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Better Crops International

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Our Cover: The People's Republic of China is making great strides in agricultural productivity. Balanced fertilization is an important reason.
Photo by Dr. Sam Portch – at a market in Yunnan province.

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Introduction to this Issue

This special issue of Better Crops International features summaries of papers presented at the Balanced Fertilization Situation Report-II, China (BFSR-II), organized by Canpotex Limited. The event took place in Beijing, People's Republic of China (PRC), in January of 1996.

While the complete papers from the BFSR-II are available in a published proceedings, the abstract articles presented here provide the highlights and key points addressed by the speakers.

Balanced fertilization is an important concept, especially for the People's Republic of China and other regions facing the challenge of increasing agricultural production. While great strides have been accomplished in recent years, much remains to be done in diagnosing field conditions, completing research efforts, and relaying information to those who need to know more about nutrient management.

The Potash & Phosphate Institute/Potash & Phosphate Institute of Canada (PPI/PPIC) and Canpotex Limited acknowledge the great cooperation of the Chinese Ministry of Agriculture in sponsoring and organizing the BFSR-II.

English summaries of the technical papers herein were prepared from the original papers by Dr. Sam Portch of the Potash & Phosphate Institute, Hong Kong office.

The authors' original papers can be found in the proceedings of Balanced Fertilization Situation Report-II, available from Canpotex Limited, Hong Kong office.

International Cooperation in the Field of Agriculture and Balanced Fertilization in China

By Liu Congmeng

Benefits to China from international cooperation range from increased funding and introduction of new technology to improving management skills and understanding agricultural development techniques. The Balanced Fertilizer Demonstration Program (BFDP) of Canpotex Limited has been a model involving foreign governments, private enterprise and the Ministry of Agriculture. The BFDP has had a large impact on China's agriculture and the economic well-being of farmers.

International experts discussing policy issues at a 1995 conference.

Since the initiation of reform and opening-up of China, international cooperation in agriculture has resulted in extensive utilization of new farm technologies, improving agricultural development and the rural economy. Of particular importance are achievements in:

- Injection of foreign funds into agricultural development. These are indispensable to China's agricultural development as they have filled the financial gap resulting from limited domestic funding.
- Human resource development. Agricultural development requires scientific research and technology transfer. Management of this development depends on highly qualified personnel. International cooperation has played an extensive role in developing this human resource base both by out-of-country and in-country training of Chinese scholars. With their views broadened, information exchanged and thinking liberalized, many have become the backbone of technical and management changes in China.
- New technology and equipment. These introductions have occurred across agriculture and include soil fertility, animal husbandry and fisheries. These technologies have become examples for others.
- Policy and rural economic reform accelerated. Through extensive international exchanges, technical and management personnel from various agricultural departments have a better understanding of current problems, solutions and lessons for

agricultural and rural economic development. With this knowledge, integrated rural enterprises have sprung up that produce products of international quality.

International cooperation in agriculture has promoted the introduction and implementation of new technologies, new varieties and new management styles. These have increased the rate of development in the agricultural sector and substantially improved the rural economy.

The People's Republic of China has about 22 percent of world population and about 7 percent of world cultivated land. International cooperation is important in implementing new technologies for continued success.

One of the important technologies introduced was balanced fertilization. Inorganic fertilizers have helped increase grain yields by 30 to 50 percent, but these costly inputs must be used efficiently to maximize production and economic benefits. Also, when used in a balanced manner to improve soil fertility, they help maintain or enhance the environment by conserving soil and water resources.

The BFDP has been a model of successful international cooperation among the Government of Canada, the Government of Saskatchewan, PPI/PPIC and Canpotex Limited on one side and the Ministry of Agriculture and its affiliated organizations on the other. BCI

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History of the Canpotex Market Development Program in China

By Perry Onstot

The Balanced Fertilizer Demonstration Program (BFDP) sponsored by Canpotex Limited was introduced in China and has been an outstanding success. With its economy and agriculture doing well, China needs to invest more in its BFDP...and in agricultural research and extension. China needs more competition in fertilizer distribution and sales to ensure better farmer prices and services along with a more balanced fertilizer program. Retail fertilizer outlets must be located closer to farmers...to be sure adequate amounts of the right fertilizers are made available at the right place and at the right time.

Canpotex Limited was formed in 1970 as a producer-owned potash marketing company. Its first potash sale to China was in 1972.

In 1984, Canpotex Limited made a long-term commitment to help Chinese agricultural development by hiring a person and establishing the basis for the BFDP. A market survey of 1,500 farmers was commissioned to learn of their knowledge about fertilizers, their sources of information and details on crops grown. Radio and newspapers were shown to be the best mass media means to reach farmers. Radio programs and newspaper articles on balanced fertilization were produced and used. Pamphlets were produced based on results of PPI/PPIC funded research to guide farmers on balanced fertilizer use. Requests came from farmers, extension personnel and scientists for more information. Many farmers became aware of the benefits of "Canadian Pink Potash."

Plans were made with China National Agricultural Means of Production Group Corporation (CNAMPGC) in 1986 for developing field demonstrations and field days in farmers' fields, which launched the BFDP. Guangxi province and the Guangxi Soil and Fertilizer Institute (SFI) were selected as the pilot project area and cooperator, respectively. PPI/PPIC worked with the SFI to ensure the scientific basis of demonstrations with sugarcane, rice and kenaf at each of two locations.

Six harvest field days were held to show farmers the benefits of balanced fertilization. Rice yields increased by 22 and 37 percent, kenaf by 39 and 88 percent and sugarcane by 32 and 37 percent. The pilot project in Guangxi was considered an outstanding success and became the model for expanding this initiative. A television documentary was developed based on this experience.

Two important criteria for program expansion to other provinces were:

- Availability of research data indicating need for potash. Recommendations for potash

This scene is from a harvest field day of the BFDP in Zhejiang: "Seeing is believing."

use were then developed from the data.

- A ready supply of all needed fertilizers.

Shortly after initiating the Guangxi pilot program, it became apparent that potash supply was lacking in many areas wanting to participate in the program. That was the decisive factor for initiating a field inspection day for leaders (policy-makers) to show them the benefits of balanced fertilization and, thereby, the need for increasing supplies of fertilizers, especially potash, throughout their province.

The BFDP expanded its influence to new provinces as information and resources permitted. Today, 22 provinces and regions in China are included in the Canpotex Limited BFDP.

This program is unique. Canpotex Limited has invested large sums of money and time to help farmers increase yields, improve crop quality, protect the environment and make profit for all concerned. In addition, Canpotex Limited has supported agricultural research and development programs through the Canada International Development Agency (CIDA), the PPI/PPIC China Program, and conferences, publications, etc.

As China moves to join world markets, the economics of fertilizer use becomes an issue of significant importance. Balancing present levels of nitrogen (N) and phosphorus (P) use with potassium (K) is highly profitable for farmers and the nation. However, China must increase potash importation to meet demand while improving marketing and distribution systems so farmers get their fertilizer products at the time crops are being planted or need to have fertilizer applied. BCI

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Significance of Balanced Fertilization Based on Long-Term Fertilizer Experiments

By Lin Bao

Balanced fertilization is the key to efficient fertilizer utilization and for sustainable high yields. Long-term experiments demonstrate that utilization of nitrogen (N) alone, or N and phosphorus (P) created deficiencies of potassium (K) that can only be overcome by application of K fertilizers. Attention must also be given to other essential nutrients as well as the use of manures. It is possible for China to become self-sufficient in N and P fertilizers, but highly unlikely that this will be achieved for K in the foreseeable future.

