/kg, it is likely to be difficult to cover costs of labor, utilities and capital investment. Reported prices for fish feed in 1984 ranged from about Y 0.28/kg in Shanghai (where the municipal government provides a subsidy of Y 0.20/kg of feed) to Y 0.52 in Nanchang. Although concentrates will be required in the production of fingerlings, fish yields in fresh water culture of 2-5 tons/ha, as assumed by Government in the Year 2000, can probably be achieved through good management and the use of grass and manure as nutrient sources.

4.87 Fish consumption at present is highly localized because of inadequate processing, cold storage and refrigerated transport facilities in areas outside of major production zones. Present development plans emphasize supply to major municipalities and development of a few large production bases. This poses something of an equity problem, viz., the production, frequently subsidized, of fish for a relatively well-to-do urban population. In the future more emphasis is warranted to improve the physical infrastructure in order to make high-quality fisheries products available to a larger share of the population. Estimates of consumption demand in 2000 (Chapter 2) suggest that present targets for production of aquatic products may not satisfy potential future consumer demands at the national level. On the other hand, production might well exceed demand in, or near, major producing areas.

4.88 Other investment priorities can be identified. In view of the protein shortages for livestock feeding, development is warranted of facilities to produce fish meal from processing wastes and trash fish.[58/] Our understanding is that the current goal of 100,000 tons of fish meal in 2000 would primarily utilize processing wastes of commercial fisheries. Additional consideration should be given to expanding the collection and processing of fish species now considered to have little economic value. One example may be the largely untapped anchovy (Engraulis) resource on China's continental shelf as the basis for expanding fishmeal production.

5. OPTIONS AND ISSUES

5.01 Between the present and the turn of the century, China's agriculture will be required to feed at better nutritional levels a population growing by at least 10 million per year and to supply the raw materials to meet rapid growth in industrial demand. It will have to provide remunerative employment to part of a rural labor force likely to grow considerably more rapidly than the total population. This will be a challenging task. At best, the land area under cultivation will not increase and could well decline. Similarly, the cropped area is likely to remain at present levels as land reclamation and irrigation development are approximately offset by lands converted to non-agricultural use. Competition for water supplies in some parts of China between agriculture, industry and human consumption will increase and make agricultural expansion more difficult. The production gains required to feed another 160 million people or more at higher nutritional levels will have to come almost entirely from increased yields on presently cultivated land. This will require more intensive production systems and a more comprehensive range of services and input supplies.

58/ However, the amount of processing wastes may be relatively small. Many of these materials such as head, roe, intestines, liver and stomach, are considered delicacies in China.

5.02 Despite these constraints, China's relatively favorable food situation, its agricultural diversity and the strength of its rural institutions permit it to pursue a somewhat wider range of options than in a situation where the overriding concern was to provide minimally adequate supplies of basic foods from a poorly-developed agricultural sector. The general direction of development is clear. It will involve efforts to shift resources into activities: (1) which are less constrained by fixed resources (land and water); (2) for which improvement of management and labor skills has a high pay-off (specialty crops, modernization of livestock and poultry production); and (3) for which the gap between existing and advanced technology is greatest (agro-industrial production). But within this framework, there are many important questions and policy options regarding speed, product mix, resources needed, and other means of implementation.

5.03 It may be argued that two decades (1980-2000) is too short a time to bring about major structural change. Indeed, development experience in a number of countries suggests that structural change in agriculture is a lengthy process. But exceptions exist and some lessons may be drawn from them. Structural change in e.g., Korean and Japanese agriculture has been striking over a roughly similar period of time (1960-80) and began from levels of development in some respects comparable to China today. It is noteworthy that these changes occurred in conjunction with declines in the agricultural labor force (excluding rural non-farm employment), and in economies more open to trade than China, but with policies which provided increased protection to the agriculture sector and which resulted in steady increases in the urban cost of living. Significantly, these structural shifts were not "planned," but were largely the responses of agricultural sectors in those countries to extraordinarily rapid growth of industrial output and nonagricultural employment. More generally, there is a close connection - with causation running in both directions - between rapid growth of the non-farm economy and rapid structural change in agriculture.[59/]

59/ In projecting possible development paths for Chinese agriculture, discretion is required when comparing geographically small countries with relatively homogeneous agricultural sectors (Korea and Japan) with China. Important similarities and differences exist. The three countries share the attributes of high population densities with regard to arable land (Appendix Table A.13), declining population growth rates and high crop yields in the base years (the early 1980s for China; 1960 for Korea and Japan). A key difference is a base period industrial growth rate in Korea and Japan which was twice that in China in 1980 (Appendix Table A.14). This was a strong inducement to pull labor out of agriculture and permit rapid increases in agricultural labor productivity. Farm labor productivity (GDP/worker) in China today appears to be approximately equal to that in Korea and Japan in 1960. In the 1960-80 decade, farm labor productivity in Korea and Japan rose 6-fold and 20-fold, respectively. In 1980 agricultural labor productivity in China was about equal to that in India, but only about half as high as in Indonesia, Pakistan and Thailand (Appendix Table A.15) Over the 1960-80 period, labor productivity in Indian agriculture grew by only 0.5% p.a. (see P.R. Brahmananda, Productivity in the Indian Economy, Himalaya Publishing House, Bombay (1982), p. 47.

Projections of Agricultural Growth

5.04 Government Objectives. The overall development objective of the Government is to improve consumption levels through a major structural change in agriculture, although projections for major crops are not fully consistent with this assumption. Nor is it apparent that the non-farm rural economy can expand fast enough to permit the envisaged steady decline (relatively and absolutely) in the agricultural labor force. Preliminary planning by the Government calls for rapid growth in livestock, poultry and sideline production and a relative decline in the crop share of GVAO by the year 2000 (Table 5.1). The farm labor force would decline sharply, while the rural non-farm workforce would rise extremely rapidly. Under these projections, the share of rural workers engaged in agriculture would fall from 94% in 1982 to about 55% in 2000, a decline which is rapid, but not unprecedented.[60/] If the projections of MAAF's Planning Bureau are realized, the total area sown to grain would remain unchanged, although wheat and rice production would grow slightly less rapidly than coarse grains and corn would become relatively more important than other coarse grains, soybeans and pulses. Similarly, no significant increases are planned for areas planted to nongrain crops, although yields are expected to increase and regional production patterns of these crops would continue to adjust on the basis of comparative advantage.

5.05 Projections of Potential Growth [61/]. Assuming a continuation of present policies, growth of agricultural production (excluding sidelines) between 1980-82 and the year 2000 is likely to be more rapid than long-run historical growth rates. Structural change, characterized in recent years by a declining share of crop production in total GVAOR, is also likely to be more rapid, though probably not so rapid as indicated by Government supply targets or consumption demands under targeted income growth. The limits to the rate of structural change have less to do with diminishing returns in crop cultivation than with constraints on financial resources, incentives, and external trade.

5.06 The projections in this section are of potential growth; they are not predictions. They are estimates of the rate of long run performance of domestic supply attainable if Government policies are broadly favorable; in fact more favorable than they have been in the past. They are internally consistent insofar as growth estimates for economic aggregates can be derived from plausible growth rates of component products. Relationships between sub-sectors and gross and net measures are consistent with present and projected

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60/ In the 1960-80 period, agriculture's share of the total labor force declined from 66% to 34% in Korea and from 33% to 12% in Japan. In 1980 India's agricultural labor force accounted for more than 65% of the total work force.

61/ Additional projections of agricultural production, consumption, employment and trade made with an economy-wide model (but with less detail within agriculture) are discussed in Chapters 2 and 3 of the main report, and in Annex D.

Table 5.1: PRELIMINARY GOVERNMENT TARGETS FOR AGRICULTURAL PRODUCTION AND EMPLOYMENT

	1982	2000	% change 1982-2000 /a
GVAO Shares (%)			
Crop production	62.8	40	-36
Livestock production	15.5	25	+61
Forestry	4.1	4	-51
Fisheries	1.7	3	+77
Sidelines	16.0	28	+88
(Of which CBE)	(11.6)	(n.a.)	
Grain Production (mln tons)			
Wheat	68.4	99	+2.6
Rice (paddy)	161.2	208	+1.8
Corn	61.0	98	+2.6
Others	62.8	75	+1.2
Total	353.4	480	+2.0
Rural Labor Force (mln) /b			
Agriculture			
Crop production	n.a.	150	
Other including ag. sidelines /c	n.a.	100	
Subtotal	304	250	-18
Nonagriculture			
Collective sector	} 31	120	
Private sector	}	40-50	
Contract labor	6	30-40	
Subtotal	37	200	+439
Total	341	450	+32

/a For grain production, refers to average annual growth, 1980-82 to 2000.

/b Excluding state farms (4.9 million), salaried staff (8.1 million), and collective labor in public service activities (6.2 million).

/c 1982 statistic excludes brigade enterprises; 2000 includes only labor in livestock, fisheries and forestry.

Source: Planning Bureau, MAAF; 1983 Statistical Yearbook, pp. 120-21,148, 153, 158, 202 and 206.

input-output relationships, and estimated relationships between aggregate outputs and aggregate inputs conform to economic logic. However, these supply projections are not necessarily fully consistent with consumption projections. The estimates of potential growth rates for output assume that the rapid growth of GVAOR since 1980 (8% p.a.), reflecting price and institutional reforms, cannot be sustained, but have brought levels of agricultural production close to maximum potential at present input levels. However, with favorable Government policies, growth rates could continue to exceed historical levels.

5.07 The performance of crop production is a fundamental factor. Growth of crop production value is unlikely to greatly exceed the 3.7% p.a. achieved in 1965-83, but to sustain rapid growth of livestock production, it is crucial that the production of feedgrains, notably corn, soybeans and certain other miscellaneous grains, grow much more rapidly than foodgrains such as rice and wheat. Potential annual growth rates of grain production (including tubers and soybeans) would be about 2.4% and non-grain crops 6.8%. Among grains, the MAAF target growth rates for fine grains seem feasible if there is little change in crop areas, but corn, miscellaneous grains and soybeans would have to grow more rapidly. The annual growth rates of various grains required to meet livestock production targets are compared below with historical rates of production growth:

	1965-83 Actual	1980-82 to 2000 Required
	%	
All grain	3.9	2.4
Rice	3.7	1.8
Wheat	6.7	2.6
Tubers	2.2	-10.2
Other	3.1	4.2

Non-grain crops would be required to grow at annual rates exceeding historical levels by 1-2 percentage points (e.g. cotton 5.6%, oilseeds 7.9%, sugar 8.6%, and fruit 9%), with differences reflecting differential consumption elasticities and competition from industrial products.

5.08 Other components of GVAOR are less subject to diminishing returns because of the land constraint, and their growth rates will be determined by the extent of Government and private investment in these subsectors, including support services, as well as the availability of feed supplies from either domestic or imported sources. Assuming a 4% annual growth rate in crops suitable for feed use and no feed imports, the following compares average growth

rates in GVAOR between 1980-82 and 2000, the lower growth rates required in 1983-2000 in view of recent achievements, and the historical growth rates in 1965-83:

	Cultivation	Livestock	Forestry	Fisheries	Total
	% p.a.				
1980-82 to 2000	3.8	5.9	5.4	5.9	4.4
1983 - 2000	3.2	5.8	5.0	5.4	3.9
1965 - 1983 (actual)	3.7	5.4	6.8	3.6	4.1

5.09 Another way of assessing the potential growth of agriculture is to examine the relationship between major factors of production and outputs in a production function context. As cultivated area cannot be significantly expanded and farm labor is regarded as in surplus supply for the indefinite future, only the growth rates of technical progress, capital accumulation and use of industrial inputs (chemical fertilizers, energy, machine services, transport, etc.) need be considered. The assumption that government policies will remain favorable to growth may be quantified by assuming a modest rate of technical progress (0.4% p.a.), adequate investment levels in fixed and working capital (at least 8% of total investment, rising from Y 12 billion at present to perhaps Y 38 billion by 2000), moderate growth rates in the use of industrial inputs (about 5% p.a.), and improved prices for livestock, forestry and fisheries relative to crops. Table 5.2 indicates the assumed relationship between input and output in each component of GVAOR. The assumed growth rate of technical progress may be compared with estimates of 1-2% p.a. for the United States and Japan at the most dynamic stages of their agricultural growth. Projected investment levels (which do not include investment in rural industry) would require mobilization of capital fron non-Government sources, but on a reasonable scale (see Table 1.2 and para. 3.42). The average growth rate in the use of industrial inputs is modest relative to historical trends (9% in 1965-83).

5.10 Net output of the agricultural sector, whether measured as NVAOR (net value of output less sidelines) or net supply of agricultural products to consumption and non-agricultural sectors, cannot rise as rapidly as GVAOR, due to a declining net/gross ratio. The net/gross ratio will decline because of diminishing returns in crop production and increased feed requirements in livestock and fisheries. In crops, growth in use of industrial inputs such as fertilizer and energy is expected to continue to exceed output growth. In livestock, a high rate of growth will require use of a feedgrain-intensive technology (cost of feed and forage use by livestock, as a percentage of livestock GVAOR, would be about 50% higher at the margin than the present average). In fisheries, growth is expected to come entirely from fish farming and, indeed, more feed-intensive pond or estuary fish raising. At the margin, feed requirements, including grass as a nutrient source, may be about 10% of

Table 5.2: AGRICULTURAL GROWTH PROJECTIONS, 1981-82 TO 2000

	Crops	Live-stock	Fores-try	Fish-eries	Total	Per worker/a
	Y billions, 1980 prices					Y
GVAOR 1980-82	152	37	10	4	203	710
Share (%)	75	18	5	2	100	
Net/gross ratio (%)/b	78	27	17	81	66	
NVAOR 1980-82/b	119	10	2	3	134	470
Share (%)	89	7	1	3	100	
Growth rates of						
Technical progress	0.4	0.4	0.4	0.4		
Capital stock	5.4	11.0	10.0	11.0		
Industrial inputs	5.0	5.9	5.4	5.0		
Real product/c	3.8	5.9	5.4	5.9	4.4	
Output price index/d		1.0	3.0	1.0	0.5	
Net/gross ratio/e	-0.3	-0.8	5.4	-0.3	-0.7	
Year 2000						
Real GVAOR/f	307	110	27	12	457	1,390
Share (%)	67	24	6	3	100	
Current GVAOR/f	307	132	48	15	502	
Net/gross ratio/f	74	23	45	77	58	
Current NVAOR	227	30	22	12	290	
Real NVAOR/g	214	29	20	11	274	840
Share (%)	78	10	7	4	100	
Historical Growth Rates (%) /h						
1965-70	3.7	2.3	6.3	1.7	3.5	
1970-80	2.5	6.3	6.8	3.1	3.3	
1980-83	8.1	7.6	7.5	8.4	8.0	

/a Assuming 285 million farm workers (excluding labor in sidelines) in 1981 and growth of 15% by the year 2000. Government projections of a declining farm labor force are disregarded (see Table 5.1).

/b NVAOR (net value of agricultural output less sidelines) is in 1981 prices whereas GVAOR is in 1980 constant prices; here differences in 1981 and constant 1980 prices are small enough to ignore. Net/gross ratios are Bank estimates.

/c Assuming Cobb-Douglas type production functions, annual growth of product is estimated as a weighted sum of growth rates of technical progress (T), capital stock (K), and industrial inputs (I). For cultivation, the product growth equals T+0.3K+0.35I; for all others, T+0.5K. The latter is intended to approximate the effects of a capital/output ratio of 2.0. For subsectors other than cultivation, the growth rate of industrial inputs is assumed to equal that of product output, except that the proportion of industrial inputs in fisheries would decline as the share of fish farming in production increases relative to sea capture.

/d Growth rates of agricultural prices measured relative to growth of industrial goods prices. In the base case, no relative change in crop prices is assumed, but adjustments to livestock, forestry, and fishery prices would be necessary to prevent rapid decline in net/gross ratios as well as to improve relative profitability of these activities.

/e The growth rate (rate of decline) in the net/gross ratio (in current prices) is approximated as a mathematical function of growth rates of output and output prices as well as industrial and agricultural inputs and their prices. Aside from the growth rate assumptions shown, it is assumed that marginal input requirements from cultivation for livestock will be 50% greater than present average input requirements; for fisheries, they will be about 10% of marginal output value.

/f Computed from annual growth rates of output, net/gross ratios and price indices above.

/g Real (1981-priced) NVAOR computed from current NVAOR by applying a consumption price index, weighted 50% for agricultural products and 50% for industrial products (the prices of the latter being held constant as numeraires).

/h From Statistical Yearbook of China, 1983, p. 150. 1970-80 GVAOR growth rates based on adjustment to 1980 prices of components originally expressed in 1957 and 1970 prices.

output value, as opposed to almost nothing at present (on the other hand, the declining share of capture fisheries will reduce industrial input requirements). Only in forestry, where labor-intensive afforestation is likely to contribute an increasing proportion to GVAOR, is there reason to expect no decline in the net/gross ratios.

5.11 Any increases in the prices of agricultural products relative to industrial products, or of the products of livestock and fisheries relative to crops, will tend to slow the decline in the net/gross ratio. Because domestic prices of pork, beef, fish and timber are low relative to international prices and also relative to domestic prices of crops and industrial products, price increases for these products would be necessary to provide incentives to sustain the fairly high growth rates assumed for components of GVAOR other than crops. If annual relative price increases for livestock, forestry and fisheries were to average about 1%, 3%, and 1% respectively, the overall net/gross ratio may be expected to decline from 66% in 1980-82 to 58% in 2000 (56% without price changes). The rate of decline could be reduced or even arrested if the overall terms of trade of the agricultural sector were further improved, at the expense of urban consumers and/or industrial producers. Depending on the extent of income increases in the urban and industrial sectors, this improvement might be required by distribution policy to prevent deterioration of rural/urban income ratios.

5.12 Under the conditions described above, NVAOR would increase at the rate of about 3.8%, compared to 4.4% p.a. for GVAOR. Assuming a growth rate of 0.6% p.a. for the farm labor force (excluding sidelines), gross labor productivity in agriculture could nearly double by 2000, and net productivity increase by 78%. The structure of agriculture would change significantly, with a decline of 8 percentage points (from 75 to 67%) in the share of crops in GVAOR and of 11 percentage points (from 89 to 78%) in its share in NVAOR.

