

# Fertilizer use by crop in Taiwan Province of China

In Taiwan Province of China, almost 800 000 families engage in small-scale farming operations. They apply a range of organic and mineral fertilizers to produce more than 200 kinds of crops in varied geographical and climatic conditions.

This report provides a comprehensive and up-to-date analysis of crop fertilizer use, trends, yields and profitability in an agriculture sector that is undergoing market liberalization. It presents data by type of crop, fertilizer and agro-ecological zone and explains recent developments in fertilizer production, consumption and distribution.

Fertilizer use by crop in Taiwan Province of China



# **Fertilizer use by crop in Taiwan Province of China**

**FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS  
INTERNATIONAL FERTILIZER INDUSTRY ASSOCIATION**

**Rome, 2002**

The designation employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations or the International Fertilizer Industry Association concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

Fertilizer use by crop in Taiwan Province of China  
First version, published by FAO and IFA. Rome, 2002

International Fertilizer Industry Association  
28, rue Marbeuf  
75008 Paris, France  
Tel.: +33 1 53 93 05 00  
Fax: +33 1 53 93 05 45/ 47  
E-mail: [publications@fertilizer.org](mailto:publications@fertilizer.org)  
Web: [www.fertilizer.org](http://www.fertilizer.org)

Food and Agriculture Organization of the United Nations  
Viale delle Terme di Caracalla  
00100 Rome, Italy  
Tel.: +39 06 57051  
Fax: +39 06 5705 3360  
E-mail: [land-and-water@fao.org](mailto:land-and-water@fao.org)  
Web site: [www.fao.org](http://www.fao.org)

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission, should be addressed to the Chief, Publishing and Management Service, Information Division, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy or by email to [copyright@fao.org](mailto:copyright@fao.org)

## Abstract

Agriculture in Taiwan Province of China is adapting to an open market environment. The island's large number of small-scale farmers uses many types of fertilizer to produce a wide variety of crops in a range of climatic and geographical conditions. With market conditions and consumer tastes evolving, innovative high-value crops are challenging the primacy of traditional staples.

The fertilizer market is also adjusting to meet the requirements of WTO entry. Fertilizer production and consumption patterns have changed and will continue to do so as the agriculture sector adapts. In addition, developments in policies and institutions have their part to play in ensuring successful reform.

This report provides both a broader picture of developments in agriculture and fertilizer as well as a detailed analysis of fertilizer use by crop in a diversified and increasingly dynamic sector.

## Preface

This study is jointly commissioned by the International Fertilizer Association (IFA) and the Food and Agriculture Organization of the United Nations (FAO). It is the first in a series of publications on crop fertilizer use.

The agriculture sector in Taiwan Province of China, is undergoing significant reform as it prepares for WTO entry. Policies and institutions that long encouraged maximum domestic production are now refocusing on efficiency and competitiveness in an open market environment.

Such changes have a direct impact on profitability and hence on farmers' decisions about which crops to grow. Changing tastes among the population further reinforce this effect, favouring a move away from traditional staples such as rice to more innovative high-value products such as exotic fruits and flowers, with consequent effects on the demand for fertilizers.

Organic and mineral fertilizers are key inputs in agricultural production. Ongoing liberalization of the fertilizer market continues to affect the production, consumption, import and export of the various raw materials and products. Here again, changes in the fertilizer market influence farmers' decisions. In addition, environmental and sustainability issues are also exerting a growing influence on the sector.

This report focuses on fertilizer use by crop. It provides a breakdown of the agriculture sector in terms of agro-ecological zones. It examines the market for the main fertilizer products, comments on recent developments in the fertilizer sector and analyses the importance of manure in agricultural production. The report then concentrates on the main crops and crop producing areas. Taiwan's mainly small-scale farmers produce an extensive range of crops (tropical, temperate, traditional, innovative, staple and high-value) and make use of a wide range of fertilizers (organic, mineral, straight and compound). This report provides a comprehensive and detailed breakdown of farmers' preferences in terms of crops and fertilizers. It presents up-to-date data on crop fertilizer use, yield and profitability and considers the impact of the changes outlined above on future crop choices and fertilizer use. The report concludes by examining the fertilizer distribution system and commenting on fertilizer access and payment.

## Acknowledgements

This study is based on the work of Mr. Mu-Lien Lin, Head Soil Scientist of the Department of Agricultural Chemistry of the Taiwan Agricultural Research Institute. The report benefited from contributions from J. Plummer, J. Poulisse (FAO), K. Isherwood, M. Prud'homme (IFA) and T. van den Bergen (FAO).

The cover photographs were made by W.K. Choo (longan), Y. Tanaka (litchi) and R. Warwick (bamboo). The source of these photographs is EcoPort. The source of the background cover photograph (sugarcane) is USDA.