Balanced fertilization is the key to efficient fertilizer utilization for sustainable high yields. Although dramatic increases in N, P and K fertilizer consumption has taken place in China, the use of P and K fertilizers is low compared to N. Also, it is important to note that secondary and micronutrient deficiencies are increasing. Research on balanced fertilization remains a high research priority because China must achieve efficient plant nutrient utilization in its agricultural production in order to accomplish its food and fiber production goals.

Results from 63 long-term (over 10 years) experiments on 10 soil types with various grain crops provide important information, as shown in Table 1. The contribution to yield from inorganic fertilizers averaged 46.3 percent with the average for rice 40 percent, summer corn 50 percent, winter wheat 60 percent and about 35 percent on certain monocrops.

Table 1. Contribution of fertilizers to crop yield (10-year average, percent).

Cropping patterns, %	No. of trials	Type of soil		Contribution to yield, %	10-year CV
Double rice/year	22	Paddy soil	Early rice	39.8	6.5
			Late rice	40.1	7.4
Paddy-dryland crops/year	14	Yellow-brown soil	Paddy	37.9	4.2
		Purple soil	Dryland crop	59.9	15.2
Two dryland crops/year	15	Chao soil	Wheat	62.7	15.7
		Drab soil	Maize	49.3	13.3
One dryland crop year	12	Black soil anthropogenic-alluvial soil	Dryland crop	34.6	9.5
Average				46.3	8.0

Table 2. Nutrient balance sheet, kg/ha in a total of 20 cropping seasons. (Zhengzhou, Henan, 1981-1990)

Treatment	Input, kg/ha			Output, kg/ha			Balance, kg/ha		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
CK	0	0	0	838	531	1,155	-838	-531	-1,155
N	2,400	0	0	2,115	873	2,085	285	-873	-2,085
NP	2,400	1,200	0	2,259	1,108	2,481	141	92	-2,481
NPK	2,400	1,200	1,200	2,386	1,136	2,859	14	64	-1,659
M	736	660	840	1,206	742	1,670	-470	-82	-830
MN	3,136	660	840	2,388	1,178	2,505	748	-518	-1,665
MNP	3,136	1,860	840	2,535	1,302	2,751	602	558	-1,911
MNPK	3,136	1,860	2,040	2,544	1,270	3,260	592	590	-1,220

Nutrient rate of inorganic fertilizers (kg/ha each crop) : N,120;P_2O_5,60;K_2O,60.
Nutrient rate of organic fertilizer (kg/ha each crop):N,31;P_2O_5,33;K_2O,42.

In double rice cropping systems, applying N alone at first increased yields, but as P and K became deficient (mined from the soil), yields dropped rapidly. Addition of P and particularly K produced dramatic increases in yield. Generally, upland crops such as wheat had a greater response to P than to K. Corn, however, responded more to K than to P.

Comparing the NPK plant nutrient removal by 20 crops with fertilizer input over 10 years, a balance sheet was obtained. It indicated that N and P were in surplus, but K was in deficit (Table 2).

In short-term experiments, N fertilizer alone had a good effect. However, with time this proved to be a poor practice. High and stable yields can only be achieved and maintained when N, P and K are combined rationally. Furthermore, applying organic manure along with NPK fertilizer was beneficial because it supplemented P and K, added some secondary and micronutrients, and improved the physical and biological characteristics of the soil. Table 3 shows deficient areas and magnitude of use for secondary and micronutrients.

Even balanced NPK fertilizer use with organic manure is not enough if a secondary or micronutrient is missing.

During the period of 1984 to 1994, fertilizer use (plant nutrient basis) increased from 17.4 to 33.1 million tonnes, an increase of 90.5 percent. Because of increasing demand for

(continued on page 11)

Table 3. Deficient and application areas of secondary and micronutrients in China.

Nutrient	Critical level, mg/kg	Deficient area		Magnitude of use, million ha
		million ha	% of total arable land	
Zn	≤0.5	48.6	51	9.7
B	≤0.5	32.8	34	5.9
Mo	≤0.15	44.3	47	1.0
Mn	≤5.0	20.5	21	0.3
Cu	≤0.2	6.5	7	
Fe	≤4.5	4.7	5	0.5
Total		26.7	166	17.4
S	—	26.7	28	41*
Mg	—	5.5	6	9
Ca	—	28.0	30	50
Total		60.2	63	101

*Calculated based on application rate of superphosphate and calcium-magnesium phosphate.

Balanced Fertilization in Southern China: A Historical Review and Prospects

By Zhu Zhonglin, Tang Jinchun and Tu Shihua

The government and industry should rapidly increase phosphorus (P) and potassium (K) fertilizer production. There should also be a better fertilizer allocation system, along with increased imports of K. Rapid price increases in recent years should be controlled or higher crop prices paid to farmers to offset higher fertilizer costs. A more timely supply and an improved distribution system are greatly needed. Farmer knowledge of proper fertilizer use needs to be better, and the soil testing/fertilizer recommendation network needs improvement.

The 14 south China provinces lie in the tropical and sub-tropical belt and provide an agricultural production base for grain, oil, seed, fruit and vegetable crops for China. The soils in this region are generally poor in natural fertility and deficient in nitrogen (N), P and K. Nitrogen and P are applied in reasonable quantities, thereby maintaining soil fertility for these nutrients. However, more K is removed by crops than is applied, creating a strong negative soil K balance.

Table 1. Potassium balance sheet for farmland in southern China.

Region	K_2O balance, kg/ha/year	Reference
Shanghai outskirts	-70.5	F. Wang (1985)
Tai Lake region	-61.5	C. Liu (1985)
Less fertile land in Fujian	-55.5	J. Wu (1987)
Hang-Jian-Lake Plain in Zhenjiang	-37.5	G. Feng (1988)
Jiangsu province	-90.0	E. Wang (1988)
Shanghai outskirts (rice-rape)	-192.0	Y. Wang (1992)
Anhui province	-46.5	Q. Yu (1993)

In recent years, Canpotex Limited supported the Balanced Fertilization Demonstration Program, in cooperation with China's efforts. It has significantly increased awareness of the importance of balanced fertilization. Although many people know of the benefits of potash for improving crop yields and quality and increasing farmer incomes, much still remains to be done, as shown in Table 1.

Research results on eight crops in six southern provinces receiving potash fertilizer in combination with N and P showed significantly increased crop yields (Table 2). Yield increases ranged from 11.7 percent with rice to 27.9 percent with wheat. In addition, K fertilizer increased crop resistance to insects and disease and improved the quality of agricultural products as well.

Balanced fertilization has improved in southern China with respect to N, P and K, but secondary and micronutrient deficiencies are becoming more frequent. True balanced fertilization must consider all plant nutrients, not just N, P and K, since inadequate supply of any essential nutrient reduces the yield-producing effectiveness of all the others.

Three main problems affect the use of balanced fertilization in southern China.These are:

High yields require balanced fertilization.

- Low recovery of applied N fertilizer.
- Low application rates of P and particularly K.
- Domestic production and sale of inorganic fertilizer.

Nitrogen recovery can be improved by slow-release N products and by improved on-farm N management. Application rates of P can be increased although domestic production often lags behind demand, and the quality of P fertilizers is generally low. Domestic potash production supplies less than 2 percent of demand and, therefore, additional potash must be imported.

Potash is allocated on a quota system that does not come close to meeting demand. As a result, it creates inefficiency in the utilization of N and P and loss of money for farmers and the nation. Larger potash imports are the only solution to this problem.

In order to realize a more balanced use of N, P and K, China must increase phosphate fertilizer use and particularly increase potash imports while exploiting other potash resources. Research and extension on balanced fertilization need to be continued, strengthened and expanded. BCI

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Table 2. Effect of balanced K fertilization on crop yields in southern China.