5.13 These projections are based primarily on supply considerations, although the directions of structural change are influenced by demand considerations. How do these projections compare with Government production targets, on the one hand, and projections of consumption requirements on the other? Such a comparison is drawn in Table 5.3, where production targets are constructed from MAAF projections of product output and GVAO shares (Table 5.1) and from the Bank's "target growth scenario" for consumption (Table 2.3). The "target growth scenario" assumes GNP growth rates of 5.5%, and population growth rates averaging 1%. Compared to the Bank's supply-side projections, the MAAF production targets involve a more modest overall growth rate, due to more conservative projections for crop production (especially for non-grain crops). However, MAAF assumes significantly higher growth rates for livestock and fisheries and thus more radical structural change. Where they fall short of demand is in growth of crops, where MAAF may underestimate the consumption requirements for industrial crops as well as the combined consumption of feedgrain and foodgrain. Indeed, net supply to consumption and non-agricultural sectors, under MAAF's projections, is likely to be lower in 2000 than in 1980-82.

5.14 The Bank's projection of potential growth of GVAOR is slightly higher than the growth rate of total supply needed to satisfy consumption

Table 5.3: COMPARISON OF ALTERNATIVE GROWTH PATTERNS /a

	Crops	Live-stock	Fores-try	Fish-eries	Total	Annual growth %	Per worker Y
	------ Y billions, 1980 prices ------						
1980-82 Actual							
GVAOR	152	37	10	4	203		710
Share (%)	75	18	5	2	100		
NVAOR	119	10	2	3	134		470
Share (%)	89	7	1	3	100		
Net supply	130	34	5	4	173		
Year 2000							
Base Case: Potential Growth							
GVAOR	307	110	27	12	457	4.4	1,390
Share (%)	67	24	6	3	100		
NVAOR	214	29	20	11	274	3.8	840
Share (%)	78	10	7	4	100		
Net supply	229	101	13	12	355	3.9	
Implied by Production Targets/b							
GVAOR	226	142	25	17	410	3.8	1,250
Share (%)	55	35	6	4	100		
NVAOR	158	31	18	15	222	2.7	680
Share (%)	71	14	8	7	100		
Net supply	128	131	12	17	287	2.7	
Implied by Consumption Requirements/c							
GVAOR	256	150	25	17	448	4.3	1,360
Share (%)	57	33	6	4	100		
NVAOR	178	32	18	15	244	3.2	740
Share (%)	73	13	8	6	100		
Net supply	152	138	12	17	318	3.3	

/a Based on projection methodology described in notes to Table 5.3. Base case presented in Table 5.3. All values are in 1981 prices.

/b GVAOR shares as implied by MAAF targets presented in Table 5.1; absolute values as derived from growth of various crops shown as CAAS targets for 2000 in Table 2.3, weighted by their approximate share in GVAOR of cultivation. NVAOR estimated through the methodology described in Table 5.3 by adjusting growth rates of capital stock and/or industrial inputs to "generate" the targeted GVAOR, assuming the same relative price changes, and deriving implied net/gross ratio growth rates to 2000.

/c GVAOR growth based on the "Target growth scenario" in Table 2.3 for products of cultivation and livestock subsectors; i.e. the requirements implied by consumption projections assuming 5.5% annual GNP growth and 1.0% annual population growth. For all other assumptions and methodology, see note b.

requirements in the year 2000. However, the structure of potential and required supply is quite different. In the Bank's projections, the value of potential crop production would significantly exceed, and that of livestock and fisheries fall short of, consumption requirements.[62/] The growth of production of rice and most non-grain crops would exceed growth of consumption requirements. A surplus of 30 million tons of rice could be produced annually by 2000.[63/] Government could respond to such a trend, as it has already with rapeseed production, by cutting prices and controlling acreage to the extent necessary. It could encourage substitution of feedgrains for rice production (or use rice as feed); or it could make an effort to develop export markets for rice and non-grain crops, exchanging surplus production for products in which supply deficits will remain, including meat, lumber and fish. Alternatively, as much as 45 million tons of feed grains and high protein meals could be imported in order to meet expected consumption demand for meat from domestic production.

5.15 Assuming that Government is successful in maintaining a high GNP growth rate, low population growth rate, and agricultural policies favorable to rapid development, this analysis suggests that supplying foodgrains sufficient for human consumption is unlikely to be a major problem in the long run. If overall supply deficits appear, they are likely to be in poultry and livestock products, or the feed grain and high-protein meal required to support their production. A challenge to government policy may be to convert China's potential for rice and non-grain crop production into increased feed supply either via external trade or a major restructuring of domestic cropping patterns, and to insure through investment and support services that high growth rates for the poultry and livestock sectors can be combined with higher efficiency.

International Trade

5.16 Planning in China continues to be premissed on basic self-sufficiency in agriculture, although it is acknowledged that trade will continue to play a role in balancing supply and demand for major agricultural products and in generating foreign exchange from the export of agricultural specialties for which China is an important supplier. However, a self-sufficiency orientation appears to conflict with the desire to satisfy a future consumption pattern more like that of a typical middle-income country. To what extent could a planned reliance on trade balance supply and demand at lower cost in terms of domestic resources?

62/ Demand for forestry products is likely to exceed domestic production for the foreseeable future under any conceivable scenario.

63/ If demand for fine grains totals 259 million tons in 2000 (Table 2.3), and production 307 million tons, a net surplus of 48 million tons would exist. Based on present consumption patterns and assuming use of part of the surplus as feed, a surplus of over 30 million tons of paddy, or 21 million tons of milled rice, would be available for export.

5.17 Emerging global developments suggest generally adequate supplies of grain on the world market during the next decade. If historical relationships between consumption and income continue, world demand for all grains would grow at 2.6% p.a. or less during the 1980s. Between 1950 and 1980, the world's population grew at an annual average rate of 1.8%, while food supplies were growing by 2.6%. One result has been the more or less steady decline in the real price of the major cereals[64/]. The world's capacity to produce required supplies of food grains and feed appears adequate at least to the end of the century. In the US alone some 50 m ha of unutilized land could produce up to 200 m tons p.a. if required. Important new production areas have opened in the Southern Hemisphere which ship to world markets well before the arrival of supplies from the North American harvest, thus reducing the need for stocks to meet inter-harvest shortages[65/]. There is no reason to believe that global food production will expand at less than the rate of the past 30 years. And while the US remains the world's largest export supplier of grain, it is a less powerful force in the market than it has been in earlier years. Alternative sources of supply, particularly for rice and wheat where the US market share is smaller, gives grain importers substantial flexibility in meeting their import requirements.

5.18 Over the next decade, overall trade in grains is not likely to grow as rapidly as in the 1970s. Factors contributing to the slowdown include increased production in a number of countries (e.g., India and China) and continued economic difficulties, particularly in countries with recent records of rapidly expanding food imports. These market fundamentals suggest that the real prices of grains will not rise appreciably over the next several years. Projections by the World Bank suggest prices (1983 dollars; FOB major exporters) in 1995 of about $327 for rice, $149 for wheat and $113 for corn. Compared with average 1976-82 prices, these prices represent declines of about 11%, 13% and 7% in the price of rice, wheat and corn, respectively (Appendix Table A.12).

5.19 Because of the large volume of world trade in feed grains, it seems unlikely that a gradual increase of China's imports of feedgrain and soymeal to as much as 45 million tons would have substantial effect on world prices. China's trading practices minimize possibilities for disruptive effects on the international market. Current imports are arranged through long-term agreements designed to be stabilizing in the event of tight markets. The national grain and oilseeds trading agency (CEROIL) demonstrated in 1983 the effective use of price strategies to provide a large degree of forward price protection. Import flows are programmed at least a year in advance on the basis of

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64/ Between 1925-29 and 1981 the real export unit value of wheat and corn (deflated by the US wholesale price index) fell by about half. Real export unit values of rice are more than 25% below levels of 20 years ago.

65/ Annual grain exports from South America (mainly Argentina and Brazil) rose from about 10 m tons in the early 1960s to 400 m tons at present. Production increases of a similar size have been achieved in the European Community.

the Government's distributional requirements which are reasonably steady. The main obstacle to increased imports would be limitations of port storage and distribution infrastructure, which could be remedied in time.

5.20 Prospects for substantially larger exports of rice are not very favorable. In recent years, several major import markets for rice have declined due to a combination of growing self-sufficiency and the tendency to substitute wheat for rice in the diet. Consequently, the world rice market, which now absorbs about 12 million tons per year, is not expected to grow to more than 16 million tons by 1995 and any sizeable additional quantities from China would likely depress world prices relative to long-term averages. However, the projected 1995 rice:wheat international price ratio is more favorable to rice than present market conditions would indicate (Appendix Table A.12). China appears to have a comparative cost advantage in rice production relative to wheat and trading limited quantities of rice for feedstuffs may continue to be an option which should be considered.

5.21 There also is potential for China to export some non-grain crops or animal products to fund feed imports. For example, China has recently turned a large import deficit in cotton into a small exportable surplus which might be continued. On the whole, the best export prospects in agriculture are likely to be for a wide variety of high-value and specialty products for which international income elasticities of demand are high. China's diversity of soils and climates suggests that a considerable range of such products could be grown. But the successful production, processing and marketing of them in international markets would require a well-developed range of support services, including research, extension, marketing infrastructure and market development. China's low cost labor in agriculture is a distinct advantage, as is its proximity to Japan and other rapidly growing Asian markets. On the other hand, prospects for rapid export expansion of many of China's traditional specialty products may be less favorable because global markets are "thin" and substantially larger exports from China would depress world prices. Tea, mushrooms, honey, hog bristles, feathers and down, and rabbit meat are examples.

Adjustments in Domestic Structure

5.22 Crops. One of the problems to be resolved is the apparent contradiction between present production trends for grains and the food requirements generated by increased incomes and changing consumption patterns. In the projections of MAAF's Planning Bureau, fine grains (rice and wheat) would constitute more than 60% of total grain production in 2000, while the requirements for direct grain consumption and animal feeding in efficient systems imply substantially smaller quantities of fine grains and more coarse grains. International trade could provide for expected feed requirements, but some adjustment of domestic production patterns would be needed to eliminate the projected rice surplus. The adjustment in domestic production might logically involve some reduction in the area planted to rice and expansion of the area under crops needed in a much larger livestock program. Corn and soybeans are prime candidates in this regard because of their efficiency in producing energy and high quality protein, but soils and climates in some areas might be best suited for other grain and oilseed crops. The potential

for further yield increases in corn and soybeans in China appears to be good, although this would require improved production incentives, better quality seeds, and larger allocations of chemical fertilizer. More production of corn and soybeans outside of the traditional areas in the North and Northeast and nearer livestock production centers in the South and Southeast would ease the transport problems which now result in marketing problems for these crops in the Northeast, while feed shortages constrain livestock and poultry production elsewhere. Cropping systems which include corn and soybeans are also agronomically preferable to rice monoculture.

5.23 One could conceive of a situation where some of the uplands of the south which now grow low-yielding rainfed rice would be converted to feedgrains and oilseeds. These products would help to support local livestock and poultry industries and perhaps supply feedstuffs to peri-urban producers near the larger cities. But such changes would not come without vigorous encouragement through adaptive agronomic research and strong extension programs. It would also be necessary to ensure a reliable supply of foodgrains to the areas which specialize in nonfood crops, although this concern would likely disappear in the presence of an effective marketing system and policies which encourage the movement of agricultural products from surplus to deficit areas in response to economic forces. Greater emphasis on corn and oilseeds would contribute to more rapid growth in grain yields by replacing low yield rice with crops with higher yield growth potential. It would allow peri-urban areas to plant higher value crops on lands now under grain and forage crops and it would provide a basis for more diversified production systems around higher value crops and livestock production in those traditionally low income areas where rainfed rice now is a major source of income.

5.24 Expanded production of nongrain crops continues to be limited by the inability of the marketing system to ensure local consumption requirements for grain and to efficiently dispose of increased commercial supplies. Yet it appears that plans for development of the transport and distribution system have not been adequately related to the much larger volumes of marketed output which would accompany the structural modernization of China's agriculture. Difficulties in transport and distribution continue to encourage administrators at all levels to plan for a considerable degree of self-sufficiency. Similar concerns over market access tend to concentrate production of perishable high-value products such as vegetables, fruit, fish and dairy products largely in the peri-urban areas, despite sharply rising economic costs of land.

5.25 Factors affecting both demand and supply suggest that China is likely to maintain its present position of basic self-sufficiency in cotton. The domestic market for textiles appears to be slowing in per capita terms and may expand at a rate more nearly approaching population growth. Exports of cotton textiles are uncertain in the face of growing protectionism and could well grow less rapidly than heretofore. Domestic production of cotton will benefit from a solid technological and resource base. In these circumstances, China seems likely to import only relatively small amounts of cotton for specialty purposes and could emerge as a significant exporter of raw cotton. Success in this regard will require continued emphasis on production and the development of cotton ginning and handling facilities which enable China to

produce exports of acceptable international standard. Particular needs will be to produce cotton bales of uniform international dimensions and weight and to provide facilities for efficient storage, handling and transport of this bulky product. Study is needed to compare the relative economic merits of further expansion of cotton production for exports or use of the land to, e.g., increase production of soybeans and coarse grains.

5.26 The surge in oilseed production in recent years, led by rapeseed, has greatly alleviated the shortages of edible oils and led to some reduction in prices. While demand for edible oils will grow steadily in response to income growth, a major consideration in oilseed production policy should be the need to increase supplies of high protein oilseed cakes and meals for livestock and poultry. The most urgent tasks in this regard are: (1) to increase soybean production and output of soybean meal which is particularly suited to swine and poultry feeding; and (2) increase the suitability for livestock feeding of rapeseed and cottonseed meal by reducing their content of anti-nutritive substances. Through research and extension it may be possible to introduce soybean varieties which can be grown over a wider range of agro-climatic conditions. Much of the work in developing non-toxic varieties of rapeseed has been done elsewhere. The task for Chinese scientists in this regard is to explore means of acquiring these materials and carry out the necessary adaptive research to ensure successful introduction into local cropping systems.

5.27 Fruits and vegetables are of future importance in Chinese agriculture for at least two reasons. Domestic demand will grow rapidly in response to income growth, and as high-value, labor intensive crops, their production offers an attractive means of creating jobs and increasing rural incomes. The major challenges lie in increasing production of the higher quality vegetables and fruit demanded by consumers and in the processing and marketing for domestic and possible export markets. It is in the processing and marketing of semi-perishables such as these that China's existing systems are most deficient and where needs for improvement are particularly pressing. There is a great need for substantially more refrigerated storage capacity as well as processing facilities to provide a high-quality product with longer shelf life. Larger exports of processed vegetables also may be possible, particularly if these are high-quality canned or fresh frozen products. The required processing and packaging technologies are new to China and export market development may be difficult. This appears to be an area where joint ventures with established foreign firms would be useful, as a source of both technology and market access. Larger exports of fresh fruit also may be possible, although improvement of product quality and packaging would be required.

5.28 Livestock. Central planners have posed ambitious targets for meat production in 2000 and the Government has recently taken several steps to encourage more rapid development of the livestock and poultry sectors. A key question is whether these targets are consistent with likely future supplies of grass and feed, the weaknesses of the transport, processing and distribution systems, and the availability of investment funds. Beef and mutton production, which depends primarily on pasture resources, is projected to expand at a rate which approaches 14% p.a. However, China's pastures for the

most part are seriously overgrazed and it is unlikely that they can provide additional meat and wool in the short run without further deterioration. At present, little effort is being made to restrict herd growth, and modern techniques of range management are not well-understood and applied. Meat and wool production from the traditional pastoral areas do not seem likely to increase much in the next several years.

5.29 The potential for increased production from ruminants in the agricultural (non-pastoral) areas or through development of the southern pastures also appears to be limited. Feed and forage supplies again appear to be major constraints. Most crop residues are already well-utilized and generally of limited suitability in high performance livestock systems. The strong demand for draft animals reduces the attractiveness of producing animals for meat and a declining trend in sheep production has been noted in the southern provinces. Increased cultivation of forage crops conflicts with other crop demands for land in many areas and the area suitable for economic development of pasture is likely to be less than current estimates.

5.30 Based on current trends, underlying production technologies and policies, prospects for pig and poultry are more favorable, but hinge importantly on increased supplies of high quality energy and protein feeds. The historical relationship between pork production, grain retained in the rural areas and pork:grain prices suggests that an annual growth rate of over 3.0% in pork output is sustainable if grain retained in the rural areas grows no faster than grain production.[66/] Poultry production has received less development emphasis historically, but favorable prices suggest that poultry meat and egg output could grow more rapidly than pork production if feed supplies are available. For both pork and poultry, modern production systems, based on improved management and feeding practices, would provide the basis for expansion. Moves in the right direction are being made, such as the encouragement of SHs and initial steps toward development of a feed milling industry. This industry would require much larger amounts of grain as raw material, yet growth of coarse grain production is projected to be slower than that of high value rice and wheat. High protein oilseed meals are underpriced, often used as fertilizer and seemingly given inadequate attention in long-term planning. Production incentives favor cereals, rather than soybeans. The South, where pig and poultry raising is concentrated, lacks corn and soybean meal, whereas the Northeast has difficulty in disposing of its surpluses. Doubt also remains as to whether price relationships between feed concentrates and pork are sufficiently attractive to stimulate private investments in pig production based on grain-intensive feeding systems.

5.31 A solid technological base exists to expand pork production. The genetic quality of the animals and management systems generally are better than those in poultry, beef or dairy production. The biggest need is to develop the support system (feed supplies, veterinary services, processing and

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66/ With constant relative prices, the elasticity of pork production with respect to retained grain is about 1.5 in China. The price elasticity of pork supply appears to be about 0.9.

marketing) for the much larger levels of production which are envisaged. The problem with feed supplies is that total quantities are likely to be inadequate and not available in the areas where pork production is concentrated. Most of China's coarse grains and protein meals are grown in the North. If the current spatial distribution of coarse grain and meat production were maintained, the nine southern provinces would require at least an additional 50 m tons of feed grains in 2000 under the efficient feeding scenario discussed in Chapter 2. Current production of coarse grains and tubers in these provinces is less than 20 m tons. Looking only at pork, which accounts for nearly 95% of China's red meat production, about two-thirds of the hogs are in the East, Central, South and Southwest regions. These regions produce just over half of the country's coarse grains and tubers and less than half of the soybean meal. The northeast region (Liaoning, Jilin, Heilongjiang) accounts for 40% of the soybean meal and 29% of the corn, but only 8% of the hog population. These locational problems might be remedied in several ways, all of them requiring substantial capital investment: (1) by encouraging more pork production in the North, with corresponding increases in north-south transport capacity for refrigerated livestock products or live animals; (2) by increasing north-south movements of coarse grains and meal, possibly by waterborne coastal transport; and (3) by exporting rice from the South and importing coarse grain in the feed grain deficit areas.