## Contents

1. INTRODUCTION	1	Special crops	22
Agricultural climatic and agro-ecological zones	1	Sugar cane	22
Northeast Zone	2	Tea	24
Northwest Zone	2	Tobacco	25
Chungchang Zone	2	Vegetables	25
Yuncha Zone	2	Bamboo shoots	25
Southeast Zone	4	Cabbage and strawberry	28
South Zone	4	Watermelon	28
East Coast Zone	4	Radish, carrot and bitter gourd	31
East Mountainous Zone	4	Cauliflower, onion and garlic	31
Central Mountainous Zone	4	Fruits and flowers	34
Farm size	6	Fruits	34
2. THE FERTILIZER SECTOR IN TAIWAN	7	Betel nut	34
Urea	7	Mango	34
Ammonium sulphate	7	Guava	34
Superphosphate simple	7	Longan and banana	37
Muriate of potash	7	Litchi and pineapple	37
Calcium ammonium nitrate	8	Flowers	39
Compound fertilizers	8	Fertilizer use by agro-ecological zone	41
Other fertilizers and soil amendmebts	8	6. CROP AND FERTILIZER PRICES	43
Recent developments in public fertilizer affairs	9	Mineral fertilizer prices associated with government distribution	43
Execution of the Fertilizer Adjustment Policy	9	Organic fertilizer prices	44
Reorganization of the Taiwan Provincial Food Bureau	10	Fertilizer use profitability	44
Legal developments	10	7. FERTILIZER DISTRIBUTION AND PAYMENT	47
Privatization	10	Fertilizer distribution	47
The Fertilizer Regulation Law	10	Private fertilizer companies	47
3. THE IMPORTANCE OF MANURE IN CROP PRODUCTION	11	State fertilizer company	47
Livestock compost	11	Importers	47
Green manure	12	Farmers' associations	47
Breakdown by agro-ecological zone	12	Taiwan Fruit Marketing Cooperative	48
4. CROP FERTILIZER USE AND RELATED YIELDS	13	Service Cooperative for Sugarcane Growers	48
5. CROP AREA AND FERTILIZER USE	15	Taiwan Tobacco and Wine Monopoly Bureau	50
Rice	15	Taiwan Sugar Company	50
Coarse grains, pulses and roots	19	Fertilizer payment arrangements	50
		ANNEX 1. DOMINANT SOIL MAP OF TAIWAN	52
		ANNEX 2. OFFICIAL FERTILIZER RECOMMENDATIONS PER CROP	53
		REFERENCES	56

## List of tables

1.	Number of farm families by farm size, 1999	6
2.	Mineral fertilizer consumption, production, imports and exports	9
3.	Mineral fertilizer consumption associated with arable land	9
4.	Farm-produced fertilizers	11
5.	Farm-produced fertilizers by AEZ, 1999	12
6.	Estimated quantities of fertilizers used by crop and related crop yields, 1999	14
7.	Harvested area of rice, 1996-2000	17
8.	Rice area and average yield in different agro-ecological zones, 2000	18
9.	Recommended N-application rates for rice	19
10.	Harvested area of various crops, 1995-99	19
11.	Fertilizer use on groundnut and maize in the main producing counties, 2000	20
12.	Fertilizer use on adzuki bean, sweet potato in the main producing counties, 2000	21
13.	Harvested area of special crops, 1995-99	22
14.	Fertilizer use on sugar cane on self-mill farms in the TSC	23
15.	Fertilizer use on edible sugar cane, 2000	23
16.	Tea, harvested area and made-tea yield, 1999	24
17.	Fertilizer use on tea in the main producing counties, 2000	26
18.	Fertilizer use on bamboo shoots in the main producing counties, 1999	27
19.	Fertilizer use on cabbage and strawberry in the main producing areas, 2000	28
20.	Official recommended rates of fertilizers for strawberry	29
21.	Fertilizer use on different types of watermelon in the main producing counties, 2000	30
22.	Fertilizer use on carrot, radish and bitter gourd in the main producing counties, 2000	32
23.	Fertilizer use on cauliflower, onion and garlic, 2000	33
24.	Fertilizer use on betel nut, mango and guava in the main producing counties, 2000	35
25.	Fertilizer use on longan and banana in the main producing counties, 2000	36
26.	Official recommended fertilizer rates for litchi for a density of 200 plants/ha	37

27.	Fertilizer use on litchi and pineapple in the main producing counties, 2000	38
28.	Fertilizer use on flowers in the main producing counties, 2000	40
29.	Fertilizer use on lily in the main producing counties, 2000	41
30.	Quantities of fertilizers procured by the government for various AEZs, 1999	42
31.	Fertilizer prices associated with government distribution, January 1991-May 2001	43
32.	Crop/fertilizer price ratios, 1995-99	45
33.	Mineral fertilizer cost as a percentage of total production cost, 2000	51
34.	Official fertilizer recommendations per crop, 1999	53

## List of figures

1.	Taiwan's agricultural climatic zones	3
2.	Map of Taiwan, with 16 counties	5
3.	Public fertilizer marketing procedure	49
4.	Dominant soil map of Taiwan	52

## List of acronyms

AEZ	Agro-ecological zone
AS	Ammonium sulphate
CAN	Calcium ammonium nitrate
SSP	Superphosphate simple
CF	Compound fertilizer
COA	Council of Agriculture
KASC	Kaohsiung Ammonium Sulfate Company
MOP	Muriate of potash
SCSG	Service Cooperative for Sugarcane Growers
TFC	Taiwan Fertilizer Company
TFMC	Taiwan Fruit Marketing Cooperative
TSC	Taiwan Sugarcane Company
TTWMB	Taiwan Tobacco and Wine Monopoly Bureau
WTO	World Trade Organization
W.A.	Weighted average

## Chapter 1

### Introduction

Agricultural production in Taiwan Province of China (henceforth, Taiwan) is highly dependent on nutrient inputs and crop protection. An intensive cropping system produces up to five crops a year. With government support, most small-scale farmers in Taiwan employ improved production techniques and farm inputs, in particular high-yielding varieties, mineral fertilizers and pesticides. These new high-yielding crop varieties only perform well when they are provided with an adequate and timely supply of plant nutrients. Farmers want to ensure good yields, and tend to apply more nitrogen fertilizer than recommended to most crops, which results in imbalanced fertilization. Balanced fertilization maintains soil fertility and high productivity and supplies all the necessary nutrients to the crops at each growth stage.