Crop	Yield, kg/kg K_2O	Percent increase in yield
Rice	7.5	11.7
Corn	10.7	24.6
Wheat	12.2	27.9
Sweet potato	65.9	21.8
Rapeseed	2.9	16.8
Peanut	5.4	13.6
Cotton	1.6	15.1
Sugarcane	86.8	21.2

Significance of Balanced Fertilization...*(continued from page 9)*

higher grain and cotton production and farmer enthusiasm for planting fruits and vegetables, inorganic fertilizer consumption is predicted to reach 42 million tonnes by the year 2000.

Grain production has not increased in relation to the increase in inorganic fertilizer consumption. This is due to two major reasons:

- Less efficiency in fertilizer utilization because of imbalances in use of primary, secondary and micronutrients.
- Large quantities that were earlier applied to grain crops are now being applied to fruit and vegetable crops.

China will gradually become self-sufficient in N, while most of the P will someday be produced locally. However, unless new deposits are discovered, K use will mainly depend on imports.

It is essential that inorganic fertilizers be used in China's push to maintain food security as population increases. Great gains in crop production can be made by improving the balance of the major plant nutrients applied, especially K. At the same time, attention should be paid to secondary and micronutrients. Utilizing more organic manure, particularly if mechanized application can be introduced, will further increase sustainable yields. But, supplies of K to farmers must be increased by importation. BCI

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Stressing Science and Quality to Promote Sales

By Deng Ke Min

Product development and market needs were accomplished using scientific technology, the result being high quality, crop and soil specific bulk blend fertilizer (BBFei). Market development made use of field research, field demonstrations, newspapers, TV, radio and pamphlets to introduce new products to farmers. When BBFei was compared to traditional fertilizing practices, it provided more profit to farmers.

The Kaida High Concentration Compound Fertilizer Factory is located in the Pearl River Delta. The complex has a warehouse storage capacity of 3,000 square meters and a production line with capacity to produce 40,000 tonnes of BBFei annually. It produces 11 crop specific Tanjiang BBFei blends, as shown in Table 1.

During all phases of BBFei production and distribution, scientific technology and product quality are stressed. Two areas receive special emphasis.

- Product development and market needs.
- Production capacity and product quality.

In both areas assistance was contracted from the Soil and Fertilizer Institute (SFI) of the Guangdong Academy of Agricultural Sciences. Through this cooperation, information on plant nutrient status of the soils and crop requirements provided science-based development of crop and soil specific fertilizer blends.

At the same time, a quality supervisory committee and laboratory were established to guarantee product quality. The SFI helped in development and in training technicians. In 1995, a certificate of high quality was awarded to Tanjiang BBFei.

Table 1. Tanjiang BBFei crop specific fertilizers.

Fertilizer type	Total nutrients	N	P_2O_5	K_2O
	%			
Rice	55	26	10	19
Citrus	55	25	10	20
Sugarcane	54	27	8	19
Litchi offshoot	54	27	11	16
Litchi flowering	56	19	8	29
Banana	56	19	9	28
Vegetable	52	27	3	22
Watermelon	55	21	6	28
Pepper	55	22	8	25
Tomato	54	22	6	26
Peanut	56	20	11	25

BBFei was applied to this banana plantation. Improved yield and higher quality fruit are advantages.

Market development was accomplished by field demonstrations, field experiments and use of the media including TV, radio, newspaper and pamphlets. All efforts were targeted to local farmers to introduce the benefits of high analysis complete fertilizers with balanced plant nutrients for their specific needs.

Customer service contributed significantly to the success of Tanjiang BBFei. Orders are received from farmers and product is delivered directly to them. Furthermore, an on-going program of market research which responds to customer feedback has been an important component. Work is also done with local officials to eliminate "fake" fertilizers that cause problems for farmers and harm the name of fertilizers in general.

Production capacity allows Tanjiang BBFei to be used on up to 200,000 ha in the area, assuring a bumper harvest in the region.

Table 2. Rice yield and grain size comparison on rice BBFei demonstration plots.

Treatment	Height (cm)	Ears/ha (10,000)	Ear Length (cm)	Grain each ear		Grain (%)	TGW (g)	Fresh kg/ha	Relative yield (%)
				total	full grains				
BBFei	111	246	26	151	136	90	28	9,621	114
Traditional fertilization	111	236	26	155	130	84	28	8,450	100

Table 2 shows comparisons of rice yield and quality when soil and crop specific BBFei versus traditional fertilization practices were used.Yield comparisons between Tanjiang BBFei and traditional farmer fertilizer practices showed that yields increased and production costs per unit decreased for rice, sugarcane, citrus and banana with Tanjiang BBFei. Farmers achieved greater profits because of the higher yields. In the cases of citrus and banana where higher quality fruit was produced, higher profits were also realized by the farmer.

Tanjiang BBFei increased sales from 2,000 to 10,000 tonnes from 1992 to 1995.

When science and technology are integrated with a quality product and a strong farmer oriented market development program, sales can be increased. The development of useful fertilizer products such as Tanjiang BBFei also provides benefits to both the factory and the local community. BCI

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A Review of Potash Application and Prospects of Potash Requirements in China

By Xie Jian-chang

A growing population is forcing China's agriculture to produce more food and fiber. Such production can only be sustained by combining the use of manures with high, balanced applications of inorganic fertilizers. Fertilizer use efficiency on grain crops has declined because there has been a shift in use from grain to high value cash crops. Also, nitrogen (N) and phosphorus (P) use efficiency has declined because of lack of use of potassium (K). The only way to remedy K deficiency is to increase K importation quickly.

China has made great progress in its agricultural productivity. Grain production increased to nearly 450 million tonnes in 1994 from 113 million tonnes in 1949. Cotton production increased roughly 10 times in the same period. Table 1 shows significant increases in grain production for four time periods beginning in 1949 and some of those reasons for the increases.

Fertilizer played an important role in these achievements. Data indicate fertilizer contributed 32 percent to food production growth, compared to 28 percent for irrigation, 17 percent for new varieties, 13 percent for mechanization, and 10 percent for other factors.

Lack of potash (on left) reduces cotton yield and efficiency of N and P.

Comparing population with grain production before and after 1984 indicates that grain production increases were much greater than population growth during the 35 years preceding 1984, while the rate of growth in population outstripped that of grain production since 1984. Demand for agricultural products will continue to increase because of increasing population.

Sustained growth in grain production is dependent on the effective use of research and the resulting technologies. Rational increase in fertilizer use is still a very important measure that can be taken.

Stable high grain yields cannot be maintained when the country's agriculture depends only on mass cycling of organic materials, even when it is augmented with small amounts of inorganic fertilizer. Combining high but balanced inorganic fertilizer rates with organic manure has proven very successful. It should be practiced.

Comparing fertilizer consumption with grain production demonstrates a fertilizer efficiency decline in recent years. There are several reasons:

Table 1. Development of grain production in China.

Duration	Increased production, million tonnes/year	Unit yield increase, percent	Main reason(s)
1949-1958 (9 years)	2.57	59.5	Expansion of cultivation area; organic manure; and improved varieties
1958-1978 (20 years)	1.40	54.1	Expansion of irrigation area; increase in use of fertilizers
1978-1984 (6 years)	4.56	42.8	Policy; high increase in use of fertilizers; short straw and hybrid varieties
1984-1993 (9 years)	1.45	14.6	Great increase in the use of fertilizers (81%)

- Possibly one-fifth of all fertilizer is applied to non-grain crops.
- Poor irrigation management.
- Increase in low analysis fertilizer use, etc.

An important reason is the current imbalance in the use of N, P and K. Potash use is far too low to meet demands of high grain production. This negatively affects N and P fertilizer use efficiency and, consequently, the opportunity for meeting the yield goals set by the government of China. Undoubtedly, if balanced fertilization is practiced extensively, great increases in food and fiber production would result. While potash consumption has been constantly growing, the rate of increase is still too slow.