5.32 Growth in per capita consumption of pork may be expected to slow in some of the higher-income urban areas along the eastern seaboard where intake levels are already high and supplies are abundant. In these circumstances, shipments of excess supplies to nearby export markets may be more profitable than shipments to inland markets. But in order to meet sanitary requirements of larger export markets, the industry will have to improve the hygenic standards and efficiency of slaughtering and processing facilities. Higher domestic incomes also will stimulate demand for a wider range of processed meats and the growing demand for lean pork suggests the need for an improved system of grading carcasses which rewards producers of lean pork with higher prices.

5.33 The Government's ambitious plans to increase per capita supplies of milk are based largely on the establishment of modern dairy farms in suburban areas and elsewhere where adequate feed is available. Prices for fluid milk have been established at levels which substantially exceed international prices for similar products and large sums have been provisionally allocated for investment in the dairy industry. Government targets have surpassed the earlier goal of insuring that dairy products are available for the young, the sick and elderly populations of the larger cities. In light of the very high investment costs required, it is worthwhile to reconsider the objectives and means in China's dairy development program. Production in suburban areas is increasingly handicapped by high land costs and the scarcity of abundant forage. Even with high milk prices, some of these operations appear to be nonviable in financial terms. Increased milk supplies for urban consumers might well be provided at lower economic costs through the importation of milk powder for reconstitution, or increased production of soy milk. The use of small-scale manufacturing plants would permit the decentralization of production and make this product more widely available.

5.34 Experience in other countries suggests that dairy production costs of individual households are frequently lower than those of state enterprises. This is also likely to be true in China. Greater emphasis on the SH as sources of dairy products seems warranted. This will require measures to ensure that such groups have access to improved milking stock, good veterinary services and high protein feed sources to supplement the grain and milling by-products of the SH. The existence of an artificial insemination network throughout much of China's potential dairy areas suggests that dairy stock could be improved in a relatively short time. Upgrading of local stock through use of high quality domestic or imported semen is likely to be preferred on technical and economic grounds to large-scale importation of female stock.

5.35 Compared with the pork industry, the technological base for poultry development in China is considerably weaker and, until recently, little emphasis has been given to research and development work in poultry breeding, management and nutrition. China's poultry industry should be accorded high priority as a means of increasing supplies of animal protein for the human population, particularly in the rural areas where consumption of animal protein remains relatively low. Poultry are efficient converters of feed to high quality protein and poultry meat is a preferred meat among Chinese consumers. While some economies of scale exist in modern broiler and egg production, the technology is "divisible" and can be carried out on a small scale, thereby permitting production by families with limited capital and land. Individual households should also be encouraged to improve production efficiency with the use of improved breeds, good veterinary services and adequate protein feeds to supplement locally available grain. But most of the commercial production for urban consumption is likely to come from SH and other larger scale production units. Producer prices for poultry products are attractive and production would probably expand rapidly if the requisites of reliable supplies of reasonably priced feeds and improved stock were readily available and if the support systems in terms of veterinary services and processing facilities were improved. The technology of modern poultry production, including high performance broiler and laying stock, is readily available internationally and easily transferable. Vigorous efforts should be made to bring this technology into China, make it widely available, and develop the technological and infrastructural base necessary to support a modern poultry industry.

5.36 Opportunities in ruminant production center on the recovery and increase of pasture productivity. An obstacle is that herdsmen must reduce their herd sizes while attempting to maintain or improve their income levels. It is doubtful that pasture and breed improvement programs alone could succeed without temporary reduction in grazing pressure (and vice versa). The extent of necessary herd size reduction cannot be determined until reliable surveys of pastureland conditions have been carried out, which should be the starting point of any improvement program. Both national and local officials responsible for animal husbandry need to understand the importance of "range management", which is based on the principle that animal numbers should not exceed the carrying capacity of the rangeland.

5.37 The critical problem is to create incentives which will induce voluntary reduction in animal numbers. Perhaps the most effective measure would be a differential procurement price policy strongly favoring young, healthy animals of improved breed. If Government subsidies are required, it might be preferable to support such a price policy rather than invest directly in pasture improvement. It appears that investment in pasture development in the south and northeast, where environmental conditions are most favorable, would be more economical and effective than investments in the traditional pastoral areas of the north and west.

5.38 Fisheries. With a reasonable amount of investment, and current emphasis on freshwater fish cultivation, the physical infrastructure required to more than double aquatic product output over two decades can be put in place. The major constraints are likely to include the supply of feed at prices which make fish culture economically viable. In most circumstances in China, fish raising appears to be most attractive financially if it is based on manure and grass as major sources of feed nutrients. But the location of fish ponds now is typically determined by contiguity to an urban market, where there are attractive alternative uses for manure (as fertilizer) and land (for vegetable production). Ultimately, growth of fresh water fish culture may depend on the growth of modern, suburban livestock enterprises which themselves are problematic on economic grounds.

5.39 Forestry. Much of the planned growth in forestry over the next two decades will take place through afforestation and the development of forest industries. Both are high priority activities, but it should be recognized that afforestation will be reflected largely in the expansion of inventories of immature trees, with little or no increments to financial income in the short run. The expenditures proposed would absorb a significant proportion of public investment in the agricultural sector. Financing of these long-term investments is likely to be a continuing problem. Much of the cost of afforestation would probably have to come through investment of rural labor with little or no immediate compensation. Many of the areas most suitable for afforestation provide few alternative sources of income to sustain a livelihood until the trees mature. Unless additional income can be generated, the incentive to cut prematurely or prune destructively for fuelwood, rather than conserve until maturity, will be very strong.

Geographic Differentials and Income Distribution

5.40 Income differences may be decomposed into urban/rural and intra-rural differentials. The latter in turn may be considered to combine geographic or interregional differentials (controlling for interpersonal differences), and interpersonal differentials (controlling for geographic differences). Urban-rural differentials, which historically have been a major focus of political attention in China, reflect the relationship between overall farm productivity, price and procurement policies on the one hand and urban wages, industrial productivity, and retail price policies on the other. Recent rural reforms in China have significantly narrowed the average urban/rural income differential (para. 1.33), although in real terms it remains large, partially because the Government pays for as much as one half of the cost of noncommodity expenditures in urban areas (rent, water and

power, schooling, child care, transportation, etc.) and urban residents receive additional consumption benefits through their employers.

5.41 During the same period, interpersonal income differentials in the rural areas almost certainly increased, with official support, as a consequence of policies designed to improve incentives and foster entrepreneurship. The Government has reintroduced an income tax as an instrument for control of interpersonal income differentials, which has been applied to SHs, but for the moment it prefers to keep tax rates low. Less attention has been paid by Government to geographical or interregional income disparities. These disparities, which have always been significant in China, originate in differences in land quality and availability, water and energy resources, transport convenience, and market access, which vary among localities. The disparities have been variously controlled or exacerbated by corresponding differentials in taxation, pricing, forced savings and input supply. For instance, cotton procurement prices in central China were set somewhat below those in north China to partially offset differences in cotton yields. Although by 1982 the yield differences had largely disappeared, regional differences in quotas and procurement bonuses had resulted in net price differentials extremely favorable to north China producers.

5.42 The 1979-82 rural reforms produced growth which was far from geographically uniform. On the one hand, some of the poorest areas were among the earliest to introduce the BGDH system, which contributed to rapid growth in crop production (e.g., Anhui, Sichuan, Guangxi and Guizhou in Map 1). On the other hand, the suburban areas (Shanghai, Tianjin, Beijing) and prosperous provinces such as Jiangsu and Guangdong benefited from freedom to expand their CBEs and growing access to free market and export prices. Shandong, as a special case, benefited from the improved incentives for northern cotton growing described above. The remaining provinces, including some of the poorest and concentrated in the northwest, central or northeastern regions, for various reasons (including natural disasters in 1982) did not share such rapid growth rates.

5.43 Relative poverty remains characteristic of much of the northwest and parts of the north and southwest (Map 2 and Annex Table A.5). These are areas with adverse natural conditions - they usually lack irrigation facilities, have poor soil, often are isolated from markets and have weak transportation systems. These factors result in extensive (as opposed to intensive) forms of cropping and animal husbandry. These areas are also relatively short of chemical fertilizer and farm machinery (Map 3 and Annex Table A.5), as supply priorities and manufacturing facilities both are centered in the wealthier areas. Similar geographic income differentials exist within provinces, for example, between hilly and mountainous areas and plains or river valleys, or between suburbs and the remote hinterland.

5.44 To what extent will current Government policies widen or narrow geographic income disparities and are there cost-effective policy options which could reduce these disparities? One view within the Government is that the best returns to investment in crop cultivation no longer can be found in the advanced, high-yielding areas; hence purely economic considerations dictate emphasis on development of the low and medium-yield areas. This applies

to supply of chemical fertilizers; however, under the current distribution system, the central Government controls only about one-fifth of total supply. It also applies to water conservancy investments. As noted in Chapter 3, the MWREP plans for irrigation development in the next two decades call for expansion of about 8 million ha, of which 15% would be in the northwest, 12% in the northeast, 20% in the North China Plain, and the remainder south of the Huai River (primarily through completion of existing water distribution systems). As high-yield areas already have relatively secure irrigation systems, most benefits may be reaped by low and medium-yield areas. But these may lie within well-off provinces: for instance the northern part of Jiangsu would be a major beneficiary of the Water-to-the-North project.

5.45 However, the Government is primarily emphasizing the development of commercial crop production bases (Map 4). Few of these are found in the poorest regions of the country, and those which are (such as the Hexi Corridor Grain Base in Gansu) may be exceptions to the general poverty of the region. The Central Government recently has offered investment funds to upgrade research, extension, pest protection and commercial seed production facilities for crop production bases. In more prosperous areas, a quid pro quo is demanded in the form of above quota crop sales for five years at a new "trade price" only slightly higher than quota procurement prices.

5.46 Government policies have attempted to assist the poorer areas. For example, procurement prices have occasionally been pegged at higher levels in more remote or mountainous areas than in high productivity crop production bases; that is, Government absorbs losses on transport costs. Concern for such pockets of extreme poverty as the Dingxi area of Gansu Province (which now depend regularly on Government welfare funds) has led Government to earmark investment funds for their development or outmigration of some residents. In general, criteria for assessing economic returns to irrigation projects are less rigorous in appraising projects in the northwest, in support of poverty alleviation goals. On the other hand, high yielding grain production areas, such as southern Jiangsu, have found it difficult to further increase yields, and thus derived little benefit from increased above-quota differentials.

5.47 The present crop price structure is favorable to reduction of geographic differentials, in that industrial crop production is more profitable than grain, and many specialty crops trade at negotiated or free market prices. Recent policies have permitted areas with low grain yields - usually poor areas - to convert grain acreage to industrial or specialty crops, boosting incomes in these areas. Cotton in northwest Shandong and sugar cane in selected areas of Guangdong and Guangxi are examples where the effect on total provincial agricultural growth has been very positive. By restricting tobacco acreage in north China but favoring its expansion in impoverished Guizhou Province, the Government is using the profitability of this crop to reduce income differentials. Similar effects arise from conversion from low-yield grain production on sandy soils to peanuts or on saline soils to sugar beets or sunflower. However, the use of this instrument for distributional purposes is limited by Government reluctance to expand the scope of grain resales, which are required for specialization in industrial crops.

5.48 Although present policies affecting crops on balance contribute to a narrowing of geographic income differentials, those relating to other components of rural production clearly tend to widen disparities. Government gives high priority to increased supply of meat, fish, milk and eggs to the urban areas. Whether this is supported through subsidies to specialized households or investment in state and cooperative enterprises, most income-generating benefits are likely to accrue to the suburbs of major municipalities if present trends continue. Prospects for income growth in the pastoral areas outside the south are decidedly poor, because degraded pasture reduces production capacity and procurement prices for sheep and beef cattle make production unprofitable. Rural industrial development is faster and more successful near major industrial areas or where agriculture is already highly productive. Thus the fastest growing components of rural production may be concentrated in the eastern coastal areas and around the cities, while growth of income from crops may be most rapid in the poorer areas of medium or high-income provinces, leaving the poorest provinces to lag behind.

5.49 Policy options which would radically change this outcome are hard to identify. The areas of extreme poverty in the northwest and southwest are typically resource-poor, and changing this situation is extremely difficult or would require investment which may not be justified on economic grounds alone. The constraints to development include lack of irrigation (a sine qua non in the northwest), salinization and harsh climate (northwest), poor soil and inadequate drainage (southwest), depleted pasture (northwest) and weak transport infrastructure (both regions).[67/] In the worst-off areas, out-migration is certain to be one of the required policy measures.

5.50 Nevertheless, policy options exist which could slow the growth of geographic income differentials. Inasmuch as the more backward areas primarily require investment in infrastructure and support services whereas the more advanced areas emphasize investment in profit-making enterprises, Government grant funding could be concentrated on the former, while the latter would be required to rely largely on interest-bearing loans as well as collective and individual investments. Price reform, without a revised taxation system, would not necessarily be beneficial to backwards areas if the present disparity between prices of industrial and grain crops were narrowed and transport cost differentials allowed to influence farm prices. However this could be resolved by a compensating tax scheme with rates proportional to differential land rents. Generally, any price reform which led to relative increases in beef, mutton and timber prices would help slow the growth of income disparities.

5.51 Investment prospects in the backward areas would become more attractive if the transport system within these areas and links to outside markets were upgraded. Related to this, ways must be found of increasing external supply of foodgrains to these areas at minimum cost; otherwise, the

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67/ Provincial data show a strong correlation between the density of road and navigable waterway transport facilities (kilometers per square kilometer of area) and provincial per capita rural income levels.

potential gains from switching low-yielding grain land into industrial or tree crops and from creating forests and pastures on unused land could not be realized. To benefit backwards areas, research and land development planning should focus on upland cropping, water-conserving cultivation and irrigation techniques, and soil improvement (including drainage works). Because these areas normally lack organic fertilizers and have nutrient-deficient soils, their priority in allocation of chemical fertilizer - especially phosphate and potash - may be justified on economic grounds alone.

5.52 On the other hand, subsidies to more prosperous areas implicit in present Government policies might well be removed or reduced. This would probably require an overall reform of the price, tax revenue and distribution system, since the subsidies have been justified as compensation for irrationalities in the existing system. The natural advantages of the wealthy areas, especially the suburbs, provide adequate means to generate rapid growth following price reform, and local savings (including municipal revenues) provide an adequate source of finance. Supplying the urban and export markets with high value foods should be given some priority as a development objective because it could contribute much to rural income growth. However, if income differentials are to be prevented from widening, the sources of supply must be geographically broadened, through development of marketing and transport infrastructure. If these are unchanged, it is likely that the ever-expanding suburbs will be the main beneficiaries of urban market growth. An attractive alternative may be to identify new potential commercial production bases for non-staple foods remote from the cities and concentrate investment to provide the infrastructure required to make long-distance supply economic.

Prices

5.53 Urban/rural income differentials are often taken in China as a key indicator of the adequacy of the overall agricultural price level relative to prices of industrial goods. An excessive differential is to be avoided, but may be more acceptable to Government than a decline in urban living standards. Consequently Government has chosen to absorb through its budget most of the increased costs of agricultural procurement rather than pass them on to urban residents. As a result, subsidies for grain, oilseeds and cotton alone (including those on imports from abroad) have risen from 3.4% of budgetary revenues in 1978 to 23% in 1981 (Y 25 billion).[68/] This has contributed to recent budgetary deficits, and has reduced appropriations for capital construction. The agricultural sector has suffered more than most other sectors from reductions in state investment.

5.54 Further procurement price increases are not favored by the Government, both because of the budgetary cost, and because post-reform marginal price levels have been sufficient to stimulate rapid agricultural

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68/ A portion of these subsidies accrue to farmers, mainly industrial crop producers who receive resales of grain. The amount exceeds the "tax" implicit in the difference between quota and above-quota procurement prices.

growth, which in turn has driven free market prices of basic foodstuffs down to approximately the level of marginal (above-quota) procurement prices. Measures are being implemented to convert the fixed quota and variable above-quota procurement structure into a system whereby fixed proportions of farm sales would receive quota and above-quota prices. This system already has been applied to oilseeds and cotton (para. 1.20), and will soon be applied to grain. While it would freeze average procurement prices (and subsidies) at current levels, marginal prices received by farmers for increased sales would no longer be above-quota or negotiated prices, but rather would be reduced to a weighted average of quota and above-quota prices. The incentive to sell to the state would be reduced, because the marginal procurement price would again be much lower than current free market prices. There may be an incentive to reduce use of fertilizer and other inputs below levels which maximize farm incomes at present, and this could cause a drop in production.

5.55 A preferable alternative, which would be just as effective in freezing the level of subsidies, might be to replace the present system with a single-tier market price structure, with Government intervention to maintain stability. In these circumstances, the indirect tax resulting from low quota procurement prices could be replaced with direct taxes based on productivity of land and other resources. Tax levels could be adjusted to leave farm incomes unchanged, and the additional tax revenues could be used to offset budgetary costs of added subsidies. Procurement agencies would be under no compulsion to purchase more than urban and rural resale requirements. However, they could maintain emergency reserves and buffer stocks, which would be available for use in price stabilization. If present above quota prices were maintained as a price floor, marginal prices, and thus production incentives, would be largely unaffected, and there would be no procurement-market price differential to discourage sales.

5.56 Aside from changes in the average agricultural price level, some changes in relative prices of specific products seem to be required in order to provide better incentives or induce greater efficiency. Probably the most complicated are those where production is marginally profitable using current, traditional technologies, but rapid targeted increases in production will require expanded use of technologies which are more costly or even unprofitable at current prices. Pig raising is a significant example: household production of a few pigs per family using a minimum of concentrates is the prevailing mode, but specialized household or larger-scale production require concentrate-intensive methods of production which are unprofitable if inputs and outputs are all priced at current market (or marginal) prices. A general price increase for pork is one remedy, but this would transfer income unnecessarily to traditional producers as well as forcing either further price subsidies or increased retail prices to consumers.

5.57 Recent policy has been to mix differential procurement prices with differential input subsidies in order to encourage producers who must use more costly production techniques. For example, these producers could purchase grain concentrate at below marginal costs (translating part of the price subsidy on grain into a price subsidy on meat). A more efficient alternative, consistent with a move to uniform market pricing, would be to allow both product and input prices to rise, and tax away the increased incomes of tradi-

tional producers. Since the advantages of traditional producers derive ultimately from their crop production, which supplies byproducts and forage at little or no cost, the tax should be applied as part of the land tax rather than as a tax on animal production per se. Uniform market pricing does not mean that price differentials according to product quality would be disallowed. Rather, the pricing system should reflect market preferences for production of, e.g., lean pork or younger beef cattle. Such quality differentials would also tend to favor producers using improved breeds and more concentrate-intensive production techniques.