With Taiwan's entry into the World Trade Organization (WTO) framework in late 2001, the agriculture sector will face increased competition from foreign countries in the rice market. To offset the 140 000 t of imported rice permitted in the first year of WTO participation, the agriculture sector will adopt planned fallow systems on 30 000 - 40 000 ha of paddy. Structural adjustments related to WTO entry mean that the total area under fallow plus land transferred to non-agricultural uses will reach 80 000 ha by 2004. Thus, the expected future trend in fertilizer use is one of slight decline.

Government policies on agriculture have shifted from upgrading agricultural productivity to increasing agricultural competitiveness coupled with moves to promote the food processing industry, quality agriculture, and agri-tourism.

#### **AGRICULTURAL CLIMATIC AND AGRO-ECOLOGICAL ZONES**

The climate in the north of Taiwan is subtropical while in the south it is tropical and characterized by high temperatures and heavy rainfall. Two-thirds of the country is mountainous. The Central Range running from north to south forms the island's backbone and occupies almost half of its total land area. There are 21 administrative counties and cities and 2 metropolises (Taipei and Kaohsiung). Of the total arable land area of 855 073 ha (COA, 1999), paddy fields account for 444 456 ha and upland fields 410 616 ha, distributed mostly along the west and east coasts of Taiwan.

Taiwan has nine agricultural climatic zones (Figure 1) which correspond well to the optimal agricultural land use in Taiwan. Broadly speaking, this report uses these agricultural climatic zones as agro-ecological zones (AEZs) and details figures for specific counties (Figure 2) where relevant.

### Northeast Zone

A feature of this zone is the cold northeast wind that blows from October to April. The mountainous area of this region experiences no clear dry season. Abundant rains during the cropping season make the area unsuitable for a second crop of rice. The main crops in this zone are rice, citrus, pomelo, wax-apple and tea. An important agricultural area is the Yeelan Plain, with a first crop rice acreage of 12 153 ha and a second crop of 289 ha in 1999. Most rice farmers cultivate green manure crops such as rape in the second cropping season. The total arable area of this zone is 27 840 ha.

### Northwest Zone

Strong winds and low temperatures in winter are important constraints on crop cultivation in this zone. Most soils in the area are red, acidic and infertile. This zone includes the counties of Taipei, Taoyuan, Hsinchu and Miaoli. The main crops are rice, fruit trees, tea and vegetables. There is plenty of paddy land under fallow for the second crop season. A common cropping system in this zone is rice-dryland crops-green manure. The total arable area of this zone is 143 986 ha.

### Chungchang Zone

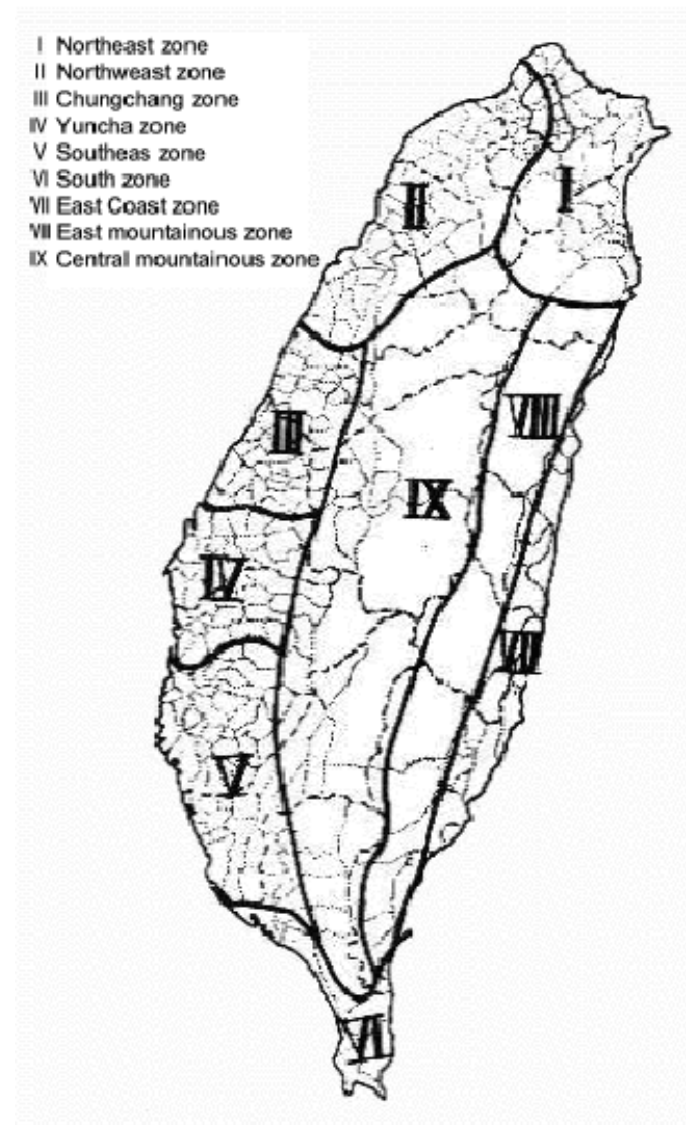
The Chungchang Zone is one of the island's important crop production areas. The area has abundant rains in summer and a dry season in winter. Most soils are neutral and rich in nutrients. The zone covers the two counties of Taichung and Changhua. The eastern part of Taichung County produces temperate fruits and tea. The Changhua Plain is renowned for good-quality rice. Other important crops in this area are vegetables and ornamental plants. The local rice farming systems are mostly two-cropping rice, with a cropping system of barley-rice-rape of about 130 ha in Changhua County. The total arable area of this zone is 122 820 ha.