Ten years ago, Jiangsu was considered a province with moderate K deficiency problems. Today, K deficiency has spread to nearly 70 percent of the total cultivated land. From this, it is not difficult to deduce that China's national K-deficient area is much larger than the 23 percent estimated a decade ago.

In 1994, the $N:P_2O_5:K_2O$ ratio in China was 1:0.31:0.13, which is considerably imbalanced when compared to the average ratio of 1:0.56:0.49 for developed countries (Table 2). More has to be done to reach true balanced fertilization with respect to K. To achieve and maintain a proper and economic nutrient balance, demand for K_2O in the years 2000, 2005 and 2010 should be 6.1, 9.2 and 12.4 million tonnes, respectively. Most of this potash will have to be imported. Phosphate consumption will stabilize at around 12 to 13 million tonnes over this decade (Table 3).

Table 2. Ratio of N, P and K fertilizers in some large fertilizer consuming countries.

Country	$N:P_2O_5:K_2O$ Ratio
USA	1:0.37:0.45
Former Soviet Union	1:0.89:0.58
India	1:0.40:0.17
France	1:0.54:0.74
Developed countries	1:0.56:0.49
Developing countries	1:0.38:0.17
World	1:0.47:0.32

Source: Xie, 1994.

Table 3. Expected demand for fertilizer in China in Year 2000-2010.[1]

Year	Total	N	P_2O_5	K_2O	$N:P_2O_5:K_2O$
	10^6 tonnes				
2000	42.6	24.3	12.2	6.1	1:0.50:0.25
2005	48.6	26.3	13.1	9.2	1:0.50:0.35
2010	53.6	27.5	13.7	12.4	1:0.50:0.45

[1]Calculated based on the annual increase rate of 1.57 x 10^6 tonnes for the years 1994-2000, 1.2 x 10^6 tonnes for the years 2000-2005 and 1.0 x 10^6 tonnes for the years 2005-2010.

Since the potash supply in China is limited, a rational distribution scheme is necessary. Southern China should receive the bulk of imported potash, particularly for cash and fruit crops. However, demand is growing in northern China because high crop yields (15 t/ha) are removing large quantities of K annually. In northern regions, locally produced potash sources should be exhausted before imported potash is used. The national 'vegetable basket' program must also be a target since vegetables require large quantities of K for high yields of high quality.

The key issue is that China must import more potash now or suffer economic losses in the future. BCI

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Soil Potassium and Potassium Fertilizer Use in Northern China

By Jin Ji-yun

Increased crop production from greater use of nitrogen (N) and phosphorus (P) in northern China has depleted soil potassium (K). Crop demands can no longer be met with application of manures. As a result, significant responses to K have been shown on a variety of crops. Potash fertilizers have not been used because of the false belief that northern China soils do not respond to K. The result, which can be corrected only with the import and use of more K, has been reduced efficiency of N and P, along with declining yields.

In northern China, with increased crop production resulting from greater N and P fertilizer use on better varieties, more K has been removed from soils than returned through applications of organic or inorganic fertilizers. Long-term field trials in Shandong and Hebei provinces showed that application of manure at normal rates resulted in soil K depletion rates of 71 to 225 kg K/ha/yr for grain crops while vegetable crops in Tianjin depleted soil K at 378 to 498 kg K/ha/season. Based on estimations, about 5 million tonnes of soil K_2O are removed by crops annually in China, while the highest and most recent application rates do not exceed 3 million tonnes annually. In fact, most soils receiving K fertilizer have a negative output-input balance, as shown in Table 1. Thus, K deficiency is now frequently found in northern China.

Table 1. Balance sheet of soil K in wheat-corn double cropping system in Yutian, Hebei, 1987-1991.

Treatment[1]	K removed, kg/ha	K added, kg/ha	Balance kg/ha
NP	711	0	-711
NPK	1,357	841	-516
NPM	920	126	-794
NPKM	1,592	967	-625

[1]K = 112.5 kg K_2O/ha/season; manure (M) = 11.7t/ha only for wheat.

Crop responses to applied fertilizer K are becoming prevalent in northern China. The average spring corn yield increase with K fertilizer in five trials in northeastern China was between 7.5 and 10.4 percent (Table 2). In the country's north central area, a wheat-corn rotation at eight sites showed wheat and corn yield increases of 6.4 and 12.3 percent, respectively.

Research in Shandong, Henan and Hebei showed that even though available soil K was 112 mg K/kg, well above the critical level, and slowly available K was 507 mg K/kg, potash application increased corn yields between 8.4 and 10.8 percent. These results indicate that critical soil test K levels currently used may be too low when high crop yields are desired. Similar findings were obtained on different soil types in Heilongjiang province.

In Jilin province, K application increased corn yield by 1.2 to 1.6 t/ha. In Tianjin, watermelon and Chinese cabbage yields were increased 12.1 and 9.2 to 41.4 percent, respectively, while cotton yields in Hebei were increased 13.3 percent. Soybean yields in Henan were increased by 28.8 to 51 percent. It is clear from these results that since the 1980s, reports

Soybeans in Heilongjiang show K deficiency symptoms and reduced yield.

of K deficiency expanded quickly and responses to applied K have become significant in northern China.

In 14 field and demonstration trials in north eastern and north central China, cotton yields increased by 28 percent, demonstrating that large increases in domestic cotton production are possible by adding K to normally applied levels of N and P. Potassium is noted for increasing fiber strength and quality. This indicates that domestic production could replace large quantities of imported cotton if adequate K fertilizer is applied to the crop.

Table 2. Spring corn yield response to K fertilizer in the north eastern region, 1993-1994.

Treatment, K_2O rate, kg/ha	Yield, t/ha	Yield increase, %
0	9.1	–
112	9.8	7.5
225	10.0	10.4

Average of five sites in two years.

In general, the supply of K fertilizers to northern China has been inadequate to meet agronomic needs and efficient N and P fertilizer use. With further development of agriculture, K requirements in northern China will grow. By the years 2000 and 2005, K_2O use in the six north eastern and north central provinces will have to be 1.05 and 1.50 million tonnes, respectively. Most of this supply will have to be met by imports since native potash supplies are limited.

Table 3. Ratios of $N:P_2O_5:K_2O$ use in China and several provinces, 1994.

	$N : K_2O : P_2O_2$
China	1 : 0.32 : 0.125
Shandong	1 : 0.29 : 0.124
Henan	1 : 0.45 : 0.101
Hebei	1 : 0.34 : 0.067
Jilin	1 : 0.08 : 0.071
Liaoning	1 : 0.18 : 0.057
Heilongjiang	1 : 0.57 : 0.087

Source: China Agriculture Yearbooks.

Increasing food and fiber demands of a large and growing population on China's agriculture and development of high yield and high quality crops will result in larger areas of K deficiency in northern China unless immediate increases in potash supplies are made available. Until this occurs, the efficiency of N and P fertilizer use will remain low because of imbalances in NPK use as shown in Table 3. Soil K will be further depleted, economic returns to farmers reduced and the cost of restoring soil K to productive levels will become extremely expensive for future generations. Presently, this imbalance can only be overcome by importing large tonnages of potash to balance present N and P used from domestic and imported fertilizers. BCI

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Bulk Blending of Dry Fertilizer Materials for China

By James D. Beaton

Bulk blending is defined as the mechanical mixing of two or more granular fertilizer materials to produce mixtures containing nitrogen (N), phosphorus (P), potassium (K) and other essential plant nutrients. It allows small batches of high analysis soil and crop specific fertilizers to be mixed and transported in an economical manner...contributing additional profit for farmers and improving the environment because it provides balanced fertilization.