5.58 As pricing anomalies involve inputs, intermediate products, and final products, it is as difficult to specify magnitudes of adjustments required as it is to make piecemeal changes. The existence of several different prices for each product has been a complicating factor. The effect on incentives of changing state quota or above-quota procurement prices cannot be predicted without reference to the uncertain behavior of free market prices. For instance, unless the state can guarantee adequate supplies of grain at fixed prices, producers will compare the free market price of foodgrain with the procurement prices of industrial crops in deciding whether and how much to specialize in the latter. This also suggests the advantage for price management of moving entirely to a market price system, eliminating multiple procurement prices and replacing hidden taxes or subsidies with direct ones.

5.59 It is likely that any comprehensive price reform will involve price increases in livestock, forestry and fisheries relative to those of crops. These increases will be necessary to stimulate the high rate of investment in these sectors demanded by Government production targets, which in turn presuppose correspondingly, rapid increases in consumer incomes and demand. With more profitable investments available in the agricultural sector, demand for development credit from the Credit Cooperatives and ABC should increase. There appears to be excess demand for credit at present prices and interest rates, but low agricultural procurement prices are used to justify low interest rates. If this justification is removed, it should be possible to further increase interest rates on bank loans to agriculture, and correspondingly increase interest rates on deposits to attract the funds needed to satisfy this demand.

CHINA

AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Net Changes in Annual Lending to the Agricultural Sector, 1980-82
(Y billion)

	Changes in lending 1980	1981	1982	Loans/deposits outstanding (12/31/82)	1982 growth (%)
Increased Lending to Agriculture					
Agricultural Bank of China /a					
Loans to collectives & individuals	3.1	1.0	0.6	17.5	3.6
Loans to state agric. enterprises	0.3	0.7	1.1	2.5	78.9
Crop advances	0.1	(0.1)	-	0.7	0.5
Subtotal	3.5	1.7	1.7	20.7	9.0
Credit cooperatives /b					
Loans to collective agriculture	1.2	0.1	(0.1)	3.5	-2.7
Loans to CBEs	1.7	0.4	0.7	4.2	19.3
Loans to individuals	0.5	0.9	1.9	4.4	74.9
Subtotal	3.4	1.5	2.5	12.1	25.7
Total Lending by ABC & CCs	6.9	3.1	4.2	32.8	14.6
% to collectives (including CBEs)	87.1	48.7	28.6	76.7	
% to state farms	4.2	23.5	26.2	7.6	
% to individuals /c	7.4	29.3	45.1	13.4	
Increased Deposits					
State banks /d	1.4	0.6	1.9	5.4	54.6
Credit cooperatives	5.6	4.7	7.0	39.0	22.0
Total Deposits	7.0	5.3	8.9	44.4	25.2
Increased Total Lending as % of Increased Total Deposits	98.7	59.0	46.9	73.9	

/a From 1982 China Statistical Yearbook, p. 450, 452. The 1982 figures in the Yearbook were preliminary and have been replaced with estimates drawn from the ABC's year-end consolidated balance sheet, on the asumption that "lending to agricultural brigades and teams" includes loans to individuals.

/b From the Yearbook, p. 451.

/c By credit cooperatives only; the ABC also does some lending to individuals.

/d "Rural deposits," from the Yearbook, p. 450, less deposits of credit cooperatives, to eliminate double counting. It is assumed that "rural deposits" include those of credit cooperatives and individuals, net of loans to credit cooperatives. Increases in net deposits by CCs in the ABC are estimated on the assumtpion that increased deposits in the CCs are either lent or deposited in the ABC. The 1982 balance sheet total is for deposits of individuals only.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Indices of Weighted Average Prices Received by Producers, 1978-82 /a
(1978 = 100)

	Indices				Annual growth (%)	
	1979	1980	1981	1982	1978/79	1979-82
Grain	126	137	145	149	25.6	5.9
Edible oils	141	151	161	159	40.8	4.1
Pigs	137	155	162	166	37.0	6.6
Cattle	120	153	174	225	19.7	23.3
Eggs	122	124	134	135	21.9	3.5
Aquatic products	149	176	199	211	48.6	12.3
Tea	128	132	135	148	27.8	5.1
Sugarcane	124	139	149	138	24.0	3.7
Sugar beet	135	141	144	141	35.2	1.4
Apples	96	111	112	125	-4.2	9.3
Mandarin oranges	97	121	140	131	-3.3	10.7
Cotton	118	139	137	142	17.6	6.5
Tobacco	102	113	129	124	1.6	6.7
Jute	101	95	83	85	1.1	-5.8
Hemp	114	112	101	106	14.3	-2.5
Fresh vegetables	110	127	137	129	9.8	5.6

/a Computed from 1982 China Statistical Yearbook, pp. 478-81. Includes effects due to change in quality mix (or weight, for animals) as well as price. Weights are based on the share of sales transacted at quota, above quota, negotiated and free market prices.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Composition of Gross Agricultural Output, 1978-82 /a
(%)

	Crop production	Livestock production	Forestry	Sideline activities		
				Total	Of which industry by brigades and teams	Fisheries
1978	67.2	14.0	4.2	12.7	8.9	1.9
1979	66.4	14.8	3.9	13.2	9.5	1.7
1980	63.7	15.3	4.3	15.1	11.1	1.8
1981	63.2	15.2	4.2	15.7	11.7	1.7
1982	62.8	15.5	4.1	16.0	11.6	1.7

/a Shares for 1978 and 1979 were originally calculated on the basis of 1970 constant prices, but have been adjusted here by subsector to 1980 constant prices. Shares for 1980-82 were calculated from data in constant 1980 prices.

Source: SSB, Statistical Yearbook of China, 1983; p. 151.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Rural Income Distribution, 1979-82

Annual income per capita	Percent of households in each group /a				
	1979	1980	1981	1982	1983
Below Y 100	19.3	9.8	4.7	2.7	/b
Y100 - 200	53.2	51.8	37.9	24.1	/b
Y200 - 300	20.4	25.3	34.8	37.0	/b
Y300 - 400	5.0	8.6	14.4	20.8	/b
Y400 - 500	1.5	2.9	5.0	8.7	/b
Over Y 500	0.6	1.6	3.2	6.7	11.9 /c
Gini coefficient	0.257	0.237	0.231	0.225	

/a Based on nationwide sample surveys which increased in size from 10,282 in 1978 to 22,775 in 1982.

/b Not available.

/c From China Daily, May 3, 1984.

Source: Data are from the State Statistical Bureau as provided to the Economic Mission. The Gini coefficients were estimated by the mission.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Selected Rural Indicators for Major Regions, 1982, and Changes, 1979-82

	GVAO		Rural population		Output and income/capita			Grain production				Livestock numbers				Arable land						Tractor power		Ferti-lizer	Commune/ brigade enterprise		
	bln	% change 79-82	mln	% share	GVAO/ capita (Y)	DCI/ capita (Y)	% change 79-82	mln tons	% share	% change 79-82	kg/ cap	Pigs (mln; yr end)	% change 79-82	Sheep & goats (mln; yr end)	% change 79-82	mln ha	% share	ha/ capita	% irri-gated	Crop-ping index (%)	Sown area (ha/ cap)	hp/ha	% change 79-82	(kg/sown ha)	GVO (bln)	% share	% change 79-82
NORTHEAST (Heilongjiang, Jilin, Liaoning)	24.7	18.1	54.2	6.7	455	136	19.4	33.0	9.3	-7.2	609	22.0	-14.5	7.5	33.6	16.4	16.7	0.30	13.0	0.99	0.30	0.59	54.7	83.0	6.2	8.1	60.0
NORTHWEST (Xinjiang, Xizang, Qinghai, Gansu, Ningxia, Nei Monggol)	14.0	21.0	47.6	5.9	294	106	36.9	16.6	4.7	4.0	350	10.6	-16.7	96.6	1.8	13.5	13.7	0.28	37.0	0.93	0.26	0.49	37.4	39.4	1.4	1.8	83.3
NORTH CHINA (Beijing, Tianjin, Hebei, Henan, Shandong, Shaanxi, Shanxi)	69.8	20.5	221.0	27.5	316	137	73.2	84.0	23.8	-0.1	380	55.9	-17.7	43.6	-1.3	29.5	29.9	0.13	48.7	1.36	0.18	0.70	28.9	107.6	21.7	28.2	53.1
EAST CHINA (Shanghai, Anhui, Zhejiang, Jiangsu)	53.5	30.4	128.4	16.0	417	165	71.1	67.2	19.0	12.0	523	46.5	-13.5	10.8	-21.4	11.2	11.4	0.09	68.2	1.96	0.17	0.88	38.3	145.9	25.7	33.2	94.8
CENTRAL-SOUTH CHINA (Hunan, Hubei, Jiangxi)	37.2	15.2	112.9	14.0	329	138	42.8	57.8	16.4	7.8	512	47.1	-3.3	2.4	-13.4	9.5	9.7	0.08	66.5	2.20	0.19	0.57	2.7	99.7	8.1	10.5	96.1
SOUTH CHINA (Guangdong, Guangxi, Fujian)	29.0	30.0	101.7	12.6	285	138	74.1	41.4	11.7	12.9	408	41.9	10.0	1.9	-6.5	7.1	7.2	0.07	60.3	1.93	0.14	0.87	17.8	140.7	9.5	12.3	145.1
SOUTHWEST CHINA (Sichuan, Guizhou, Yunnan)	34.8	29.4	138.1	17.2	252	101	56.6	53.4	15.1	15.5	386	76.9	5.6	19.0	-4.8	11.3	11.5	0.08	39.0	1.68	0.14	0.34	12.1	91.8	4.5	5.9	88.4
Total	262.9	23.5	803.9	100.0	327	133	59.8	353.4	100.0	6.4	440	300.8	-5.9	181.8	-0.7	98.6	100.0	0.12	44.8	1.47	0.18	0.64	29.3	104.6	77.2	100.0	81.8

s: Gross Value of Agricultural Output (GVAO): Includes crop production, fisheries, forestry, animal husbandry and brigade- and team-managed rural enterprises and other sideline activities. Figures are in terms of 1980 prices. The 1982 GVAO in current prices is Y 278.5 billion.

Rural Population: End-year population, from 1982 Census.

Distributed Collective Income (DCI): Income (in cash and kind) from collective work activities distributed to members of production teams. These data exclude private incomes (from various household activities), remittances, cash wages paid to workers in rural enterprises and casual labor payment.

Grain Production: Unprocessed grain. Includes tubers (at one fifth the wet weight) and soybeans.

Cropping Index: Includes green manure and forage crops.

ce: Derived from official data supplied to the Economic Mission or given in Statistical Yearbook of China, 1983; Chinese Agricultural Yearbook, 1980, 1981 and 1982.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Food Balance Sheet, 1982
(National figures in million metric tons except where otherwise noted)

Commodity	Production (1)	Imports (2)	Exports (3)	Domestic supply (4)	Domestic use /a: Nonfood & waste (5)	Domestic use /a: Food (6)	Per capita supply /b: Kilograms per year (7)	Per capita supply /b: Energy (kcal) (8)	Per capita supply /b: Protein (gm) (9)	Per capita supply /b: Fat (gm) (10)
Crop Production										
Total Grains /c	353.43									
Rice /d	161.24	0.45	0.74	160.94	60.23	100.71	99.89	1001.64	17.52	2.19
Wheat	68.42	13.26	0.00	81.68	22.30	59.38	58.89	564.74	18.23	2.42
Corn	61.00	0.20	0.00	61.20	26.39	34.81	34.53	342.45	8.51	3.22
Sorghum	6.50	n.a.	n.a.	6.50	2.91	3.59	3.56	34.81	0.74	0.23
Millet	5.50	n.a.	n.a.	5.50	2.66	2.84	2.81	27.30	0.82	0.12
Tubers /e	26.68	n.a.	n.a.	26.68	10.67	16.01	15.88	223.59	2.61	0.57
Soybeans (food) /f	4.97	0.30	0.14	5.13	0.75	4.38	4.34	47.57	4.17	2.11
Soybeans (oil) /g	4.06	0.06	0.00	4.56	4.09	0.47	0.47	11.34	0.00	1.28
Pulses /h	5.06	n.a.	n.a.	5.06	0.66	4.40	4.37	39.94	2.80	0.16
Other grains /i	10.00	n.a.	n.a.	10.00	4.64	5.36	5.32	50.43	1.43	0.26
Peanuts (food) /j	1.96	n.a.	n.a.	1.96	0.25	1.71	1.69	14.04	0.70	0.90
Peanuts (oil) /k	1.96	n.a.	n.a.	1.96	1.41	0.55	0.54	13.11	0.00	1.48
Edible oils (except soy and peanut) /l	3.27	0.00	0.00	3.27	0.10	3.17	3.15	76.20	0.00	8.62
Sugar	3.16	2.16	0.00	5.32	0.11	5.21	5.17	55.12	0.00	0.00
Fruit /m	6.90	0.00	0.57	6.33	0.63	5.70	5.65	7.77	0.06	0.03
Vegetables /n	103.17	n.a.	n.a.	103.17	10.32	92.85	92.10	66.11	4.04	0.76
Subtotal							338.36	2576.00	61.63	24.34
Animal Products										
Pork, beef & mutton /o	13.51	0.00	0.23	13.28	0.40	12.88	12.78	105.09	4.10	9.73
Poultry meat /o	0.99	n.a.	n.a.	0.99	0.03	0.96	0.95	5.17	0.41	0.38
Other meat /o	0.14	n.a.	n.a.	0.14	0.00	0.13	0.13	0.46	0.06	0.02
Fish /p	5.15	n.a.	n.a.	5.15	0.26	4.89	4.85	8.38	1.37	0.28
Eggs	2.34	0.00	0.06	2.28	0.11	2.17	2.15	8.53	0.68	0.60
Milk	1.86	0.01	0.00	1.87	0.09	1.78	1.76	3.06	0.15	0.17
Animal fats	0.99	0.06	0.00	1.05	0.14	0.91	0.90	22.36	0.00	2.48
Subtotal							23.53	153.00	6.77	13.66
Total							361.88	2,729.00	68.39	38.01

/a Percentage losses due to seed requirements, use as livestock feed, nonfood manufacturing uses, waste, milling, and other processing (Column 5) are specified in Piazza (1983), p. 94. These losses are deducted from domestic supply (Column 4) to determine food (Column 6).
/b Assuming a mid-1982 population of 1,008.2 million.
/c Total grains include rice, wheat, corn and other coarse grains, tubers at one fifth wet weight, and soybeans and other pulses.
/d Rice production, trade, and domestic supply expresssed in paddy weight. Food is expressed in dehusked weight.
/e One fifth the wet weight.
/f An estimated 55% of soybeans are consumed as beans, milk and curd.
/g An estimated 45% of soybeans are crushed for oil. Trade figures are expressed in oil equivalent.
/h Pulses are estimated as a residual of total grain production figures (see footnote /c above) and include broad beans, dry beans and other beans.
/i Other grains estimated using the USDA's (1983) estimates of barley and oats production.
/j An estimated 50% of peanuts are consumed directly as food.
/k An estimated 50% of peanuts are crushed for oil. Trade figures are expressed in oil equivalent.
/l Edible oil from cottonseed, rapeseed, sesame seed, and sunflower seed.
/m Fruits include bananas, apples, oranges, pears, grapes, pineapples, red dates and persimmons.
/n Vegetables include leafy vegetables, root and stem crops, and fruiting crops.
/o Production figures are dressed weight.
/p Production figures are liveweight.

Source: Data sources and methodologies are in Alan Piazza, Trends in Food and Nutrient Availability in China, 1950-81, Staff Working Paper No. 607 (Washington, D. C., The World Bank, 1983).

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Per Capita Food and Nutrient Availability in China and Other Countries /a

	Energy (Kcal/day)							Protein	Fat	Grain Consumption (kg/year)/b (1975-77)		
		From										
	Total	Grain/b	% of total	Animal Origin	% of total	Oils & fats	% of total	-(gm/day)-		Direct	Feed /c	Total
China (1980-82)	2,548	2,145	84	148	6	102	4	66	35	209	44	253
World average	2,571	1,439	56	435	17	225	9	69	62	N/A		
Asia average	2,251	1,580	70	196	9	125	6	58	37	N/A		
All developing	2,260	1,531	68	205	9	134	6	57	38	N/A		
Low Income												
Afghanistan	1,896	1,573	83	150	8	59	3	59	26	171	9	180
Bangladesh	1,796	1,563	87	62	3	54	3	39	13	164	0	164
India	1,919	1,294	67	93	5	136	7	47	30	130	4	134
Nepal	2,002	1,713	86	137	7	88	4	48	27	182	1	183
Pakistan	2,281	1,462	64	281	12	195	9	63	42	156	3	159
Sri Lanka	2,059	1,369	66	80	4	67	3	42	44	137	0	137
Tanzania	2,066	1,264	61	202	10	102	5	49	33	97	3	100
Vietnam	2,135	1,740	81	178	8	42	2	53	25	169	7	176
Middle Income												
Brazil	2,559	1,156	45	421	16	184	7	62	49	103	124	227
Cuba	2,635	1,175	45	574	22	236	9	67	54	115	77	192
Egypt	2,787	1,887	68	179	6	230	8	77	50	194	34	228
Indonesia	2,118	1,628	77	52	2	123	6	43	33	157	4	161
Korea, Rep. of	2,785	2,111	76	178	6	55	2	73	27	205	33	238
Malaysia	2,613	1,542	59	294	11	229	9	58	46	150	35	185
Mexico	2,655	1,370	52	366	14	206	8	66	60	137	88	225
Philippines	2,216	1,498	68	216	10	108	5	51	32	140	9	149
Thailand	2.098	1,492	71	146	7	41	2	46	23	157	19	176
Yugoslavia	3,446	1,796	52	715	21	371	11	101	90	173	393	566
Industrial	3,353	1,014	30	1,073	32	510	15	97	134	N/A		
Germany, FR	3,382	1,796	53	1,318	39	618	18	86	158	82	283	365
Japan	2,946	1,438	49	547	19	284	10	88	74	137	118	255
USA	3,578	719	20	1,312	37	583	16	106	166	N/A		
Germany, DR	3,644	1,177	32	1,336	37	668	18	100	151	123	592	715
USSR	3,460	1,598	46	950	27	357	10	103	102	165	435	600

/a For China, 1980-82 average. All other countries are 1977 figures.