### Yuncha Zone

This is a fertile plain area with alluvial soils. The Yuncha Zone includes the counties of Yunlin and Chiayee and is Taiwan's major rice (two crops) and vegetable production area. Some farmers adopt rice-rice-vegetable farming systems. Rice-rice-rape and rice-groundnut-rape farming systems are also

common. Another important crop in this area is sugar cane. The total arable area of this zone is 164 081 ha.

**Figure 1**  
Taiwan's agricultural climatic zones



### Southeast Zone

The climate in this area is hot, with heavy summer rains and a 5-6 month dry season in winter. Summer typhoons and heavy rains are the most important factors affecting crop growth. This zone includes the counties of Tainan and Kaohsiung and most of Pingtung County. It forms one of Taiwan's important agricultural regions. Major crops in this zone are two-crop rice, sugar cane, wax-apple, banana, guava, mango, longan, pineapple and vegetables. Cropping systems of vegetable-rice-adzuki bean and rice-rice-adzuki bean are common.

### South Zone

The climate in this zone is humid in summer and dry in winter. However, it is not suitable for seasonal crop cultivation. Seawater flowing backward during the typhoon season makes the crop planting sequence very important. The main crops are rice, sugar cane, banana, coconut and wax-apple, but it is not an important agricultural area.

For the purposes of this report, the South and Southeast zones form one zone: the South Zone with a total arable area of 232 101 ha.

### East Coast Zone

The climate in the northern part of this zone is similar to that of the Northeast Zone, while in the south it is similar to that of the South Zone. Summer typhoons are frequent. Important crops in this zone are rice, sugar apple, Valencia, tea and coconut.

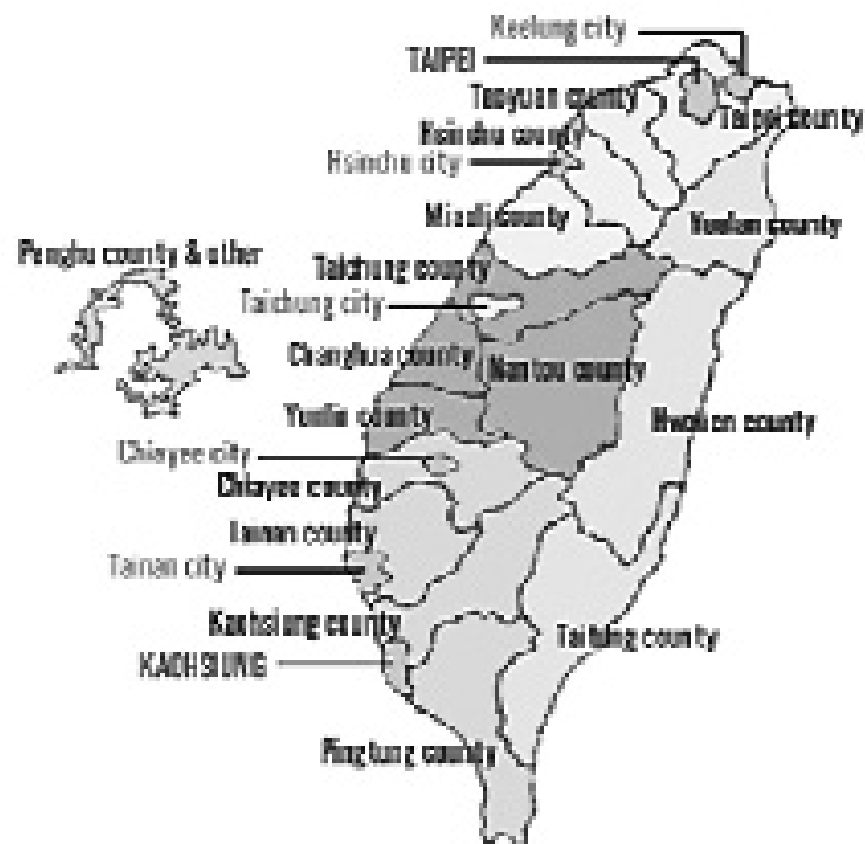
### East Mountainous Zone

Located at approximately 500 m above sea level, this area enjoys a smooth distribution of rainfall, though with a higher precipitation in September-October. Crops grown on windward slopes are liable to suffer typhoon damage. The main crops are citrus and Japanese apricot. In addition to two crops of rice, farmers in the Taitung area follow a cropping system of millet-sweet potato-rape.

### Central Mountainous Zone

The region covers the west side of the Central Range ridge (500 m above sea level). Summer precipitation is high, particularly in June. The main crops in the Central Mountainous Zone are fruit trees, tea, ornamental plants, betel nuts and vegetables. This zone extends over the eastern parts of the counties of Taichung, Nantou and Chiayee. The total arable area of this zone is 66 135 ha.

**Figure 2**  
Map of Taiwan, with 16 counties



## FARM SIZE

Table 1 shows that most farmers in Taiwan own less than 0.5 ha. This is especially true for rice paddy fields, where puddling and ponding water depth are necessary. Fruit and tea farms are generally larger (the average tea farm is about 1 ha). Small farms are not suitable for mechanized operations and incur high production costs.

Table 1  
Number of farm families by farm size, 1999

Total	Tilling farmers									Non-tilling farmers
	Sub-total (ha)	<0.1	0.1-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10	>10	
787 407	782 566	31 747	356 339	207 591	134 584	29 693	17 662	4 519	431	4 841

Non-tilling farmers are persons who have their own land or have tilling land of less than 0.05 ha and who meet at least one of the following requirements: raise at least one head of cattle for the year; raise at least three hogs or goats for the year; raise at least 100 birds of poultry for the year; sell own agricultural products worth US\$570 or more in one year.