Acceptance and expansion of bulk blending in North America was phenomenal. From 1953 to 1957, bulk blend fertilizer factories increased from 14 to 92 in the state of Illinois. On a national basis, by 1980 there were between 5,000 to 5,300 bulk blend facilities in the U.S.A. and presently it is estimated there are about 7,500 facilities operational. Dry fertilizer blends accounted for 45.9 percent of all fertilizer sold in the U.S.A. in 1992. A similar trend occurred in Canada.

Bulk blending involves two vital components:

- Manufacture of high quality granular fertilizers by basic producers at large strategically located factories.
- Bulk transport of these materials to relatively small, local bulk blending factories for formulation of specific mixtures.

Bulk blends are 'prescription mixtures' based on specific soil and crop requirements. Soil testing helps establish recommendations for the blend. Fertilizer recommendations based on soil tests are agronomically and environmentally superior to those made without some knowledge of the soil fertility status of the fields to be fertilized.

Bulk blending requires materials that are well granulated, similarly sized and dry to prevent segregation, caking and deterioration. High quality bulk blended fertilizer has the following characteristics:

- Granular and free flowing.
- Components provide required plant nutrients homogeneously mixed.
- Free from segregation during handling.
- Quantities of nutrients reflect guaranteed analysis.
- Material is not dusty and is non-hygroscopic.

Bulk blending is popular because the process is easily accomplished, and investment cost for establishing the factory is relatively small. This generally results in savings for farmers purchasing the fertilizer. Blends are usually high analysis material that cut transportation costs. Prescription bulk blends are agronomically sound so that high profits from increased yields and quality are realized by the farmer.

Most modern blending facilities have 4.5 to 9 tonne capacity mixers. The former can produce up to 45 tonnes blended material per hour.

The major problems with bulk blending are segregation and methods of including secondary and micronutrients. Segregation can occur in storage bins due to coning action or from vibration. Standards exist for granule size and the acceptable degree of segregation. Secondary and micronutrients need to be sprayed on blended fertilizers, using a sticky substance.

Bulk blends are high quality granular materials.

Ingredients used to formulate bulk blends must be chemically compatible. Urea and ammonium nitrate should not be mixed because of wetting. Urea reacts with single superphosphate (SSP) and triple superphosphate (TSP) to release water, resulting in stickiness and caking. Ammonium bicarbonate will likely be a problem because it is unstable and decomposes to release ammonia, carbon dioxide and water. Diammonium phosphate (DAP) should not be mixed with SSP or TSP. However, DAP is well suited for blending with most N and K fertilizers. Most blends use urea, DAP and potassium chloride (KCl) as sources for the three major plant nutrients.

While ammonium bicarbonate and SSP are commonly used fertilizers in China, they are not recommended for bulk blending. Their use will result in blends that are dusty, subject to caking and of low and inaccurate analysis so that they are generally unsatisfactory to farmers.

There is a great future for bulk blending in China because it is a proven, practical and economically attractive method of practicing balanced fertilization. BCI

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Experiences with Balanced Fertilization in India

By H.L.S. Tandon

Intensive crop rotations and imbalanced fertilizer use have resulted in multiple nitrogen (N), phosphorus (P), potassium (K) and other nutrient deficiencies. For intensive, high yielding cropping systems, current recommended NPK rates are inadequate and need revision upwards. Privatization of the fertilizer industry already in process will provide farmers with a wider choice of fertilizers and better prices and services. It appears that education of policy makers is of equal importance to the education of scientists, extension personnel and farmers with regards to proper fertilization practices.

In India, fertilizers have contributed 60 percent of recent increases in food production. Balanced fertilizer use was the major strategy used, with an ideal $N:P_2O_5:K_2O$ ratio of 1:0.5:0.25 for grain-based production systems. India was approaching this ideal ratio until policy changes which removed subsidies from P and K but retained them for N were introduced in 1992. While P and K consumption immediately slumped, farmers gradually are increasing consumption of these plant nutrients again because of improved crop prices and farmer awareness of the benefits of balanced N, P and K use.

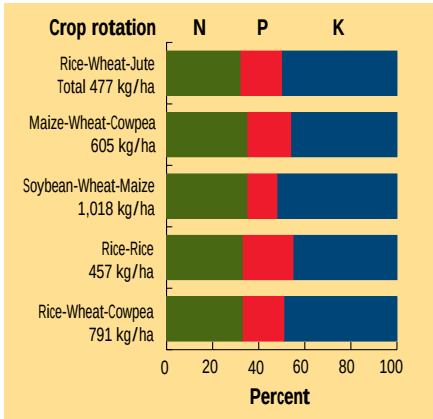

Figure 1. Mean annual nutrient uptake by some intensive irrigated rotations. Data for each rotation is mean total uptake of $N+P_2O_5+K_2O$, kg/ha.

Intensive crop rotations take up and remove large quantities of N, P and K annually (Figure 1). When N, P and K applications are imbalanced, large quantities of the nutrients not applied in adequate amounts are mined from the soil until they become critically deficient. India is already in the era of multiple nutrient deficiencies with N, P, K, S and Zn being the most widespread. Average wheat field trial yield responses to these plant nutrients are 1,092, 488, 371, 813, and 360 kg/ha, respectively (Table 1). Such findings underscore the fact that balanced fertilizer use for high yields goes beyond N, P and K application.

Balanced fertilizer use is a profit maximizing approach not only in intensive irrigated farming, but also in rainfed-dryland farming where both high productivity and yield stability are required. Balanced fertilizer use produced millet grain yields of 3 t/ha or more 14 out of 17 years. In contrast, average millet yields in India are less than one t/ha.

Long-term experimental results in India show that continuous use of only N, P and K fertilizers is not sustainable. With the addition of 12 to 15 t/ha manure each year, the system

is sustainable. This is possibly due to additional K, S and specific micronutrients being provided in the manure as well as improvements to soil physical properties. Continuous applications of P and K generally result in a positive P balance, but a negative K balance indicating more K needs to be added.

For intensive high yield cropping systems, recommended "optimal" N, P and K rates are inadequate and hence, need revision upwards. This is amply demonstrated by large numbers of on-farm trials where soils testing "high" had sizable responses to additional P and K, Table 2.

Table 1. Average yield responses of wheat to various plant nutrients in India.

Nutrient	Trials	Average response, kg/ha	Nutrient	Trials	Average response, kg/ha
N	3,768	1,092	Zn	2,358	360
P	3,768	488	Fe	60	190
K	3,768	371	Mn	59	590
S	32	813	Cu	35	380
			B	34	380

Table 2. Soils testing high in P and K still respond to applications of these nutrients.

Nutrient rate, kg/ha	Soil test rating	Number of trials	Average response, kg/ha	Rs/ha
P_2O_5, 60 kg/ha	Low	2,140	680	2,448
	Medium	2,446	669	2,408
	High	147	486	1,350
K_2O, 60 kg/ha	Low	749	245	882
	Medium	2,167	250	900
	High	1,834	192	691

Soil testing in India has not been a successful program. Less than 10 percent of the farmers adopt recommended fertilizer rates. And, only a few samples are sent to the 518 operational soil testing laboratories.

Fertilizer recommendations in India are not made on a flexible basis. Thus, if a farmer cannot afford the total recommendation or cannot obtain a particular nutrient, he does not know how to adjust the recommendation.

India has an elaborate fertilizer distribution and marketing system where private traders play an important role. Of the 253,000 establishments engaged in selling fertilizers to farmers, 69 percent are private dealerships and 31 percent are cooperatives or similar organizations. There is an increasing shift towards further privatization of the fertilizer sector, with the exception of urea. This is expected to provide a more competitive environment resulting in wider product choice with better prices and improved farmer services.

There are over 174,570 private fertilizer dealers in India.