/b Includes rice, wheat, coarse grains, and tubers at one fifth wet weight. Figures for soybean and other pulse are not included in direct grain consumption figures.

/c Includes rice, wheat, coarse grains, tubers (at one fifth wet weight) and pulse. Grain millings (bran, etc.) and oilseed cake have not been included.

Source: For China, see Piazza (1983). Data for other countries are from FAO.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Characteristics of the National Grain Bases (1977)

	Name of base	Type of bases H,L,N /a	Frost free period (days)	Average precipitation (mm)	Cultivated area (thousand ha)	Cultivated area/capita (ha/capita)	Total grain production (m tons)	Grain yield (kg/ha)	Production/ capita (kg/capita)	Commercialization rate (%)
I.	NORTHEAST									
	Songnen /b	L	100-130	400-500	5,899.2	0.329	9.610	1,935	473	34.9
	Sanjiang /c	L	130-145	550±	911.5	0.245	1.440	1,920	443	37.2
II.	NORTHWEST									
	Hexi Corridor /d	N	125-150	100-200	608.6	0.217	1.360	3,068	363	27.2
	Ningxia Hetao /e irrigation area	N	150	200±	183.8	0.124	0.605	4,065	301	24.4
III.	NORTH CHINA									
	Huaibei /f	N	200-225	700-800	1,716.8	0.139	4.350	3,420	339	19.6
IV.	EAST CHINA									
	Taihu /g	H	230-250	1000-1200	913.0	0.085	5.805	7,635	490	32.7
	Jianghuai /h	H	220-230	900-1100	1,077.7	0.093	5.390	5,940	428	23.9
V.	CENTRAL-SOUTH CHINA									
	Dongtinghu /i	H	245-270	1200-1400	879.5	0.089	4.450	6,233	420	24.9
	Jianghan /j	H	245-270	1200-1400	1,044.9	0.121	4.700	5,940	490	30.8
	Boyanghu /k	H	250-270	1500-1900	723.3	0.102	3.470	5,573	435	26.9
VI.	SOUTH CHINA									
	Pearl River Delta /l	H	350	1800-2500	794.3	0.092	4.830	7,628	505	38.3
VII.	SOUTHWEST CHINA									
	Chengdu /m	H	250-300	900-1300	650.9	0.085	3.470	7,425	370	28.3

/a H = High productivity bases. Traditional grain base, generally good climate and water resources. However, extremely high population density means future growth will rely on increased fertilizer and improved irrigation.
L = Low productivity bases. Limited by short growing season, mostly extensive agriculture. Future growth will rely on mechanization, irrigation and drainage.
N = New bases under construction. In desert or near desert, most improved regions since 1949. Future growth must rely on irrigation and land reclamation.

/b Large, flat and fertile plain with deep soil, short growing season, frequent spring drought. Needs increased irrigation, mechanization, drainage, fertilizer.

/c Similar to Songnen Plain except higher commercialization rate and need for major drainage work.

/d Drought, sandy soil, irrigation essential, low productivity. With irrigation, large development potential, windbreaks required.

/e Irrigation highly developed but high salinity and low yield; requires drainage and fertilizer.

/f Intermittent flood and drought, low yield, vulnerable to salinization, requires improved irrigation, drainage and fertilizer.

/g Highly productive and under intensive cultivation; good climate and irrigation. Little potential for further development.

/h Drought and flood problems, drainage work required.

/i Climate and water resources favorable, flood and drought problems, drainage improvement costly.

/j Similar to above.

/k Lowest yielding of southern bases, unreliable irrigation and drainage, low MCI. Expanded water storage and irrigation required.

/l Frost-free, plentiful supply of water, MCI = 2.10%, highest commercialization rate, uneven productivity. Requires improved drainage and increased fertilizer.

/m Favorable soil, irrigation and climate, uneven productivity. Requires development of underground water and increased fertilizer.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Comparison of 1982 Border Prices with Domestic Procurement Prices (Y/ton)

Product	1982 unit value /a Exports	Imports	Farmgate border price /b	Quota procurement price /c	Above-quota procurement price /d	Free market price /e	Average procurement price /f
Crops							
All grain				257	386	581	
Paddy rice	687		435	231	347		
Wheat		394	411	314	472	500-700	
Corn		299	316	214	322	360-480	
Soybean	529	574	590	692	692	700-800	
Lint cotton		2,801	2,817	2,956	3,843	5,000-5,600	3,236
Oilseeds	1,321	1,221	1,238				
Rapeseed		910	927	715	1,072		
Peanut kernel		721	738	966	1,449		
Edible oil		1,029	1,046			3,910	2,773
Jute		644	660	367	441		480
Tobacco (smoked)	3,107		2,927	1,741			1,532
Vegetables	517		460				
Sugar (refined)		564	580				
Sugarcane			26	42			50
Sugar beet				75			85
Forestry							
Fresh fruit	652		589				
Apples	633		571			449	387
Mandarin orange	738		671			619	481
Tea (processed)	3,939		3,720			12,821	3,548
Natural rubber		1,620	1,637				6,090
Timber		194	211	87			
Animal husbandry							
Pork /g	3,774		3,562	1,787		1,671	2,000
Sheep /g						3,056	2,336
Beef /g	2,590		2,435			1,625	2,925
Chicken /g	2,072		1,942	2,200		3,600	
Egg /g	1,876		1,755			3,036	1,864
Milk /h		1,820	213				600
Wool		6,361	6,378				3,580
Honey	1,522		1,417				1,882
Fishery							
Fresh fish	3,342		3,151	700		2,112	922
Inputs							
Urea		374	428	500			
Ammonium sulphate		170	213	254			
Superphosphate (P_2O_5) /i		360	898	938			
Potassium chloride	52	209	255	261			
Soymeal		444	501	330			

/a Unit values ex customs, FOB for exports and CIF for imports, computed from China Statistical Yearbook, 1983, pp. 412-419; or export prices FOB China in US$ converted at Y 1.7=US$1, as reported in Rural Credit Project; or 1982 international prices, as estimated by the World Bank, Economic Analysis and Projections Department, in US$, adjusted for ocean transport cost and converted to yuan at Y 1.7=US$1.

/b Unit values of export or import commodities converted to farmgate equivalency with adjustments for quality differences (if any), internal transport (assuming 200 km rail freight at Y 5.1 total, 25 km margins (assumed to be 5%), and conversion to unprocessed product (if any required). For agricultural product imports, costs between port and consumption point are added and, between the latter and the farm, are subtracted; for exports, all costs are subtracted; for imported inputs, all costs are added.

/c As reported for 1981 in Handbook of Agrotechnical Economics (Beijing, 1983), pp. 742-43 and soybean prices were adjuted for the 50% quota price increases in September 1981. Input for products procured outside the plan would generally be higher.

/d 50% greater than quota-prices for grain and oilseeds (except soybean), 30% for cotton, and 20% for bast fibers. It is believed that other products do not received fixed above-quota premiums, although procurement may take place at negotiated or free-market prices.

/e The unit value of "sales of farmers to the nonfarm population," from 1983 China Statistical Yearbook, p. 384. is taken to approximate average free-market prices; where a range is given, prices are those reported in the North China Plain Project area in 1982.

/f As reported in 1983 China Statistical Yearbook, pp. 478-82; or, if otherwise unavailable, local procurement prices as reported in World Bank projects.

/g Prices of animals given on a per head or per unit basis have been converted to price per ton dressed weight, assuming dressed weights at slaughter of 61.5 kg (1981), 77.5 kg (1979), and 10.7 kg (1979) for pigs, cattle, and sheep respectively. Eggs were assumed to weigh 50 g apiece.

/h The import price of milk is that for powder; the farmgate border price converts this to fresh milk on the assumption reconstitution requires 8.3 parts water: 1 part powder.

/i The import price is for TSP (triple superphosphate, 46% P_2O_5); this is converted to a border price of phosphate (P_2O_5) and compared with domestic prices of equivalent P_2O_5 supplied from ordinary superphosphate (about 16% P_2O_5).

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Timber Production, 1981
(million cu m)

	Total production /a	Of which allocated by the state /a
Nei Monggol	4.27	3.42
Jilin	6.14	4.22
Heilongjiang	15.40	13.21
Zhejiang	0.64	0.48
Anhui	0.36	0.27
Fujian	3.67	2.83
Jiangxi	2.70	2.37
Hubei	0.65	0.47
Hunan	2.08	1.99
Guangdong	3.27	1.59
Guangxi	1.60	1.10
Sichuan	3.44	2.61
Guizhou	0.83	0.79
Yunnan	2.00	1.87
Tibet	0.19	0.17
Shaanxi	0.33	0.23
Gansu	0.45	0.25
Xinjiang	0.52	0.38
Total	49.42	38.33

/a Totals may not sum due to rounding and reporting errors.

Source: Almanac of China's Economy (1982), English translation by the Foreign Broadcast Information Service.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Investment Requirements for Hypothetical Agricultural Development Program
(US$)

Type of investment	Units	Investment range Minimum	Maximum	Median	Quantity ('000)	Investment (millions)
Crop Cultivation						
Irrigation						
Surface						
- No major structures /a	$/ha	2,250	3,000	2,630	6,900	18,110
- Major works /b	$/cu m	0.15	0.35	0.25		
- Major works /c	$/ha	5,250	6,880	6,060		
- No major structures /d	$/ha	1,690	3,710	2,700	650	(1,760)
- Power lift /e	$/ha	3,000	7,500	5,250	550	(2,910)
Well, 100 m lift /f	$/ha			2,250		
Trickle /g	$/ha			920		
Sprinkler /h	$/ha			400		
Drainage						
Major /i	$/ha			500	1,000	500
Minor (no mains) /j	$/ha			380	6,670	2,500
Minor (no mains) /k	$/ha	530	1,280	900	1,670	(1,500)
With desalinization /l	$/ha			750	3,350	2,500
With desalinization /m	$/ha	440	560	500		
Hydroelect. (small) /n	$/kWh	0.16	0.41	0.28		
Land Reclamation						
NW, incl. irrigation /o	$/ha	3,750	6,000	4,880	2,000	9,750
NE, except main drains /p	$/ha			330	3,330	1,090
Coastal /q	$/ha	3,000	3,750	3,380	570	1,910
Loess plateau arid /r	$/sq km	10,000	15,000	12,500	70	880
Red-yellow soils						
Tea planting /s	$/ha			230	45,000	10,130
Orchard establishment /t	$/ha			75	15,000	1,130
Forestry						
Afforestation						
Hand /u	$/ha			230	45,000	10,130
Aerial /v	$/ha			75	15,000	1,130
Maintenance /w	$/ha			590	60,000	35,100
Animal Husbandary						
Pasture Development						
Basic improvement /x	$/ha			200	33,330	6,520
With irrig., enclosure /y	$/ha			1,130		
Cult. pasture /z	$/ha	490	660	570		
Feed Processing						
Small scale /aa	$/t			16	172,000	2,670
Large scale /bb	$/t			95	28,000	2,650
Dairy Cattle						
Suburban dairy /cc	$/cow			2,500	8,450	21,130
Pastoral dairy /dd	$/ha	1,500	2,250	1,880	10,100	18,940
Poultry						
Small scale /ee	$/coop			280	15,400	4,240
Fisheries						
Fishpond creation /ff	$/ha			10,500	35	370
Fishpond creation /gg	$/ha			7,500	550	4,130
Pond improvement /hh	$/ha	3,750	5,900	4,830	800	3,860
Total						156,400

/a Average for marginal investment costs nationwide.
/b Another estimate of marginal investment costs.
/c NW: two dam/canal projects.
/d NW: reservoir enlargement of second stage projects.
/e NW, pumped from Yellow R with lift of 100-300 m.
/f Hexi corridor; pumping costs >Y 120/ha at subsidized electricity prices.
/g Including water sources; Chinese-produced movable system Y 750-1,050/ha.
/h Friendship Farm; including wells and equipment; yield increase 1.2 t/ha in dry year.
/i Sanjiang Plain: cost of main drains divided by area to be cultivated.
/j S. China: total area requiring improvement.
/k S. China: lesser area with higher costs and average benefits of +1.6 t/ha.
/l N. China saline areas; costs based on experimental areas and may be understated.
/m Hoxi Corridor project, benefits + 1.5-2.3 t/ha.
/n Small projects n.i. distribution lines; medium with high-power lines.
/o Yiels of 1.5-2.3 t/ha expected.
/p Unit cost based on Heilongjiang Land Reclamation project, excluding farm machinery, etc.
/q About 33,300 ha/year now reclaimed.
/r Terracing, grass/tree planting, Gansu only.
/s Red-yellow soils area (assumed 20% of total requiring improvement)
/t Red-yellow soils area (assumed 80% of total requiring improvement)
/u Including removal of scrap (assumed 75% of planned national total).
/v Seeding alone (assumed 25% of planned national total).
/w Maintenance up to harvest (on both hand and aerial seeded area); primarily labor.
/x Seed, fertilizer, fencing but no irrigation or water.
/y Areas such as Nei Monggol, Hebei, etc. where irrigation required,
/z S. China pastoral areas.
/aa One t/hr, volumetric mixing.
/bb 3.4 t/hr, 5,500 t/yr, automatic mixing by weight.
/cc Concentrate-intensive (assumed 50% of increased; 3.0 t/animal in stock).
/dd S. China farms, counting stock, infrastructure, pasture development (assumed 50 of increase output, 2.5 t/grassfed animal in stock).
/ee Specialized household coop raising, 100 bird coop including feed and other equipment.
/ff Ten municipalities, conversion from swamp; assumed yield 3.75 t/ha total area.
/gg Conversions in other areas (assumed 3.0 t/ha; assumed to be a residual source of increased output).
/hh All existing ponds improved, with added yield of about 2.35 t/ha.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Commodity Prices and Price Projections
(1983 Constant Dollars)

Commodity	Unit	Average 1976-82	1983 (actual)	1995
Cereals				
Rice /a	$/mt	369	277	350
Wheat /b	$/mt	172	170	177
Corn /c	$/mt	121	136	135
Oilseeds				
Soybeans /d	$/mt	294	292	299
Soybean meal /e	$/mt	249	238	269
Cotton /f	US¢/kg	185	185	178
Rubber /g	US¢/kg	124	124	145
Tea /h	US¢/kg	229	233	237
Sugar /i	$/mt	229	187	315
Fertilizers				
Urea /j	$/mt	174	135	260
TSP /k	$/mt	137	135	170
DAP /l	$/mt	179	184	294
Potassium chloride /m	$/mt	82	75	100
Selected Price Indices /n				
Agriculture, food	1977-79=100	88	80	87
Agriculture, nonfood	"	130	105	112
Metal and minerals	"	150	99	129

/a Thai, milled, 5% broken, FOB Bangkok.
/b Canadian, No. 1, Western Red Spring, in store, Thunder Bay.
/c US, No. 2 Yellow, FOB US Gulf Ports.
/d US, CIF, Rotterdam
/e Dutch, Crude, FOB, ex-mill.
/f Mexican Middling 1-3/32; CIF N.W. Europe.
/g RSS No. 1, spot, New York.
/h London Auction, average price received for all teas.
/i World, ISA Daily price, FOB and stowed at Greater Carribbean Ports.
/j FOB Europe, bagged.
/k Triple superphosphate, FOB US Gulf.
/l Diammoniumphosphate, FOB US Gulf.
/m Muriate of Potash, FOB Vancouver.
/n Constant prices.

Source: World Bank, Price Prospects for Major Primary Commodities, 814/18, September 1984

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Basic Characteristics of Comparator Countries, 1980

Country	Per capita GNP ($) (1)	Population ('000) (2)	Land area (mln ha) (3)	Population density (per ha) (4)	Arable land (%) (5)	Population per ha of arable land (6)	Total gov't exp. in GDP (%) /b (7)	Degree of openness trade (X + M) share in GNP (%) (8)	Type of economic system /a (9)
China	290	976,700	930.496	1.05	10	10.0	33	19	CPE
Korea	1,520	38,197	9.819	3.89	23	17.3	19	83	MIX
Japan	9,890	116,800	37.103	3.15	13	23.9	18	31	M
India	240	673,200	297.319	2.26	57	4.0	34	14	CPE
Pakistan	300	82,200	77.872	1.06	26	4.0	26	37	MIX
Thailand	670	47,000	51.177	0.92	35	2.6	18	47	M
Indonesia	430	146,600	181.135	0.81	11	7.5	26	47	MIX
Egypt	580	39,800	99.545	0.40	3	13.9	61	34	CPE

/a CPE: Centrally planned economy, M: Market-oriented economy, MIX: mixed economy.

/b Shares of government expenditure in GDP for China, Korea and Japan are computed from data of national statistical sources. Ratios for India, Pakistan and Egypt are taken from World Bank economic reports or sector reports. For Thailand and Indonesia, data collected from IMF, International Finance Statistics.

Sources: Columns (1), (2) and (8) are from IBRD, World Development Report, 1982.
Total and arable land data are from FAO Production Yearbook, 1981.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Agriculture's Shares and Relative Economic Performance in comparator countries
(%)

Country	Year	Per capita GNP ($) (1)	Agriculture's share (%) in GDP (2)	Agriculture's share (%) in Labor force (3)	% of rural population (4)	Ave. annual growth rates in past decade: GDP (real) (5)	Population (6)	Agricultural production (real) (7)	Industrial production (real) (8)	Agricultural products' shares in Exports (9)	Agricultural products' shares in Imports (10)	% of imports are food (11)
China	1980	290	31	71	81	6.0/a	1.3/a	6.0/a	8.4/a	48	54	15
Korea	1960	76	37	66	72	5.1	2.8	5.5	16.4	56	35	10
	1970	243	28	50	59	8.6	2.5	4.4	17.2	17	26/b	16
	1980	1,520	16	34	45	9.5	1.7	3.2	15.4	9	27	10
Japan	1960	458	13	33	38	8.0	1.3	3.0	18.2	10	66	17
	1970	1,890	8	19	28	10.9	1.0	4.0	10.9	4/b	49	14
	1980	9,890	4	12	22	5.0	1.1	1.1	5.5	2	31	12
India	1980	240	37	69	78	3.6	2.1	1.9	4.5	34	19	9
Pakistan	1980	300	31	57	72	4.7	3.1	2.3	5.2	43	19	13
Thailand	1980	670	40	76	86	7.2	2.5	4.7	10.0	57	12	5
Indonesia	1980	430	26	58	80	7.6	2.3	3.8	11.1	22	19	13
Egypt	1980	580	23	50	55	7.4	2.1	2.7	6.8	22	40	32

/a For China, average growth rates over the period of 1978-82 are used.
/b Crude estimates.