Source: Central Taiwan Division, COA, 2000.

## Chapter 2 The fertilizer sector in Taiwan

### UREA

Taiwan is short of raw and intermediate materials for producing commercial fertilizers. It imports liquefied natural gas and liquefied ammonia to manufacture urea. In 1999 Taiwan consumed 161 544 t of urea. Domestic urea production was 109 690 t while urea imports totalled 162 363 t (mainly from Indonesia, Saudi Arabia and Russia). In 2000, the Taiwan Fertilizer Company (TFC) closed its urea factory, therefore Taiwan does not manufacture urea.

### AMMONIUM SULPHATE

Taiwan is self-sufficient in ammonium sulphate (AS) production. The domestic market amounted to 246 312 t in 1999, compared with a total production of 448 819 t, mostly by the China Petrochemical Development Corporation (CPC). The CPC's major foreign customers for AS include Thailand, Viet Nam and Malaysia. In 1999 about 64 000 t were exported. In 2001, the government stopped procuring AS and so farmers' associations now obtain supplies directly from other sources.

### SINGLE SUPERPHOSPHATE

In 1999, domestic consumption of single superphosphate (SSP) was 122 598 t, while production totalled 192 018 t. Taiwan imports rock phosphate from Israel, Jordan, Morocco and Nauru. The TFC has also recently made a test purchase of low-grade rock phosphate from the People's Republic of China. The TFC is the sole manufacturer of single superphosphate on the island.

### MURIATE OF POTASH

Taiwan does not produce muriate of potash (MOP). Canada is the main supplier, although for the NPK blend and to make potassium sulphate, MOP imports come mainly from Israel, Jordan or the Former Soviet Union. In 1999 Taiwan consumed 62 507 t and imported 63 902 t of MOP.

## CALCIUM AMMONIUM NITRATE

Compared with a 1999 consumption figure of 15 577 t, domestic production of calcium ammonium nitrate (CAN) amounted to 16 265 t in 1999, while imports totalled 4 103 t. The TFC intends to shut-down the only CAN plant because of the limited domestic consumption and the high production and transportation costs.

## COMPOUND FERTILIZERS

Compound fertilizers (CFs) are in widespread use in Taiwan, especially CF1 (20-5-10) and CF5 (16-8-12). CF consumption was 543 246 t in 1999. In the same year, locally produced CFs amounted to 640 107 t, accounting for 40.7 percent of Taiwan's total annual production of mineral fertilizers (Table 2). In 1999, imports totalled 11 772 t while exports were 784 t. In addition to the TFC, three other companies also produce CFs: Honhen Chemical, Kuanhwa and Henyee produce CF42 (23-5-5 for tea), CF5 and CF4 (11-5.5-22 for banana), respectively. In 2000, the Kaohsiung Ammonium Sulfate Company (KASC) imported CF39 (12-18-12) from Korea. In 2001, the government abandoned administrative procurement of CF43 (15-15-15-4 [MgO]) and CF39; local demand for both is low.

## OTHER FERTILIZERS AND SOIL AMENDMENTS

Although Taiwan consumed 1 505 t of other fertilizers and soil amendments in 1999, it produced 10 567 t of products such as lime, magnesium fertilizers and organic fertilizers. There was a decrease of about 90 percent in consumption and production compared to the previous year. Taiwan imports many kinds of mineral fertilizers in small quantities from throughout the world. The 1999 import tonnage was 19 207 t (7.5 percent of the 1998 figure). This reflects the fact that many importers withdrew from the market. Japan is the largest supplier, particularly for slow-release and organic fertilizers. Other competitors are Korea, the United States, Germany, the United Kingdom, France and some other European Union nations. The recent depreciation of Taiwan's currency has weakened the competitiveness of foreign suppliers. The prices of imported fertilizers in the local market are generally higher than those for traditional fertilizers sold by the farmers' associations. The export decreased from about 76 000 t in 1998 to 700 t in 1999.

Table 2 is expressed in mineral fertilizers, not nutrients. The balance of Table 2 is positive, as production of some fertilizers is higher than consumption creating a build-up of stocks while fertilizer application rates also fell. Except for MOP, fertilizer use by crops in Taiwan decreased between 1995

Table 2  
Mineral fertilizer consumption, production, imports and exports (t)

Year	Production	Consumption	Imports	Exports
1995	1 442 628	1 370 206	262 369	15 483
1996	1 493 598	1 381 434	299 881	23 638
1997	1 473 788	1 192 288	232 581	19 926
1998	1 579 681	1 184 944	219 747	35 761
1999	1 406 899	1 151 784	242 158	64 841

Source: Central Taiwan Division, COA, 2000.

Table 3  
Mineral fertilizer consumption associated with arable land

Year	Arable land (ha)	Mineral fertilizer use (kg/ha)	Change on previous year (kg/ha)
1995	873 378	1 583	+4
1996	872 159	1 596	+13
1997	864 817	1 391	-205
1998	858 756	1 392	+1
1999	855 073	1 378	-14

and 1999. Fruit trees tended to receive more potassium in Taiwan (consistent with the recent increases in fruit acreage). The reduced application of mineral fertilizer (Tables 2 and 3) was partly due to the decrease in arable land and to the enhanced use of organic fertilizer on high-value crops such as vegetables, tea, fruit and flowers.