In August 1992, all P and K fertilizer prices...but not N...were decontrolled. This created an immediate imbalance in fertilizer consumption favoring N. Even though crop prices were improved to compensate farmers, the excessive use of N in relation to P and K was exaggerated by this policy change. If continued, this could lead to yield decline due to P and later K deficiencies. However, India's farmers did not reduce P and K use in proportion to their increase in prices. This was a good sign. Arrangements for financial credit for farmers are helping them purchase more P and K fertilizers, thereby practicing a more balanced fertilization strategy.

Presently, it appears that education of policy makers on the importance of balanced fertilization needs as much attention as educating farmers, extensionists and scientists. BCI

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Balanced Fertilizer Practices in Taiwan – Fertilizer Application and Balance in the Field

By Wang Yinpo

Crop production in Taiwan has outstripped domestic demand for food because modern farming technologies, including the balanced use of nitrogen (N), phosphorus (P), potassium (K) and other fertilizer nutrients, have been practiced. More than 10 times the amounts of NPK are used today than in 1945. The N:P_2O_5:K_2O ratio being applied approximates that of developed countries. A good fertilizer program is measured by its ability to provide a balanced nutrient supply at the appropriate physiological stages in adequate quantities over the crop's growing period. Taiwan has a strong extension service and strong government support to supply all essential nutrients to farmers so they can practice balanced fertilization.

Modern agriculture in Taiwan began early in this century. During that period, agricultural research institutions were established and land was surveyed and classified according to its productivity. New crops and varieties, field management practices, and inorganic fertilizers were introduced as new agricultural technologies.

In the past five decades, Taiwan's agricultural production increased rapidly so that it greatly exceeds domestic food demand. Before crop diversification was introduced in 1984, rice production virtually increased in proportion to increases in NPK application. Yields went from 0.58 million tonnes to over 2.5 million tonnes.

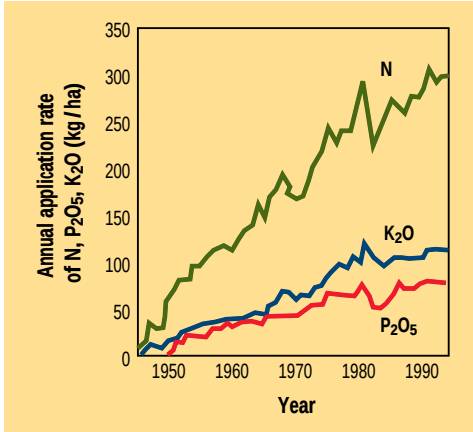

Figure 1. Annual application rate of chemical fertilizer in Taiwan (per hectare of land area).

Presently, Taiwan's annual fertilizer consumption is 265,000 tonnes N, 74,000 tonnes P_2O_5 and 105,000 tonnes K_2O, with a country-wide ratio of 1:0.28:0.4. Annual application rate of N-P_2O_5-K_2O is 304-85-120 kg/ha of cultivated land, or 256-72-101 kg/ha/crop. Annual consumption is 10 times higher than in 1945 (Figure 1).

The purpose of nutrient balance is to maintain high soil fertility and high productivity over a long period and to supply balanced nutrients to

Taiwan uses balanced fertilization – 429 kg/ha/crop at the balanced $N:P_2O_5:K_2O$ ratio of 1:0.28:0.40.

crops at each growth stage. For high yielding cropping systems, it is essential to provide adequate, balanced nutrition over the growing season to satisfy requirements at each physiological stage of crop development.

The use of Rhizobium inoculation for soybeans is effective in reducing N fertilizer needs. Its effectiveness is enhanced by proper use of P and K. In northern Taiwan, where soils are acid and have a low nutrient content, inoculation alone increased yields by only 8 percent, whereas inoculation along with applications of P and K boosted yields by 29 percent.

Studies in Taiwan have shown when other essential nutrients were adequate, increasing supply of a deficient or less than sufficient nutrient increased yields. That means balanced use of all nutrients increases the use efficiency of each nutrient for a combined positive effect. In contrast, if all plant nutrients are not applied in a balanced manner, efficiency of those applied is reduced and economic losses occur.

Extension of research results to farmers is as important as the research itself. In other words, to practice knowledge is as important as the knowledge itself. Taiwan has made great efforts to follow this philosophy, using the following:

- Teaching the concepts of balanced fertilization in classes to students, farmer groups, and advisors.
- Transferring knowledge by mass media.
- Supporting field demonstrations and workshops.
- Making conditions easier for farmers to practice balanced fertilization by providing adequate supplies of all fertilizers at appropriate times. BCI

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World Potash Supply/Demand Situation and Outlook

By C. Howard Cummer

World potash supply/demand was studied to determine whether global production capacity can meet growing demands in China, which should be using about 5 million tonnes of K_2O by the year 2000. If this consumption level is met, China needs to increase imports by 2 million tonnes in the next four years. Saskatchewan has a surplus capacity of 4 million tonnes per year and can supply China's requirements for the foreseeable future.

China poses an interesting question: Does the world have sufficient potash to satisfy China's demand to achieve true balanced fertilization? Best estimates indicate this would require a near doubling of present imports. To answer the question requires a study of projected world supply and demand.

World potash production increased in 1994 after five years of decline. World capacity over the medium term is expected to decline, but only marginally. It is readily apparent from Table 1 that many existing potash facilities are producing at rates well below capacity. The potash industry continues to register surplus capacity, currently 5.9 million tonnes K_2O. This is expected to decrease to approximately 3.8 million tonnes by 1999. Because of production over-capacity, supply is expected to keep pace with increases in demand. The Canadian potash industry is capable of supplying increases in demand, especially in Asia and particularly in China.

Table 1. World potash production and capacity in 1994.

	Production, million tonnes K_2O	Capacity, million tonnes K_2O	Operating rate, %	Percent world capacity
Canada	8.1	12.2	67	34
CIS	5.1	12.0	43	34
Germany	3.3	3.65	74	11
Others*	5.7	———	80	21

*Europe (excluding Germany), U.S.A., Israel, Jordan.

Recently, potash demand increased in most regions of the world, the exception being the Confederation of Independent States (CIS). Statistics published by the International Fertilizer Industry Association (IFA) show that world potash consumption increased to 19.2 million tonnes K_2O in 1994, and is expected to continue increasing in the coming years.

Anticipated long-term growth in world potash demand is in the large populated developing countries such as China and India. Table 2 explains current and future markets and emerging opportunities. Stable markets are notably identified by their low N:K ratio. Growth in emerging/developing markets may be variable as factors such as weather and government policy influence each country's purchasing decisions.

China is the largest potash consumer in Asia...second only to the U.S.A. in the

Good shipment management cuts costs.

world...and with tremendous growth potential. China is also the world's largest fertilizer consumer. Currently, annual potash imports purchased by China fluctuates between 2 and 3 million tonnes KCl. Canada traditionally supplies between 20 and 50 percent of that requirement.

It is clear that China will do everything possible to maintain high levels of crop production. Potash demand is estimated to grow at 10 percent annually. However, it is and will continue to be constrained by internal planning processes, distribution inadequacies, foreign exchange availability and government priorities making annual consumption levels unpredictable.

Agronomic realities indicate that potash consumption will continue to increase as Chinese agronomists and scientists recommend and prove the need for a balanced NPK fertilization ratio of 1:0.50:0.25. China's consumption ratio has steadily improved over the years to about 1:0.35:0.13. However, potash consumption must increase significantly...essentially double current usage levels...to reach the recommended ratio. Most of the increase will come from imports.

By the year 2000, China needs to use 5 million tonnes K_2O, an increase of 2 million tonnes. Saskatchewan, Canada has surplus capacity of about 4 million tonnes and is well placed to supply China's requirements.