Sources: Most data are from World Development Report, 1982 and 1983.

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AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Per Worker and per Hectare Contribution to Agricultural GDP in Comparator Countries

Country	Year	Ag. GDP at current prices ($ mln) (1)	Ag. GDP ($) per Ag. labor (2)	Ag. GDP ($) per Arable ha (3)
China	1980	93,333	298	938
Korea	1960	1,395	288	681
	1970	2,287	469	995
	1980	8,471	1,819	3,837
Japan	1960	5,598	308	922
	1970	12,397	1,182	2,268
	1980	41,599	6,291	8,523
India	1980	52,543	317	311
Pakistan	1980	6,653	529	327
Thailand	1980	8,364	526	465
Indonesia	1980	18,148	610	931
Egypt	1980	5,283	888	1,850

Sources: Column (1) from China: Recent Economic Trends and Policy Developments (World Bank Report No. 4072-CHA), Annex 2, Table 20 (Chinese data), country data sources (Korea and Japan), and World Development Report, 1982.

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Specialization in Industrial Crops

1. A significant issue concerning Chinese cultivation of industrial crops (here referring to crops requiring considerable industrial processing including oilseeds, fiber crops, sugar crops and tobacco) is whether further gains in production efficiency could be realized from a greater degree of local specialization. The issue arises in part because of past Chinese Government encouragement of local self-sufficency in a wide range of crops, a practice abandoned only in the last few years. MAAF plans for the next two decades favor an unchanged overall area in industrial crops, but shifts among those crops to the most suitable locales. According to a MAAF briefing, present production of these crops is regarded as too dispersed.

2. The extent of specialization refers to the tendency of some localities to put a higher percentage of acreage in a particular crop than other localities, and the relation of these percentages to comparative advantage. It does not refer to the size of crop area proportions in isolation. One could also distinguish international specialization from internal specialization. The former is dealt with in the Annex (Section 5) whereas this Appendix will consider the latter. The issue will be analyzed using province-level data, but highly disaggregated data could well lead to different conclusions. Whether or not the extent of provincial specialization is in line with comparative advantage, it is possible that specialization between counties, communes, teams and/or farms is not. One hypothesis which merits study is that transport and commercial barriers to specialization between large geographic areas are more significant than those within such areas. If this is valid, problems of specialization between localities within larger areas are likely to be more amenable to short-run solutions.

3. Because provinces represent large geographic areas with diverse microenvironments, and because long-distance transport costs, even with the best of transport systems, encourage local production, considerable diversity of crops is to be expected at the provincial level. Therefore, the extent of specialization possible or desirable can only be assessed relative to some comparator. As a geographically large LDC in which cropping decisions are not so constrained by planning, India is a logical choice for a comparator country.

4. The question to be addressed is whether the significance of various industrial crops (measured as sown area in a crop relative to total sown area) in different provinces is in accord with provincial comparative advantage. The measure of comparative advantage used here is the provincial average yield of the industrial crop relative to that of cereal grains, normalized by dividing by the same ratio for the country as a whole. Thus, actual yields are adjusted by a measure of overall agricultural productivity (grain yields), and normalized so that a comparative advantage index of 100 indicates no relative advantage compared to national average productivity, whereas anything greater indicates positive comparative advantage.

5. The comparative advantage index (CAI) constructed has three potential deficiencies: (a) because yield data for a single year have been used in constructing the index, weather anomalies causing intertemporal yield fluctuations may affect the index. In the case of cotton in China, this influence has been corrected by using three-year average yields, with notable improvement in clarity of results; (b) the existence of a small area of exceptionally high productivity in a province which is otherwise unsuited for production of a particular crop can lead to anomalous findings. To control for this effect, provinces which plant less than 0.1% of total acreage in a crop (an arbitrary choice) have been excluded from the data, along with one or two extreme instances where the area percentage was less than twice this cutoff; and (c) if conditions within a province favor local specialization and such specialization exists, the CAI may give misleading results. For example, Shanghai Municipality has a large area north of the Yangtse River and along the coast which has always been specialized in cotton. Since the CAI compares high cotton yields in this subarea with very high grain yields in other parts of the municipality, it does not verify this comparative advantage.

6. With these caveats, Table A indicates the CAI for each state or province in India and China in seven major industrial crops, and the corres ponding proportion of sown area in each crop. The summary Table B indicates the cross-sectional correlation between the CAIs and the sown area percentages, along with some statistical attributes of the distributions of these variates. A positive correlation coefficient indicates that cropping proportions bear the expected relation with comparative advantage. A high coefficient of variation and degree of concentration about the mean (kurtosis) for the CAI might also suggest that the presence of significant area in a crop is poorly related to comparative advantage.

7. The conclusion which emerges is that provincial specialization according to comparative advantage is more characteristic of 1981 China than 1977/78 India. This is not to say that in either country specialization has been carried very far; merely that there is a more systematic relationship between acreage proportions and comparative advantage in China. (Tobacco is one exception: the high taxes levied on tobacco products in China, along with a high proportion of the population who smoke, may contribute toward a tendency for farmers to grow their own). It is also true that, overall, China has a smaller proportion of total sown area in industrial crops (tobacco being the lone exception among the seven crops compared).

8. The conclusion is surprising only because so much has been made of the self-sufficiency ethic and lack of specialization in China. On average, India's farmers are closer to subsistence, and subsistence producers tend to be as diversified as possible. Also, China's collective farming system, despite recent reforms, probably continues to reduce risk to the individual farmer, permitting a higher degree of specialization. This has been countered to some extent by the self-sufficiency orientation and weaknesses of the marketing and transport system. Further specialization has occurred in China since 1981.

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Provincial Comparative Advantage and Cropping Patterns, India (1977/78) and China (1981)

	Comparative advantage index /a							% of crop area /b							Relative cereals yield /c
	Ground-nut	Sesame	Rapeseed/ mustard	Cotton	Jute	Sugar-cane	Tobacco	Ground-nut	Sesame	Rapeseed/ mustard	Cotton	Jute	Sugar-cane	Tobacco	
India															
And. Pradesh	113	86	-	63	-	145	95	8.2	1.1	-	3.4	-	1.3	1.7	96
Assam	-	235	166	63	104	61	74	-	0.3	3.2	0.1	3.1	1.4	0.2	92
Bihar	-	121	97	-	97	68	93	-	0.2	0.9	-	1.3	1.2	0.1	94
Gujarat	124	118	101	147	-	118	184	19.2	1.1	1.0	17.9	-	0.6	0.8	84
Haryana	111	-	78	154	-	61	-	0.1	-	3.2	4.9	-	3.6	-	133
Himachal Pradesh	110	111	50	108	-	30	-	0.2	0.9	0.4	0.1	-	0.4	-	108
Jammu & Kashmir	-	80	151	98	-	11	-	-	0.5	3.5	0.1	-	0.2	-	119
Karnataka	78	175	-	89	-	124	64	8.5	0.9	-	9.0	-	1.4	0.4	105
Kerala	90	87	-	-	-	76	-	0.9	0.5	-	-	-	0.2	-	137
Madhya Pradesh	93	114	99	70	-	73	-	2.4	1.2	1.1	2.9	-	0.4	-	73
Maharashtra	109	162	-	86	-	227	-	4.3	0.9	-	11.8	-	1.3	-	74
Manipur	-	157	47	-	-	32	-	-	1.0	1.4	-	-	1.0	-	151
Meghalaya	-	-	116	55	111	-	-	-	-	3.4	3.0	3.0	-	-	105
Nagaland	-	-	125	-	-	66	-	-	-	1.8	-	-	2.6	-	86
Orissa	156	235	102	-	177	126	-	1.3	1.9	1.4	-	0.6	0.6	-	85
Punjab	50	174	46	101	-	43	-	2.5	0.2	2.1	9.7	-	1.9	-	232
Rajasthan	146	114	171	247	-	142	-	1.4	2.1	2.0	2.2	-	0.4	-	58
Tamil Nadu	88	102	-	101	-	121	98	13.5	1.6	-	4.2	-	2.3	0.3	153
Tripura	-	141	95	103	85	69	-	-	0.8	1.1	0.5	1.1	0.5	-	113
Uttar Pradesh	85	62	97	-	-	81	-	1.4	3.3	8.7	-	-	7.3	-	104
West Bengal	-	232	59	-	103	82	78	-	0.4	0.9	-	6.0	0.4	0.2	131
Total	100	100	100	100	100	100	100	4.2	1.4	2.0	4.6	0.5	1.9	0.3	100
China /d															
Beijing	50	49	38	56	-	-	-	2.8	0.5	0.4	0.3	-	-	-	121
Tianjin	82	84	-	40	21	-	-	1.4	0.9	-	1.5	0.1	-	-	73
Hebei	114	111	78	86	-	-	-	3.0	0.6	0.2	6.0	-	-	-	76
Shanxi	108	85	108	79	-	-	-	0.1	0.2	0.2	4.9	-	-	-	75
Neimengu	-	-	54	-	-	-	-	-	-	1.7	-	-	-	-	47
Liaoning	79	65	31	73	-	-	90	2.8	0.3	0.2	1.0	-	-	0.3	131
Jilin	67	-	-	-	-	-	104	0.2	-	-	-	-	-	0.3	93
Heilongjiang	-	-	-	-	-	-	165	-	-	-	-	-	-	0.2	61
Shanghai	-	-	128	93	-	-	-	-	-	9.5	15.5	-	-	-	147
Jiangsu	87	-	101	108	49	-	-	1.3	-	3.4	7.8	0.1	-	-	139
Zhejiang	60	86	85	86	89	71	-	0.2	0.1	6.1	2.3	0.7	0.2	-	149
Anhui	103	113	117	77	105	-	97	1.9	1.6	6.3	4.2	0.6	-	0.6	105
Fujian	88	78	38	-	86	106	49	3.4	0.1	1.8	-	0.2	2.0	0.7	134
Jiangxi	63	57	36	67	61	75	44	0.9	1.1	4.6	1.9	0.2	0.4	0.1	119
Shandong	134	99	95	107	53	-	118	6.4	0.2	0.2	9.0	0.2	-	0.9	100
Honan	67	108	79	110	123	-	148	1.8	2.6	2.3	5.8	0.4	-	1.3	91
Hubei	91	109	69	104	106	-	82	0.5	1.9	3.6	8.0	0.2	-	0.5	117
Hunan	47	65	55	73	99	69	55	0.5	0.1	4.6	2.1	0.1	0.2	0.7	142
Guangdong	77	41	31	-	87	100	53	6.7	0.3	0.4	-	0.5	3.5	0.5	116
Guangxi	61	47	35	-	74	75	65	2.8	0.4	0.2	-	0.7	2.6	0.6	103
Sichuan	70	107	114	63	86	57	60	0.8	0.2	4.7	2.0	0.2	0.4	0.5	119
Guizhou	61	-	104	43	-	57	87	0.5	-	9.9	0.1	-	0.1	2.7	100
Yunnan	70	-	76	61	-	95	127	0.7	-	2.4	0.1	-	1.2	1.9	92
Sizang	-	-	112	-	-	-	-	-	-	5.2	-	-	-	-	89
Shaanxi	111	72	157	90	-	-	94	0.2	0.2	2.6	5.4	-	-	0.3	65
Gansu	-	-	134	-	-	-	209	-	-	1.2	-	-	-	0.1	54
Qinghai	-	-	110	-	-	-	-	-	-	14.8	-	-	-	-	69
Ningxia	-	-	51	-	-	-	-	-	-	0.3	-	-	-	-	63
Xinjiang	-	-	75	121	-	-	-	-	-	3.4	7.8	-	-	-	66
Total	100	100	100	100	100	100	100	1.7	0.6	2.6	3.6	0.2	0.4	0.5	100

/a Comparative advantage index: for each crop, the yield (tons/ha) divided by average cereals yield for the same locality; all divided by the same ratio for national average yields as a numeraire, and multiplied by 100. Thus a value of 100 means that the yield of that crop relative to grain is the same as for the country as a whole; a value greater than 100 implies a comparative advantage in that crop relative to the locales with values below 100.

/b Percent of crop area sown to each crop, with total sown area in the locale equal to 100.

/c With national average equal to 100.

/d Chinese cotton index is based on three-year average yields of cotton and grain (1979-81).

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Interprovincial Specialization in Industrial Crops in China and India /a

	Correlation coefficient		Characteristics of distribution							
			C.A.I. /b				% of crop area /c			
	India	China	India		China		India		China	
	R/d	R	V/e	K/f	V	K	V	K	V	K
Groundnuts	0.16	0.23	113	0.18	66	0.23	218	0.21	138	0.42
Sesame	-0.17	0.33	64	0.22	103	0.31	97	0.22	191	0.15
Rape	0.22	0.43	84	0.27	44	0.41	133	0.37	104	0.36
Cotton /g	0.19	0.42	114	0.22	82	0.24	183	0.25	140	0.32
Jute	0.46	0.45	339	0.12	162	0.21	426	0.48	198	0.25
Sugarcane	-0.02	0.54	64	0.27	256	0.12	122	0.22	389	0.23
Tobacco	0.48	0.15	291	0.24	117	0.24	418	0.22	172	0.18

/a Cross-state or cross-provincial data for India (1977/78) and China (1981) from Table B.1. Statistics apply to varying numbers of states/provinces which produce various crops.

/b Comparative advantage index. For each crop, the yield (t/ha) divided by the average cereals yield for the same locality, all divided by the same ratio for national average yields as numberaire, and multiplied by 100. Instead of comparing allocations for each crop across provinces, it would also be possible to compare allocation for each province across crops. This exercise, however interesting, would not permit cross-country comparisons.

/c Percent of state/provincial crop area shown to each crop.

/d Correlation coefficient between comparative advantage index and percent of area sown to crop across states/provinces.

/e Coefficient of variation: 100 x standard deviation/mean.

/f Coefficient of kurtosis: a measure of "peakedness" of distribution, i.e. concentration around the mean (higher K implies greater concentration).

/g Chinese CAI based on 1979-81 average cotton yields.

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A Methodology to Examine Potential for Ruminant Livestock on China's Grasslands

1. If ruminant animal husbandry is to play a major role in the diversification of China's agriculture by the year 2000, the extensive grasslands concentrated in the northern and northwestern provinces will need to be developed as a major animal product base (see Map No. 5). These grasslands, and others throughout China, if managed well, have the potential to support more productive populations of cattle, sheep, goats and other ruminants. However, the present status of these grasslands is one of serious degradation. The poor condition of most of China's grasslands is the result of decades of overgrazing under collective management, which treated the pastures as a "commons", used by all but protected by none.

2. The various Production Responsibility Systems, along with other rural management reforms, appear to offer a basis for an improvement in pasture conditions in the grasslands and hence higher incomes to the livestock producers based there. Recently promulgated grassland regulations in Inner Mongolia and Hebei anticipate a national grasslands law which allocates management rights of grasslands to individuals and households. Allocation of individual use rights is essential to improved productivity of these lands. Other significant management reforms include the creation of provincial grassland authorities to oversee pasture rehabilitation and protection and to improve rural marketing channels for livestock and livestock products. This note outlines a methodology for estimating the quantitative potential for grassland animal husbandry and applies the methodology to develop a crude estimate of production in the year 2000.

Grassland Livestock Development: Technology and Policy

3. Development of ruminant livestock in the grasslands involves two major types of technologies, viz., those related to pasture improvement and those involving herd management. Separate analysis of these two activities forms the basis of this methodology. Pasture development is as important as better management of herds and flocks. Increases in dry matter output and improvements in its nutritional quality are essential for any significant improvement in China's ruminant livestock industry.

4. The most immediate objective of pasture development can be summarized most conveniently in terms of increased metabolizable energy available from the grasslands. This concept combines physical yield and nutrient content into energy yields per hectare of grassland. The ultimate objective, however, is not increased production of plant material. Instead, it is a larger supply of animal products, in terms of meat, milk, wool, hides, and hair. This emphasis on actual off take of livestock products is different from the Chinese measurement of livestock output which makes increased value of animals on the hoof an important component of reported production. In

other words, the key consideration is not the conversion of plant material into more animals but into more animal products. The methodology used below concentrates on this process by focusing on improved herd management: younger herds, better nutrition per head and more rapid growth and slaughter.

5. Appropriate policies for development of grasslands animal husbandry can best be understood in terms of their impacts on pasture improvement and herd management. Pasture improvement is most likely to result from improved incentives for grassland rehabilitation and maintenance and more information on the best techniques to those ends. Modern techniques of rangeland management, implemented within an institutional framework which allocates private use rights for the range, are among the most important elements in improvement of China's grasslands.

6. Incentives and technical information are also primary ingredients of successful herd management. Incentives for greater efficiency and productivity would most likely come from price reforms which incorporate higher prices for younger animals. With incentives in place, information on the merits of improved herd management and animal nutrition are essential to the introduction of improved technologies. Above all, successful development policies need accurate technical information for land use planning. Surveys of grassland potential and herd conditions and their analysis should be a prerequisite for any development investments. The information gained in such surveys also would be invaluable in validating the technical coefficients which underlie the analysis in this note.

Estimating Output in the Year 2000 - Stylized Technologies

7. The methodology employed here makes use of stylized technologies to estimate dry matter production and herd management under alternative development scenarios. Stylized technologies are extremes of poor and good management. Levels of development are then represented as weighted combinations of poor and good management extremes. The four major steps in the analysis are:

(a) Identify and estimate existing areas of different grassland regions from herd population data and available information on carrying capacity [Table 1];

(b) Calculate metabolizable energy yields in these regions under two stylized pasture management technologies, one representing current conditions, the other representing more optimal potential [Tables 2 and 3];

(c) Develop low, medium and high scenarios for year 2000 pasture development as different combinations of the two stylized pasture management technologies [Table 4];

(d) Estimate animal product offtake levels in 2000 in the low, medium and high scenarios taking into account different combinations of poor and improved herd management technologies [Table 5]. Herd management scenarios have total metabolizable energy requirements

matching pasture production levels. In general, the method estimates the dry matter production base, and then calculates the herd size and product offtake levels which that base supports.

8. The first step in estimating the dry matter production base is to determine the area of China's grasslands. Detailed data are unavailable and regional variability is large. Some grasslands are very productive; some are essentially desert. Estimating the dry matter production base therefore requires a breakdown of grassland area by type. Seven types of grasslands are identified. Their areas are estimated from data on herd sizes which graze each type and from crude estimates of carrying capacity. Assumptions about carrying capacity are then adjusted to arrive at a total grassland area which matches the official figure.