## RECENT DEVELOPMENTS IN PUBLIC FERTILIZER AFFAIRS

### Execution of the Fertilizer Adjustment Policy

In order to liberalize fertilizer production and marketing in Taiwan, the authorities enacted the Fertilizer Adjustment Policy in 1995 (effective from 1996 to 2002). This policy has provided an important legal basis for free competition in fertilizer distribution in Taiwan and has changed the local fertilizer situation considerably. It entails the gradual reduction of fertilizer subsidies to farmers, the cancellation of natural gas compensation to the TFC, and the establishment of free competition systems for fertilizer supply to the

governmental procuring agency. According to the Council of Agriculture (COA), the total mineral fertilizer procurement for 2001 amounted to 666 100 t (including straight and compound fertilizers). The government will fully decontrol fertilizer distribution from the start of 2003.

### Reorganization of the Taiwan Provincial Food Bureau

Local government reorganization in 1999 led to the merging of the former fertilizer-procuring agency, the Taiwan Provincial Food Bureau, into the COA. For the previous 50 years, this agency had played the leading role in fertilizer transportation, distribution and marketing. The new title of the organization is the 2nd Division, COA. The division is now a government unit in charge of fertilizer distribution and marketing. The office responsible for processing fertilizer procurement is the 3rd Section, with about 20 staff handling the administration of fertilizer distribution. Around the end of 2002, the section responsible for fertilizer affairs will undergo further reorganization.

### Legal developments

The Fair Trade Law (1992) and the Government Procurement Law (1998) have established fair and open procurement procedures, promoted the efficiency and effectiveness of government procurement operations, and ensured the quality of procurement. Every fertilizer producer or supplier has an equal right to bid for the fertilizer supply agreement offered by the 2nd Division, COA. Open competition systems can generate operational problems for former state-owned companies such as the TFC. However, in some of their fertilizer production systems, core operations have quickly adapted from a producer to a supplier role, with reportedly lower running costs.

### Privatization

The TFC became a privatized company in September 1999. The KASC is now the only state-owned fertilizer company in Taiwan. Its main products are organic fertilizers that use oilseed residues as raw material. The KASC ceased AS production in 1997. However, the KASC does sell AS produced by the CPC.

### The Fertilizer Regulation Law

The focus of the revised Fertilizer Regulation Law (1999) is on ensuring fertilizer quality. The COA issued the relevant enforcement bylaws in 2000.

## Chapter 3 The importance of manure in crop production

Because of government promotion of sustainable agriculture, the consumption of farm-produced fertilizing materials has increased recently (Table 4). This has been especially significant in green manure production, partly due to government encouragement to grow green manure crops after harvesting the second rice crop and to adopt a fallow system for the second crop rice by growing green manure crops such as sesbania.

Table 4  
Farm-produced fertilizing materials (t)

Year	Total	Green manure	Compost	Animal dung	Ashes	Straw	Rice husks	Others
1995	3 176 650	905 662	716 149	1 014 988	27 496	311 333	23 399	177 623
1996	3 275 394	1 063 179	643 926	1 030 476	25 717	329 376	25 146	157 574
1997	3 712 835	1 077 022	582 307	1 463 448	26 331	354 589	31 725	177 413
1998	3 627 480	1 541 741	484 676	1 098 550	20 911	286 333	25 011	170 258
1999	4 146 794	2 034 710	460 038	1 135 045	25 535	311 548	17 022	162 896

Source: Central Division Office, COA, 2000.

### LIVESTOCK COMPOST

The development of the livestock industry in Taiwan has generated the annual production of large amounts of animal wastes. In 1997, the estimated discharge of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O in these wastes was 120 000, 59 000 and 38 000 t, respectively, equivalent to 52, 96 and 38 percent of the annual mineral fertilizer consumption. In order to recycle these nutrients, the government has promoted the use of compost made from animal wastes and crop residues. Promotional strategies include financial aids for constructing district animal-waste treatment centres and composting facilities, improving compost quality, and subsidizing utilization of compost made from livestock wastes, with a subsidy on 8 t of compost for long-term crops of about US\$230/ha (about US\$115/ha for 4 t of compost for short-term crops). Currently, there are more than 300 animal-waste composting factories in Taiwan. In 2000, the total subsidized crop area was 19 420 ha. Although the government encourages compost use, its high cost means that only high-value crops such as fruit trees,

vegetables and high-grade tea can yield positive returns. Farmers who apply organic fertilizer tend to reduce their use of mineral fertilizer. Most farmers report an improvement in crop quality.

Sustainable agricultural development is a long-term goal of Taiwan and there are currently more than 800 ha of farmland where organic fertilizers are the main sources of nutrients.

### GREEN MANURE

The provision of free seeds has encouraged farmers to grow green manure crops during the fallow seasons in winter and in summer. The main green manure crops are rape, berseem clover, *Crotalaria*, soybean and *Sesbania*. In 1999, the planted area of green manure crops was 99 462 ha (COA, 2000). The main factor behind the considerable growth in acreage in recent years has been government promotion to grow green manure crops (particularly *Sesbania*) on paddy fields under fallow. Most rice farmers appreciate sowing fast-growing rape as a green manure crop. Its incorporation into fields about six weeks after sowing entails no loss of time, as the practice is part of a series of tillage operations.

### BREAKDOWN BY AGRO-ECOLOGICAL ZONE

Table 5 highlights the predominance of the South AEZ in terms of animal dung production. This reflects the concentration of animal husbandry in this area.