As China's potash imports grow, planning and delivery of shipments need efficient management to avoid excessive transportation and handling costs. China presently experiences these problems when purchases exceed 1.5 million tonnes K_2O annually. Expertise and assistance of Canpotex Limited are offered for devising better planning and procurement systems to ensure timely and cost effective delivery of the potash China needs for agricultural development in the 21st century. BCI

Table 2. Major world potash consuming countries.

Country	Consumption, million tonnes K_2O	Rank	Trend	N:K ratio
U.S.A.	———	1	1 - 2%/yr.	———
China	1.2 to 1.8	2	10%/yr.	1:0.13
Brazil	1.6	3	5%	———
India	1.2	5	10%/yr.	1:0.11
Japan	0.6	9	stable	1:0.83
Malaysia	0.5 to 0.6	8	4 - 5%	1:1.67
S. Korea	0.3 to 0.36	15	stable	1:0.56
World 1999	22.00	---		

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Analysis of Macro-Economic Efficiency of Balanced Fertilization in China

By Mei Fangquan

The positive impact on yield and profit from the use of inorganic fertilizers has been reduced because of their imbalanced use, particularly potassium (K). While inorganic fertilizer use is increasing, grain yields are not increasing at the same rate. This is due to imbalanced use of nitrogen (N), phosphorus (P) and K and the fact that large amounts of inorganic fertilizers are being used on cash and fruit crops instead of the grains. Balanced fertilizer use could produce a huge increase in fertilizer use efficiency. By the year 2000 China will need to import at least 4 million tonnes of potash annually to maintain high production and high fertilizer use efficiency.

The recent positive impact of inorganic fertilizers on crop production has been compromised because of imbalanced N, P and K use. Today, 59 percent of the cultivated land in China is deficient in P, 23 percent deficient in K, and 14 percent deficient in both nutrients. Imbalanced use of N, P and K in the long term will obviously restrict overall efficiency of applied inorganic fertilizer. This means economic losses to farmers and the nation.

Recent data demonstrate that while inorganic fertilizer consumption is increasing, grain production is not rising at the same rate as before. This undoubtedly is due to two factors: 1) reduced use-efficiency of inorganic fertilizers because of imbalanced application rates, and 2) farmers fertilizing cash and fruit crops at high rates and reducing nutrient applications on grain crops.

The main reason for the historical imbalance in fertilizer use is the nature of domestic fertilizer production. The average N:P_2O_5:K_2O ratio of this production has been approximately 1:0.25:0.05 for many years. In order to overcome this imbalance and increase efficiency of domestically produced P and K, more potash must be imported because local resources are very limited.

Balanced fertilizer use significantly improves both fertilizer efficiency and economic benefit to farming wherever it is applied. Considering the period up to 1993, China's efforts in implementing more fertilization boosted national yields by 8 to 15 percent, increasing total grain production by approximately 12 billion kg and providing an increased value of grains plus cash crops in excess of 10 billion Yuan (RMB)[1].

[1]*Yuan (RMB) can be converted to value in U.S. dollars as follows: 8.2 RMB = US$1 (one U.S. dollar).*

By the year 2000 this balanced fertilization should be practiced on 60 million ha, where grain would occupy 47 million ha. Grain production will be increased by an estimated 17.5 billion kg; 3 million ha of cotton will have increased yields of 450 million kg; while 5.3 million ha in oil seed crops would produce 1.4 billion kg oil. This total increase is estimated to contribute an additional 23.4 billion RMB of income to farmers. However, to achieve this, more P and K fertilizers must be imported.

Shortages of potash continue to exist, even in the areas where balanced fertilization is being promoted. This is a costly shortage because without it China cannot sustain high yields, high quality products and high fertilizer use efficiency.

Potash fertilizer use efficiency has become much higher, particularly in the red soils regions of southern China where potash use efficiency is outstanding. It has been shown that 3.0 million tonnes of potash would create a 14.8 billion RMB increase in production, giving an output to input value ratio of 3.3:1.

"China must import more potash for balanced fertilization."

Potash plays an important role in raising farmer incomes. In southern China, the value of increased rice yield from potash was 5.1 million RMB, or 15 percent of the net income.

In China, there is a great potential to raise grain yield with potash fertilizer. To achieve this potential, imported potash must increase from 3.0 million nutrient tonnes in 1993 to 4.0 million by the year 2000 (Table 1). Estimates indicate that for rice in southern China higher potash consumption would increase the production by 9.9 million tonnes with a value of 9.9 billion RMB at an output to input ratio of 4.5:1. The efficiency and net benefit is indeed very high. BCI

Table 1. Inorganic fertilizer demand and output for 1990 and projections for 2000 and 2020.

Demand	1990	2000	2020
Total	25.9	34.5	54.0
N	18.2	18.0	30.0
P_2O_5	7.25	9.0	15.0
K_2O	0.26	4.5	9.0
N:P_2O_5:K_2O ratio	1:0.40:0.15	1:0.50:0.25	1:0.50:0.30
Rate, kg/ha	188	230	377
Output			
Total	1,880	2,650	4,600
N	1,464	1,850	3,000
P_2O_5	411	740	1,500
K_2O	5	50	100
Imported fertilizers (10,000 t.)	925	800	800
Compound fertilizers (%)	14	30	50

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Several Policy Issues Related to Inorganic (Mineral) Fertilizer in China

By Luo Yousheng

Inorganic fertilizers are important to successful agricultural production in China. Investment for increasing domestic fertilizer production must be made quickly. There is need for constant revision of fertilizer price controls and narrowing the gap between supply and demand. Balanced fertilizer use could increase crop production and farmer profit potential. To achieve balanced fertilization will require additional imports of phosphorus (P) and particularly potassium (K) until increased domestic production of these essential nutrients is realized.

Mineral fertilizers are an important input for agricultural production. Fertilizers have contributed one-third of China's total grain production since the start of economic reforms.

China's investment in the fertilizer industry through 1994 has been 68 billion Yuan (RMB). The annual investment now is about 10 billion RMB. The main fertilizers produced in 1994 were nitrogen (N), about 17.4 million tonnes, and P, about 5.0 million tonnes.

The Chinese government supports fertilizer production by favorable policies such as preferential prices for electricity for small and medium sized factories, exemption of value-added taxes for raw materials, and priority rail service and fuel supplies for large factories. Tax exemption is granted when fertilizer is marketed to the China National Agricultural Means of Production Group Corporation (CNAMPGC), marketing cooperatives, state farms, agricultural extension organizations and major agricultural projects. The Government has also provided funds for CNAMPGC to purchase and store fertilizers in the off-season.

Fourteen common types of fertilizers are exempt from registration with the Ministry of Agriculture (MOA). All other materials, either for sale or donated, must be inspected and registered. Advertisements in the mass media for fertilizer products can only be done after permission is obtained from the MOA.

The Chinese fertilizer marketing system is mainly handled by the CNAMPGC and its local agents. No other company or individual is permitted to deal in fertilizers. Fertilizer importation is managed at the national level by the China National Chemical Import and Export Corporation (SINOCHEM).

Price controls for fertilizers have been changing in the last two years. The State Planning Commission (SPC) has allowed a uniform business margin to be built into sale prices. Imported fertilizers can sell at prices approximately 10 percent higher than domestic products. The SPC checks fertilizer prices periodically. Quotas for supply of fertilizer are controlled by the SPC. Retailing is done on a commission basis.

There are problems with the present system of distribution. These are:

- Domestic production cannot supply enough N, P and K nor supply them in a balanced manner. The shortfall must be made up with imports. This is likely to increase unless

new domestic facilities are soon brought into production.