9. The second step is to estimate metabolizable energy from each type of pasture and from other principal sources of dry matter (grass and legume hays, silage, concentrates). This estimate is made for two stylized technologies. The first technology represents unimproved grassland conditions as they were in 1980. Dry matter yields and quality are low, as represented by the low metabolizable energy content. See Table 2 for these 1980 "no-improvement" production estimates. The second pasture technology represents output levels, with both high physical yields and high nutrient (energy) content. A more optimal development strategy also would increase areas planted to non-grass dry matter sources (legumes, silage, concentrates). The areas, yields, and energy output levels for optimal development are given in Table 3.

10. These rough estimates suggest that the full development of China's grasslands would quadruple the metabolizable energy from levels currently available. However, it is unlikely that all of China's grasslands will be developed to their full potential by the year 2000. The stage of development will likely be somewhere between the no-improvement scenario and full development. Thus, in step 3 different intermediate development stages are represented by a weighted average of the two extreme, stylized, technologies. This methodology represents only a simplifying technique; actual pasture development is likely to involve a wide range of development levels.

11. The methodology assumes that for each type of grassland and dry matter source, a portion of the area is developed to its full potential while the rest is left unimproved. Furthermore, we can assume that some of the grasslands can be developed more quickly and at lower cost per hectare. As other grassland areas are increasingly more difficult to improve, the per-hectare cost would increase. Hence, different dry matter output scenarios and their associated costs can be projected. This is done in Table 4. The low, medium and high scenarios effectively double, triple and quadruple available metabolizable energy, respectively.

12. Step 4 links dry matter supply and livestock product offtake levels. The methodology assumes two stylized herd management alternatives. With unimproved or traditional management, herds are old, slow growing, and low in per-head offtake levels. Although per-head feed energy requirements are low, per-head offtake is also extremely low. Under improved management,

however, herds are younger, heavier and slaughtered earlier. For a given level of dry matter production, there are fewer animals, but they are better fed. Although the per-head requirement is higher than in the no-improvement scenario, the value-offtake per head is much higher and more than compensates for the increased feed costs. For example, the two extreme herd management technologies assumed here for cattle suggest that the well-managed herd may require over three times as much metabolizable energy per head on average, but has a value offtake more than ten times greater than in the no-improvement case.

13. For the year 2000, low, medium and high management scenarios assume different mixes of stylized herds, with total animal numbers adjusted to match metabolizable energy available for each scenario. As a result of improved herd management, the value of offtake obtained from a given level of dry matter increases, amplifying the economic significance of increases in feed availability. Illustrative results are given in Table 5 and highlight the importance of range cattle as sources of meat and milk.

A Caveat - The Need for Accurate Technical Parameters

14. The basic purpose of this note is to illustrate a methodology to assess the productive potential of China's grasslands. While the exercise suggests that productivity could be substantially increased, the validity of this conclusion depends heavily on the reliability of underlying information and assumptions in regard to livestock numbers, range conditions, nutritive values of particular plant materials and the relationship in Chinese conditions between the consumption of feed by livestock and the offtake of animal products. In each of these areas, knowledge is limited and better information is required to establish a more accurate picture of the role which the grasslands might play in meeting China's future demands for livestock products.

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Pastoral Herds and Grassland Area by Type, 1971 /a
(Sheep animal unit equivalent) /b

	Unit	Rangeland		Desert		Cold highlands			Total
		Wooded range	Dry range	Mountainous	Plains	Mt. meadow	Northern plateau	Southern mountain	
Livestock (Sheep A.U.)									
Cattle	mln	11.6	5.8	5.8	17.9	37.8	6.7	7.2	92.6
Horses	mln	4.7	4.3	3.8	10.5	2.3	0.3	0.2	26.1
Donkeys	mln	2.0	0.4	0.2	3.4	0.2	/c	0.2	6.4
Mules	mln	0.5	0.3	/c	0.1	0.1	/c	/c	1.1
Camels	mln	/c	0.7	0.4	1.8	/c	/c	/c	3.0
Goats	mln	0.6	1.9	0.6	3.2	1.3	2.7	0.8	11.1
Sheep	mln	1.3	7.1	6.6	23.6	12.2	1.7	3.1	5.6
Pigs	mln	11.0	3.5	0.3	2.5	1.1	/b	0.1	18.5
Total sheep A.U.	mln	31.7	24.0	17.7	62.9	55.1	11.4	11.8	214.5
Nonpig total A.U.	mln	20.7	20.5	17.4	60.4	54.0	11.4	11.7	196.0
Pasture Land Area									
Chinese mu	mln	103	225	523	1,510	486	284	233	3,365
Hectares	mln	7	15	35	101	32	19	16	224
Share of total	%	3.1	6.7	15.5	44.9	14.4	8.4	6.9	100.0
Carrying Capacity									
Mu/sheep A.U.		5	11	30	25	9	25	20	-

/a "Wooded" is from the Chinese sen-lin and implies a good water supply. "Meadow" is the Chinese dian and implies well-watered pasture. 15 mu = 1 ha.

/b Sheep A.U.: sheep = 1, cow = 5, goat = 0.6, horse = 6, mule = 6, donkey = 3, camel = 8, pig = 2.

/c Less than 100,000.

Source: "Comprehensive Chinese Agricultural Geography," Economic Geography Division, Geography Research Institute, National Academy of Sciences, (Beijing: 1980), p. 302 (in Chinese), and author's calculations in Albert Keidel (1984), "China's Pastoral Ruminant Livestock: Development Potential in the Year 2000," Parts I and II; Rock Creek Research, Washington, D.C., April 1984.

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Metabolizable Energy by Source, 1980

	Area (mln mu)	Yield (kg/mu)	% dry matter	Dry matter yield (kg/mu)	Energy (MC/kg of DM)/c	Energy yield (MC/mu)	Total energy (bln MC)
Grazing land							
Wooded range	103	300	25	75	0.48	36	3.7
Dry range	225	225	25	56	0.48	27	6.1
Mountain meadow	486	250	25	63	0.48	30	14.5
Northern plateau	284	115	25	29	0.48	14	3.9
Southern mountain	233	130	25	33	0.48	16	3.6
Desert plains	1,510	100	25	25	0.48	12	18.0
Mountainous desert	523	85	25	21	0.48	10	5.4
Grass for hay	125/a	175	85	149	0.96	142	17.8
Legumes, grazed/hay	2/b	350	85	298	1.43	426	0.9
Maize silage	2/b	500	30	150	1.91	287	0.6
Concentrates	5/b	50	40	20	2.63	53	0.3
Farm by-products	10/b	200	15	30	1.59	48	0.5
Total Metabolizable Energy							75.2

/a Grass for hay in 1980 assumed to be one fourth of "meadow" and "wooded" lands.

/b Assumed very small for ruminant livestock use, based on data and observation from Inner Mongolia, Hebei and Heilongjiang.

/c MC: megacalorie.

Source: Grazing areas from Table C.1. Other data from various Chinese sources and yield and energy information from FAO and IFAD livestock and range development projects in North China, and calculations in Albert Keidel (1984), op. cit.

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Potential Metabolizable Energy With Improved Management

	Area (mln mu)	Yield (kg/mu)	% dry matter	Dry matter yield (kg/mu)	Energy (MC/kg of DM)	Energy yield (MC/mu)	Total energy (bln MC)
Grazing land							
Wooded range	103	500	25	125	1.19	149	15.4
Dry range	225	300	25	75	1.19	90	20.2
Mountain meadow	486	350	25	88	1.19	105	50.8
Northern plateau	284	200	25	50	0.72	36	10.2
Southern mountain	233	250	25	63	0.96	60	13.9
Desert plains	1,510	175	25	44	0.72	31	47.3
Mountainous desert	523	100	25	25	0.72	18	9.4
Grass for hay	200	300	85	255	1.43	366	73.1
Legumes, grazed/hay	50	450	85	383	1.91	731	36.6
Maize silage	15	1,500	30	450	2.39	1,075	16.1
Concentrates	15	150	75	113	3.11	349	5.2
Farm by-products	30	300	15	45	1.59	72	2.2
Total Metabolizable Energy							300.3

Source: As in Table C.2.

CHINA

AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Dry Matter Production Under Alternative Development Scenarios, 1980, 2000

	Energy yield (MC/mu)	1980 Area (mln mu)	1980 Energy (bln MC)	2000 Low Area (mln mu)	2000 Low Energy (bln MC)	2000 Medium Area (mln mu)	2000 Medium Energy (bln MC)	2000 High Area (mln mu)	2000 High Energy (bln MC)
Grazing land									
Wooded land									
Unimproved	35.8	103	3.7	83	3.0	33	1.2	-	-
Improved	149.3	-	-	20	3.0	70	10.5	103	15.4
Dry range									
Unimproved	27.0	225	6.1	165	4.5	65	1.8	-	-
Improved	89.6	-	-	60	5.4	160	14.3	225	20.2
Mountain meadow									
Unimproved	29.9	486	14.5	386	11.5	236	7.0	-	-
Improved	104.6	-	-	100	10.5	250	26.2	486	50.9
Northern plateau									
Unimproved	13.9	284	3.9	134	1.9	24	0.3	-	-
Improved	35.8	-	-	150	5.4	260	9.3	284	10.2
Southern mountain									
Unimproved	15.5	233	3.6	233	3.6	233	3.6	-	-
Improved	59.7	-	-	-	-	-	-	233	13.9
Desert plains									
Unimproved	11.9	1,510	18.0	510	6.1	110	1.3	-	-
Improved	31.3	-	-	1,000	31.3	1,400	43.8	1,510	47.3
Mountainous desert									
Unimproved	10.3	523	5.4	223	2.3	73	0.7	-	-
Improved	17.9	-	-	300	5.4	450	8.1	523	9.4
Grass for hay									
Unimproved	142.1	125	17.8	100	14.2	50	7.1	-	-
Improved	365.5	-	-	50	18.3	125	45.7	200	73.1
Legumes, grazed/hay									
Unimproved	426.4	2	0.9	1	0.4	-	-	-	-
Improved	731.0	-	-	15	11.0	40	29.2	50	36.6
Maize silage									
Unimproved	286.7	2	0.6	1	0.3	-	-	-	-
Improved	1,075.0	-	-	4	4.3	10	10.8	15	16.1
Concentrates									
Unimproved	52.6	5	0.3	5	0.3	5	0.3	-	-
Improved	349.5	-	-	-	-	-	-	15	5.2
Farm by-products									
Unimproved	47.8	10	0.5	7	0.3	2	0.1	-	-
Improved	71.7	-	-	10	0.7	20	1.4	30	2.2
Total Improved Land /a		-		1,709		2,785		3,674	
Total Energy Available (bln MC)			75.2		143.5		222.7		300.3
Marginal cost/mu (Y) /b		-		5		20		50	
Additional cost (Y mln)		-		8,545		21,520		44,450	
Accumulated cost (Y mln)		-		8,545		30,065		65,970	

/a Total includes both grazing and nongrass dry matter sources.
/b Incremental to the previous scenario.

Source: Energy yields and area ranges from Tables C.2 and C.3. Cost data estimated from various ongoing IFAD and FAO projects.

CHINA

AGRICULTURE TO THE YEAR 2000: PROSPECTS AND OPTIONS

Overall Ruminant Production and Dry Matter Requirements

	Dry matter needs per head (000 MC)/a	Average offtake value per head (Y)	1980 Herd size (000 head)	1980 Total energy needs (bln MC)/a	1980 Total offtake value (mln Y)/b	2000 Low Herd size (000 head)	2000 Low Total energy needs (bln MC)/a	2000 Low Total offtake value (mln Y)/b	2000 Medium Herd size (000 head)	2000 Medium Total energy needs (bln MC)/a	2000 Medium Total offtake value (mln Y)/b	2000 High Herd size (000 head)	2000 High Total energy needs (bln MC)/a	2000 High Total offtake value (mln Y)/b
Cattle														
Draft	2.39		10	/c		5	/c		5	/c		1	/c	
Nondraft														
Well-managed	3.87	293	20	0.1	6	17,000	66	4,977	36,000	135	10,247	55,000	213	16,102
Poorly-managed	1.19	24	18,295	21.9	434	18,000	22	427	12,000	6	119	0	0	0
Sheep														
Well-managed	0.43	23	1,000	0.4	23	40,000	17	916	70,000	30	1,602	150,000	65	3,434
Poorly-managed	0.29	12	70,153	20.1	836	50,000	14	596	50,000	14	596	0	0	0
Goats														
Well-managed	0.33	10	100	/c	1	5,000	2	48	5,000	2	48	5,000	2	48
Poorly-managed	0.19	4	23,379	4.5	94	5,000	1	20	3,000	13	281	0	0	0
Horses	3.58	-	4,937	17.7		4,500	16		4,000	14		4,000	14	
Donkeys	1.91	-	2,104	4.0		2,000	4		2,000	4		1,500	3	
Mules	3.58	-	346	1.2		350	1		350	1		300	1	
Camels	4.78	-	471	2.3		400	2		400	2		350	2	
Total Energy Requirements				72.2			145			222			299	
Total Offtake Levels			(000 t)			(000 t)			(000 t)			(000 t)		
Beef			100		250	945		2,532	1,860		5,010	2,743		7,407
Mutton			241		650	369		997	520		1,404	755		43
Goat meat			27		73	22		58	19		52	16		43
Milk			559		168	9,465		2,840	19,260		5,778	28,875		8,663
Wool			82		163	235		470	370		740	675		1,350
Goat hair			5		10	3		7	3		6	2		5
Hides/skins ('000 units)			8,625		78	7,790		80	9,040		93	7,850		82
Total Annual Offtake Value (mln Y)					1,393			6,984			13,083			19,586

/a MC: megacalorie. bln MC: billion megacalorie.
/b From all products. Changes in total offtake from horses, donkeys, mules and camels considered negligible and ignored.
/c Less than 100 million MC.

Source: Dry matter needs and offtake per head from various international, official Chinese, and IFAD, UNDP, or FAO consultant reports, with calculations from Keidel, op. cit. Other data derived from previous tables.

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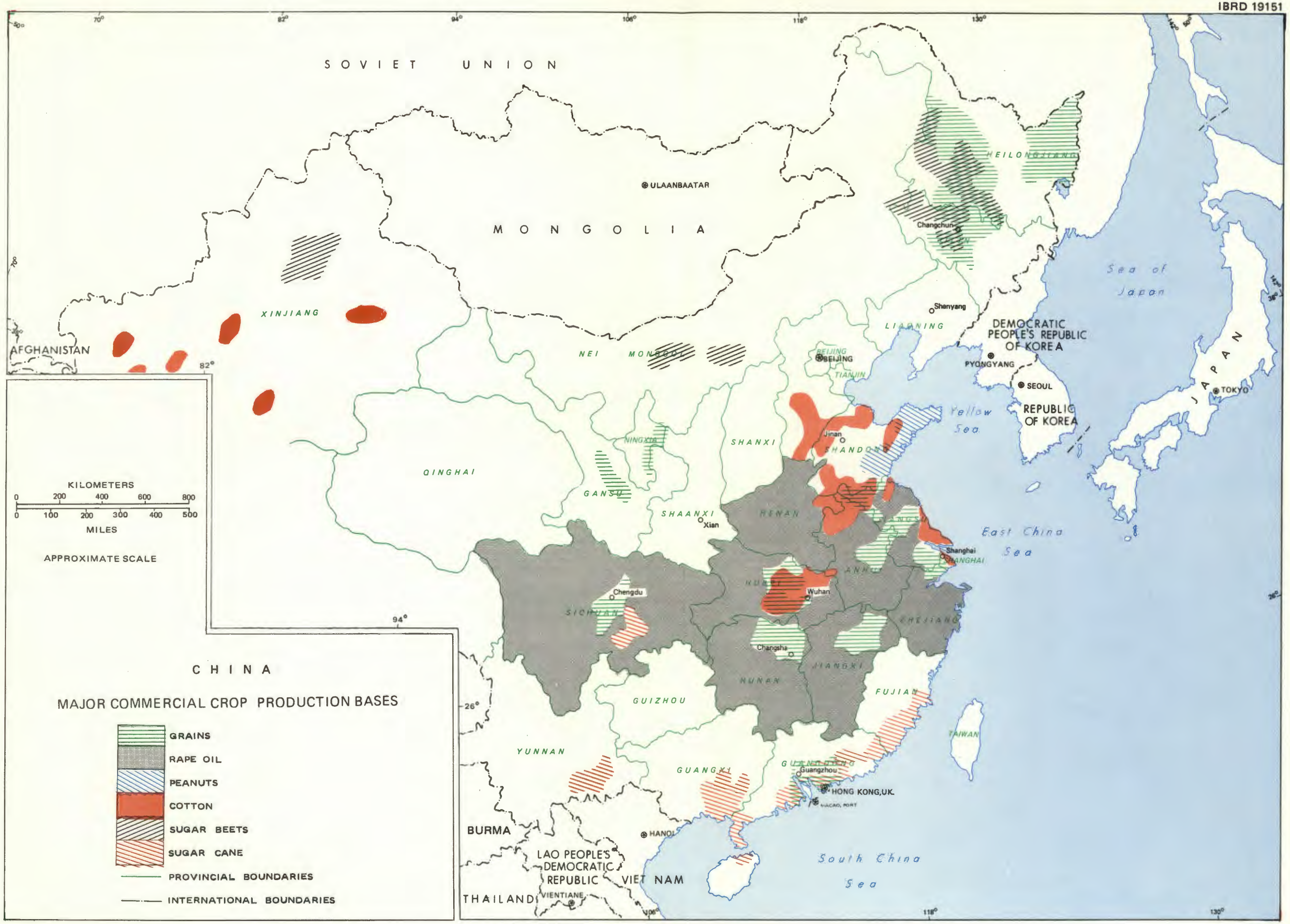