Table 5  
Farm-produced fertilizers by AEZ, 1999 (t)

AEZ	Total	Green manure	Compost	Animal dung	Ashes	Straw	Rice husks	Others
Northwest	93 877	67 761	9 356	3 199	923	11 679	499	460
Northeast	464 245	284 247	33 112	60 096	6 517	50 999	4 814	24 460
Chungchang	609 486	301 440	105 558	116 790	8 651	66 651	6 688	3 708
Central	259 337	16 818	73 776	52 126	1 133	12 905	1 135	101 444
Yuncha	697 004	500 164	53 565	73 611	3 652	50 268	1 474	14 270
South	1 760 260	713 518	157 188	794 529	3 354	73 534	564	17 573
Hwatumg*	262 585	150 762	27 483	34 694	1 305	45 512	1 848	981

\* Hwatumg: sum of Hwalien and Taitung counties, with a total arable area of 93 660 ha.

## Chapter 4 Crop fertilizer use and related yields

Based on fertilizer recommendations for various crops and harvested area (COA, 2000), Table 6 lists the estimated crop fertilizer use and related yields. For sugar cane and pineapple, the estimates relate to the shares of the ratoon crop area because the ratoon crop tends to require less fertilizer, particularly phosphate fertilizer.

Table 6 shows that rice consumes the largest amount of fertilizer, followed by bamboo shoots. Except for potash fertilizer, official fertilizer recommendations for the first crop of rice are generally higher than those for the second crop because yields are lower and the growing conditions for second-crop rice in the Northwest, Northeast and Yuncha AEZs are less favourable. Government promotion of fallow on the rice acreage after the second crop is lower than that after the first crop. Fertilizer consumption on rice will fall steadily in the coming years as rice production adjusts to the impacts of WTO entry.

Although groundnut is the main crop in the coarse grain and leguminous crop category, maize consumes the largest amount of fertilizer. Coarse grain production is heavily dependent on farmland availability. Compared to imports of 8 440 000 t in 1999 (mostly maize and soybean), domestic production of coarse grains and leguminous crops was 530 000 t. However, coarse grains and leguminous crops are useful in crop rotations.

Sugar cane and tea are important special crops in Taiwan, and both receive large amounts of fertilizer. Edible sugar cane is notable for the high input of nitrogen fertilizer. Flower cultivation is intensive and uses large amounts of nutrients and water. Farmers' applications far exceed official nutrient recommendations for the crops. Vegetable production in Taiwan consumes large quantities of fertilizers and water, particularly nitrogen fertilizers and organic fertilizers. Multiple cropping systems are common. There is evidence that frequent irrigation of leafy vegetables results in significant nutrient leaching. Fruit crops appear to require high amounts of mineral fertilizer. Most fruit trees in Taiwan are grown on marginal lands for long-term production. Most fruit growers apply organic fertilizers to their orchards either annually or every other year. Green manure crops usually need starter nitrogen and phosphorus doses. Because of the future increases in field under fallow, the area under green manure crops will increase. Taiwan has a small dairy industry and fertilizer consumption for pasture is low.

**Table 6**  
**Estimated quantities of fertilizers used by crop and related crop yields, 1999**

	Harvested area (ha)	Average yield (kg/ha)	Estimated quantities of fertilizers used		
			N	P <sub>2</sub> O <sub>5</sub> (t)	K <sub>2</sub> O
<i>Rice</i>					
First crop	197 123	6 218	24 640	9 856	7 885
Second crop	155 942	4 428	17 153	5 458	8 577
<i>Coarse grains, pulses &amp; roots</i>					
Fodder maize	19 880	4 477	1 988	1 392	994
Sweet maize	14 974	7 493	1 497	1 048	748
Sweet potato	9 962	21 940	299	299	1 195
Groundnut	26 495	2 535	539	1 192	1 060
Sorghum	6 693	5 018	669	268	268
Adzuki bean	5 144	1 602	206	206	154
Soybean	163	2 169	3	10	5
<i>Special crops</i>					
Sugar cane	30 657	81 337	6 438	1 073	2 146
Sugar cane (ed.)	1 605	93 287	401	289	401
Tea	19 142	1 103	8 040	2 680	2 680
Tobacco	4 169	2 203	250	500	750
Sesame	838	550	32	21	42
<i>Ornamental plants</i>					
Chrysanthemum	1 625	24 607	640	480	640
Gladiolus	841	19 062	210	210	210
Lily	245	21 212	100	50	100
Rose	289	48 606	150	120	150
Anthurium	129	25 152	25	15	18
<i>Vegetables</i>					
Radish	5 152	33 392	721	412	567
Carrot	3 843	43 200	692	461	461
Ginger	1 211	25 727	194	121	194
Taro	2 651	16 252	1 856	265	1 326
Scallion	5 498	21 512	1 320	522	495
Potato	1 700	21 243	255	255	340
Onion	750	34 711	113	23	90
Leek	991	37 856	79	30	59
Asparagus	1 538	4 838	1 077	154	308
Leaf-mustard	2 954	28 892	473	266	443