- Plant nutrient balance is a critical problem. Nitrogen supply is close to sufficiency, but P and particularly K fall far short of demand. Furthermore, the locations of domestic P and K resources are distant from major areas of use creating transportation difficulties. Imports are needed to improve plant nutrient balance.
- Better local storage facilities to absorb off-season production as well as imported fertilizers are needed.
- Both domestic and imported fertilizer prices increased recently, and price controls of farm products are being abused. High fertilizer prices dampen farmer enthusiasm to produce crops and invest their labor and money in agriculture.

Further reform in agricultural policy is needed along the lines of these suggestions:

- Domestic fertilizer production needs to increase rapidly to stabilize prices and provide adequate supplies to farmers. This can be done by opening new facilities and technology improvements to increase efficiencies in present small and medium sized facilities.
- Fertilizer prices must increase to allow reasonable producer profits, which in turn encourage greater production.
- Fertilizer use efficiency is low. Emphasis is needed on extending modern technologies, including balanced fertilization, to farmers. Prices farmers receive for crops are also important incentives.
- The fertilizer distribution system needs reform. Several cuts can be made to reduce transportation costs. Having the marketing cooperatives purchase fertilizers based on contracts from farmers would improve the supply and demand situations.

Fertilizer policy and regulations need improvement. Registration should be institutionalized, standardized and streamlined. Licensing systems are needed for domestic purposes and standards set to identify fertilizers. Quality monitoring needs improvement and punitive actions set for those who break the rules. BCI

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Potash supply in China is too low:

- **Productivity is limited**
- **Crop quality is reduced**
- **N and P fertilizer efficiency lowered**

Problems and Future Needs for Balanced Fertilization in China: A Summary

By Sam Portch

China must import more potash to meet its balanced fertilizer needs, to achieve economic and fertilizer use efficiency. Policies are needed to speed the registration of new fertilizer products, so Chinese farmers are not at a disadvantage compared to farmers in other countries. The fertilizer sector should encourage foreign investment to speed the production and distribution of soil and crop specific bulk fertilizers. Also, education and extension programs need to be expanded. China should establish the long-term objective of privatizing the fertilizer sector.

At the first Balanced Fertilizer Situation Report Meeting in 1991, a tremendous shortage of potash was reported. The effect was low crop production, reduced nitrogen (N) and phosphorus (P) fertilizer use efficiency, continued soil degradation, negative environmental impacts and lower profits for farmers, which affected China's economy. After five years, only limited improvements were made in the $N:P_2O_5:K_2O$ balance and Chinese farmers and the Chinese people continued to suffer. Hence, it was important to address the issue of balanced fertilization in a second Situation Report.

Many speakers have praised the Balanced Fertilizer Demonstration Program of Canpotex Limited for its success. Farmers and the general public understand the benefits of balanced fertilization. Still, potash supply remains far short of demand because of import restrictions and quotas.

All Chinese speakers indicated that the only way to improve balanced fertilization is to drastically increase potash imports. It was clearly stated that although organic manure must be used as much as possible, organic sources are insufficient to sustain high crop production.

Economic analysis indicates that the longer China waits to increase potash applications to its crops, the greater are its economic losses, the difficulty and cost of improving soil fertility, and environmental damage. In short, the longer it takes, the more China stands to lose. Thus, the question: Why delay?

Bulk blending (BBFei) is a highly effective way of providing balanced, soil and crop specific, high quality N, P and potassium (K) fertilizers to farmers. The Guangdong model BBFei donated by Canada in 1988 was successful, but BBFei has not spread widely outside Guangdong. Why? The answer frequently heard is inconsistent government policy.

China has proclaimed that market economics of supply and demand should establish the prices farmers pay for fertilizers. But, many levels of government control prices. Such controls...seemingly helpful to farmers...are harmful because they lower foreign investment in BBFei facilities. Thus, this cost-effective method of achieving balanced fertilization is unlikely

Balanced fertilization and good crop growth...for high yield, sustainable agriculture.

to be widely adopted in China. Farmers are often willing to pay more for a quality balanced fertilizer, but are left without the tools to practice balanced fertilization.

Five years ago, most fertilizer used in China was applied to grain crops. Today, it is uncertain how much organic or inorganic fertilizer is applied to cash or grain crops. Thus, care is needed when evaluating the impact of fertilizers on grain crops. The calculation of total fertilizer consumption versus grain production is no longer reliable. It indicates that while NPK use increased, the rise in grain production was not proportional. An incorrect conclusion could be reached; that is, NPK fertilizer use efficiency for grain sharply declined, when actually a shift in fertilizer use from grain to vegetable and other high value crops was, in part, the reason.

Everyone is concerned about the rise in "fake" fertilizers marketed in China. This must be stopped. But, China's fertilizer rules, regulations and policies must consider farmer needs first. Regulations, while strict, should be expeditious so farmers have quick access to new products, both domestic and foreign, as quickly as farmers in other countries. Regulations must be enforced in a timely and equitable manner. This requires the establishment of effective and impartial monitoring systems and enforcement of regulations. However, when considering regulations, fertilizers are like any other product. The best regulator is an educated consumer. Increased efforts to inform farmers about fertilizer quality is necessary.

Fertilizer policy in China should set a clear and ultimate objective to completely privatize the sector...from production, importation and distribution to sales and services. Examples in both developed and developing countries show privatization, with appropriate government controls, is the most economical and efficient system for the fertilizer sector. This cannot be achieved in a few years. It requires long-term planning, massive training, infrastructure changes, new financial systems, field staff, etc. If started today, the goal could be reached in 7 to 10 years. It is a challenge that must be achieved to feed China's growing population. Time is short. China cannot afford to waste it.

Lester Brown, President of World Watch Institute (USA), recently stated that soon China would not be able to feed its growing population and that this situation would disrupt world grain markets unless China's agricultural policies were changed. It is believed China will make the necessary policy changes to more efficiently farm its land. BCI

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Agricultural Policy and Fertilizer Use

By David W. Dibb

In today's global market place, agricultural inputs and production policies of one country often affect those of others. In a true market economy, input and crop prices are determined by supply and demand. There are few such examples in the world's agriculture today. The U.S., Western Europe and China have tried subsidies to control production. Such practices fail in the long term because they defy the laws of supply and demand.

In today's world we are a global family, not isolated countries. Food supplies, fiber for clothing, wood for homes, and fuel come to us from countries around the world. Agricultural policies in one country often affect agriculture in other countries. Thus, it is imperative that we understand how agricultural policy affects production and distribution of food and other commodities necessary for our survival.

In a true market economy, prices of agricultural inputs and crops produced are determined by the market responding to supply and demand. Unfortunately, there are very few examples of true market economies in agriculture. For example, China tried to increase grain production by using subsidies on fertilizers and other inputs. These were largely terminated because they were depleting government revenue while creating inefficient fertilizer use.

The most efficient and profitable way to increase production is to provide all inputs to farmers in a timely manner, allowing them to make a reasonable profit on their investment and for their hard work. For farmers, the fertilizer/crop price ratio is often considered to be most important. However, the optimum fertilizer rate is changed very little by price of either the crop or fertilizer, provided the crop continues to be agronomically responsive to the nutrient applied.

Sometimes subsidies on crop prices are used to stimulate production. However, as the European Union can testify, they can also have negative effects of significant consequence. Thus, subsidies must be carefully considered and should only be a temporary measure.

China has pushed for self sufficiency in food production. This concept should be replaced by a goal of high production efficiency at a reasonable level of food security. One of the major constraints to achieving this goal has been the lack of timely delivery of mineral fertilizers to farmers. Poor timing results from the large number of non-farmer dependent agencies involved in getting fertilizer to farmers and the fact there is no competition to force improved delivery and services to farmers. China should seriously consider a course of rational privatization of its fertilizer sector. The government's role should be to ensure competitiveness and to provide quality assurance to farmers. BCI

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