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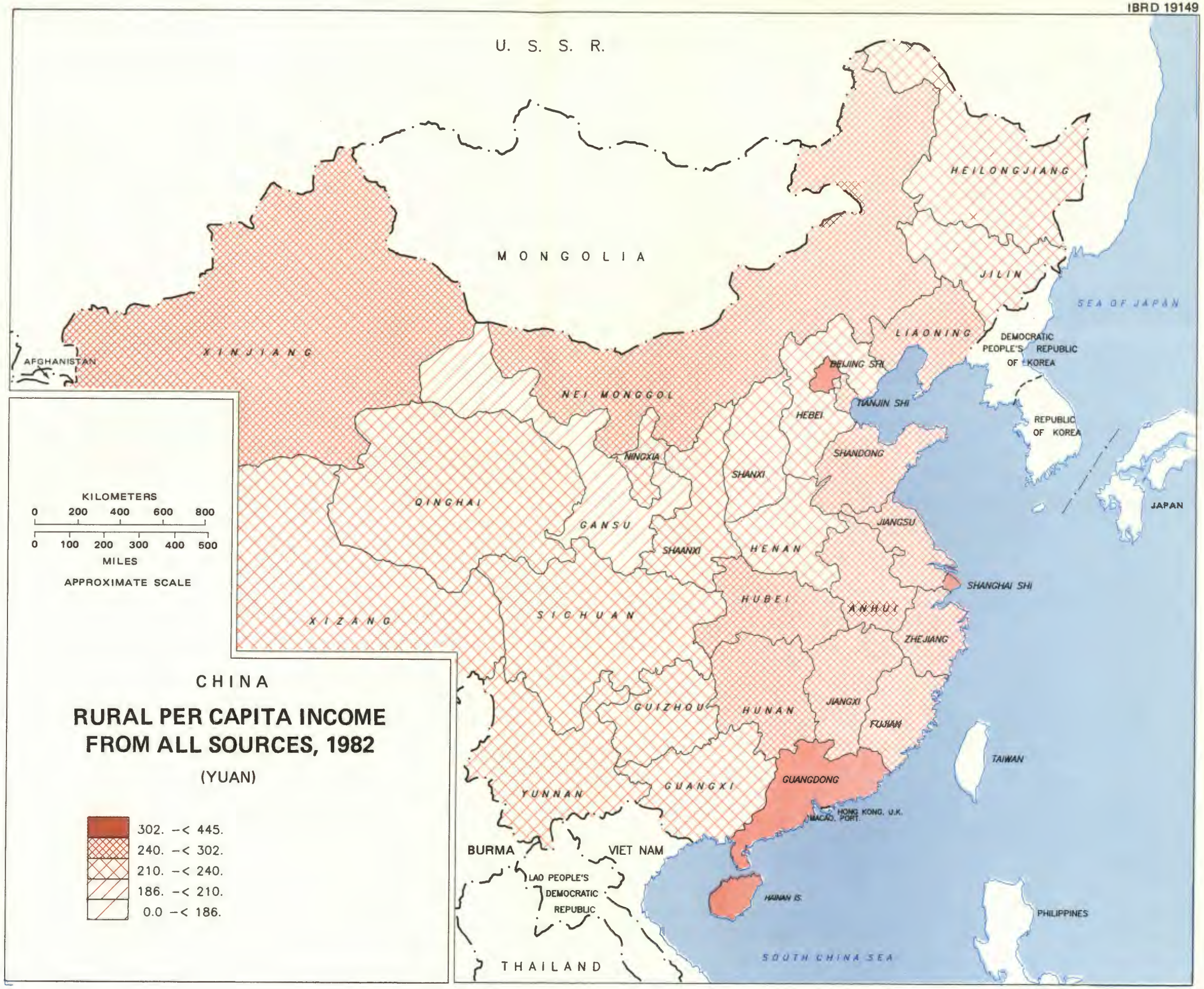

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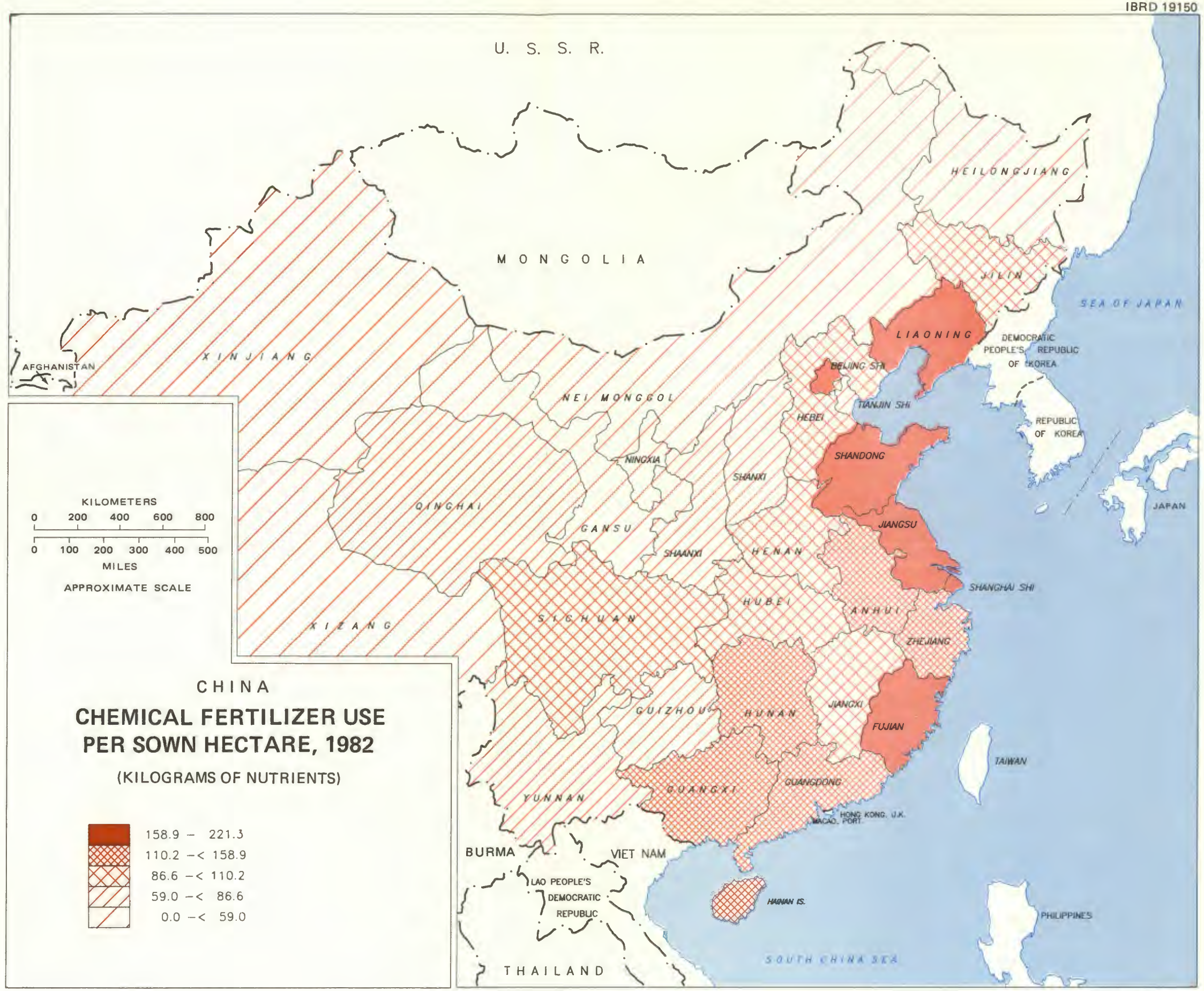

CHINA

CHEMICAL FERTILIZER USE PER SOWN HECTARE, 1982

(KILOGRAMS OF NUTRIENTS)

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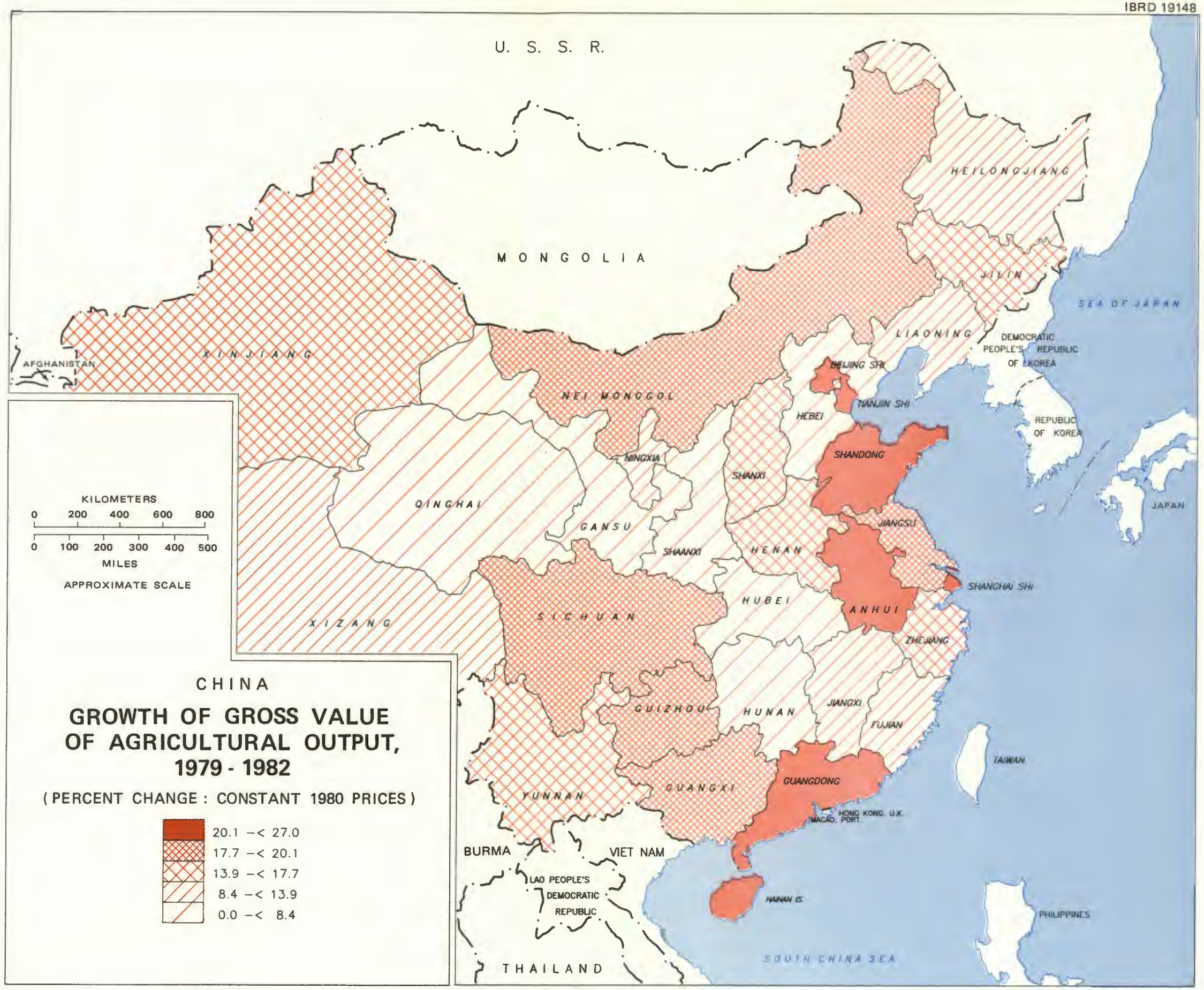

CHINA

GROWTH OF GROSS VALUE OF AGRICULTURAL OUTPUT, 1979 - 1982

(PERCENT CHANGE : CONSTANT 1980 PRICES)

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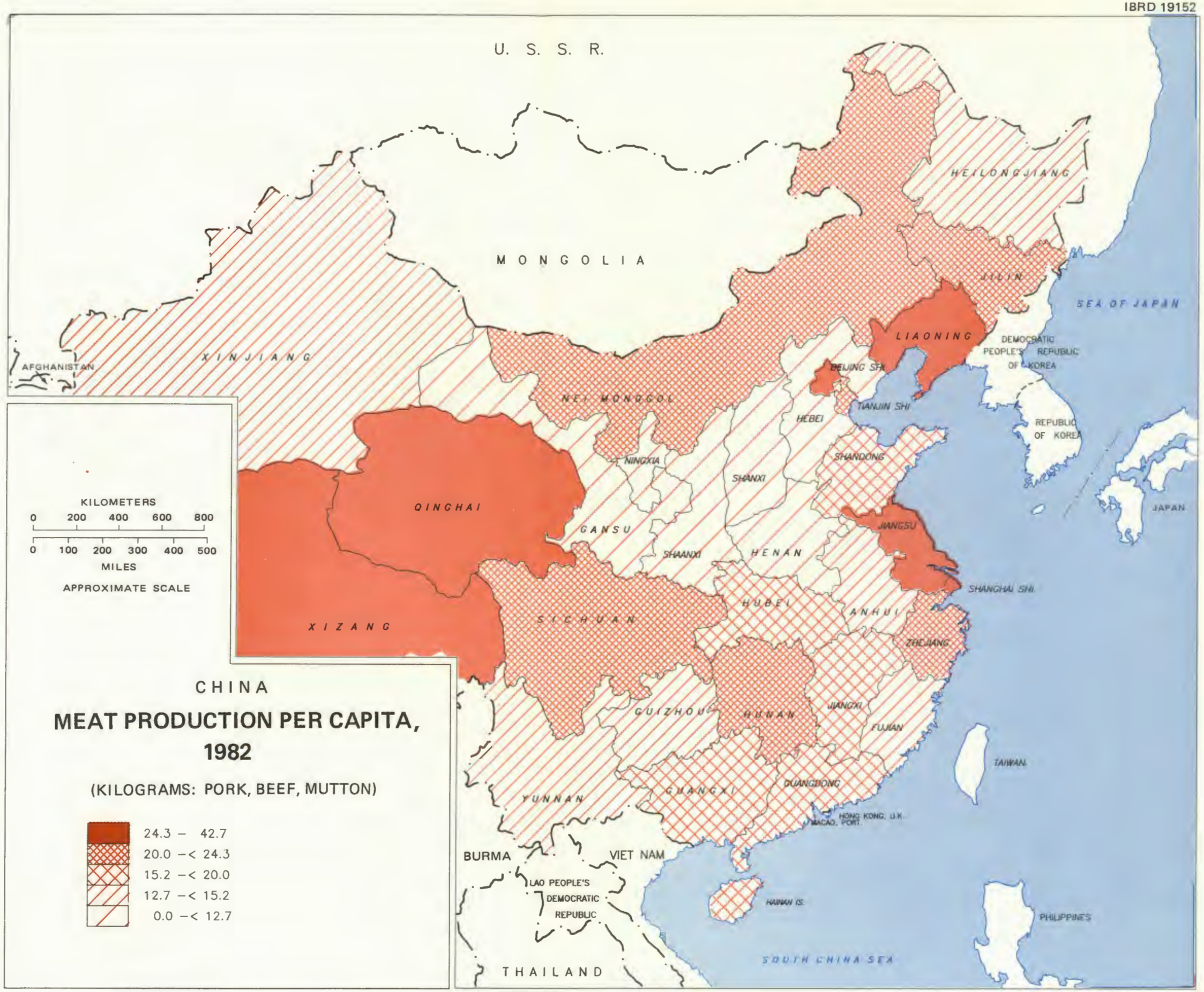

CHINA

MEAT PRODUCTION PER CAPITA, 1982

(KILOGRAMS: PORK, BEEF, MUTTON)

- 24.3 – 42.7
- 20.0 –< 24.3
- 15.2 –< 20.0
- 12.7 –< 15.2
- 0.0 –< 12.7

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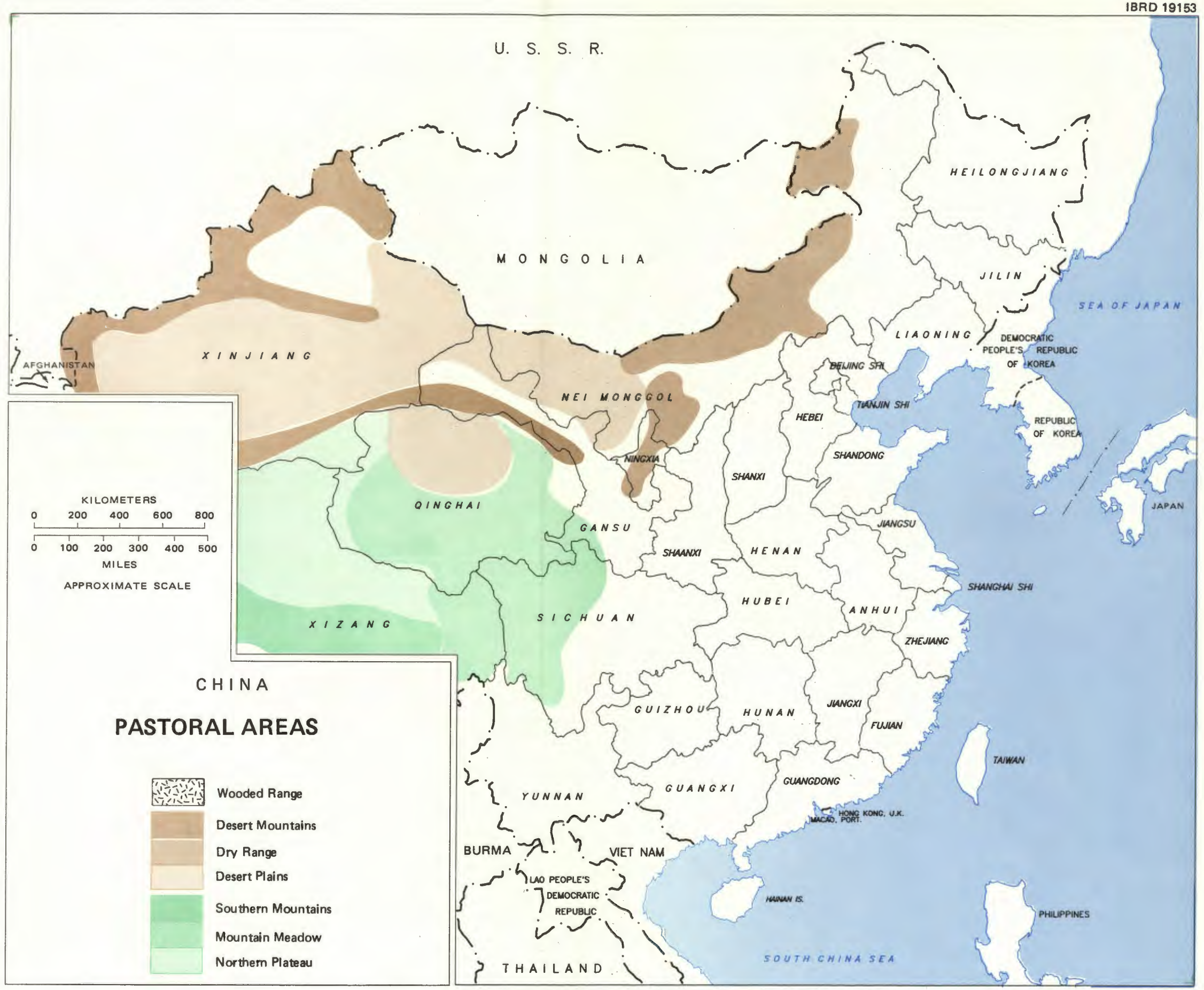

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