	Harvested area (ha)	Average yield (kg/ha)	Estimated quantities of fertilizers used		
			N	P <sub>2</sub> O <sub>5</sub> (t)	K <sub>2</sub> O
Water morning glory	2 344	19 714	281	117	234
Celery	1 631	22 460	245	98	245
Chinese cabbage	6 139	34 861	1 228	553	737
Cauliflower	3 967	25 272	714	278	516
Lily flower	953	909	95	86	57
Ori. pick. melon	518	23 780	114	62	93
Green garlic	1 572	21 672	314	141	189
Water bamboo	1 710	22 480	342	171	171
Bamboo shoot	29 819	12 030	14 910	3 727	5 069
Cabbage	9 653	39 254	2 413	676	1 158
Cucumber	3 497	21 027	874	420	1 049
Bitter gourd	3 073	20 334	768	307	461
Eggplant	1 837	18 733	1 121	1 470	1 157
Tomato	3 823	28 398	573	382	382
Pepper	3 738	11 019	449	449	561
Kidney bean	1 868	13 002	168	112	187
Pea	1 918	9 732	38	96	115
Vegetable soybean	7 644	7 945	459	459	459
Watermelon	19 720	19 685	3 550	2 366	3 944
Muskmelon	3 499	15 120	525	315	350
Cantaloupe	7 026	14 731	843	1 265	1 265
Strawberry	463	11 843	69	69	69
<i>Fruits</i>					
Banana	8 961	23 718	2 216	1 090	4 433
Pineapple	7 340	47 474	2 422	440	1 321
Pineapple (ratoon)	2 936	-	734	0	294
Citrus-ponkan	8 661	14 083	2120	1060	1 590
Citrus-tankan	4 928	13 299	1413	707	1 060
Wentan pomelo	6 225	14 396	747	374	560
Pai pomelo	706	14 411	143	72	107
Liucheng	7 648	15 873	1400	700	1 050
Grapefruit	787	16 626	227	113	170
Lemon	1 245	14 674	370	185	278
Mango	18 700	11 065	449	299	673
Guava	6 768	25 699	2707	1 516	2 707
Wax-apple	7 724	13 462	8 496	8 496	8 496

	Harvested area (ha)	Average yield (kg/ha)	Estimated quantities of fertilizers used		
			N	P <sub>2</sub> O <sub>5</sub> (t)	K <sub>2</sub> O
Grape	3 032	35 156	45	38	45
Loquat	996	7 212	134	67	101
Plum	4 642	8 586	167	111	167
Peach	2 496	9 374	154	86	135
Persimmon	2 496	9 374	75	25	125
Japanese apricot	8 823	6 277	706	353	706
Litchi	10 530	9 385	316	211	284
Litchi (S. Tai.)	1 030	-	26	26	26
Carambola	1 738	17 303	130	109	174
Pear	8 569	13 716	1234	686	960
Apple	768	10 690	154	96	115
Papaya	3 687	43 097	516	959	590
Jujube	1 585	16 312	157	84	188
Sugar apple	4 836	11 677	1693	967	1693
Passion fruit	267	16 107	64	26	155
Coconut	4 154	10 666	125	50	249
<i>Green manure &amp; Forage crops</i>		<i>Tot. prod.(t)</i>			
Soybean (g. manure)	1 752	29 644	35	105	53
Field pea	7	55	0.14	0.35	0.42
Rape	36 457	555 249	365	656	0
Pangola grass	4 991	50 476	1 597	699	699
Napier grass	3 023	341 088	2 056	423	907

## Chapter 5

### Crop area and fertilizer use

Forecasts indicate the cultivated area declining from about 860 000 ha in 2001 to about 840 000 ha by 2010. Farmers will need to make full use of natural resources and new technology, crops and cultivars to achieve high yields and high produce quality. People in Taiwan are eating more wheat-based foods and dairy products and less rice, and rising living standards have boosted demand for exotic flowers and fruits. In addition, the rice-field diversion programme and preparation for WTO entry have also prompted farmers to diversify into horticulture, agri-tourism, fruits and vegetables introduced from abroad, chemical-free organic produce, new cultivars, and other high-value products.

Minor factors contributing to the decreases in cultivated area are urbanization, conversion of land to industrial uses, and the improvement of transport infrastructure.

In terms of planted area in 1999, rice ranked first followed by betel nut, sugar cane, maize, bamboo shoots, groundnut, mango, tea, watermelon, litchi, longan and banana.

#### RICE

In 2000, the total area under rice was 346 819 ha, with a harvested area of 195 055 ha for the first crop rice and 151 764 ha for the second crop. The decrease in acreage (Table 7) also suggests a decline in the quantities of fertilizers used. Table 8 presents rice area and yield data for 2000.

Fertilizer costs for rice increased from less than US\$158/ha in 1991 to about US\$170/ha in 1999. However, they did not constitute a major share of

Table 7  
Harvested area of rice, 1996-2000 (ha)

Year	Total	First crop	Second crop
1996	347 762	182 807	164 955
1997	364 212	202 010	162 202
1998	357 687	201 424	156 263
1999	353 065	197 123	155 942
2000	346 819	195 055	151 764

Source: COA, 2000.

Table 8  
Rice area and average yield in different agro-ecological zones, 2000

AEZ	Total	Area (ha)		Average yield (kg/ha)	
		1st crop	2nd crop	1st crop	2nd crop
Northeast	12 103	11 942	161	6 097	2 900
Northwest	63 381	34 975	28 406	5 663	3 780
Chungchang	90 344	47 025	43 319	6 508	5 294
Central	4 209	1 895	2 314	6 493	5 704
Yuncha	87 239	51 709	35 530	6 642	4 938
South	54 547	33 251	21 296	6 726	4 285
Hwutung	28 128	14 262	13 866	5 208	4 653

the total production costs for rice. Farmers use traditional rice fertilizers such as CF39 (basal application), CF1, CF5, urea and AS. They buy mainly from farmers' associations. All farmers' associations have a safe-stock of fertilizers for more than six weeks. Most farmers purchase rice fertilizer twice a year, about one month before or after rice transplanting in each cropping season. Peak purchasing times vary as transplanting dates for the first crop in northern Taiwan may lag those in the south by up to one month. According to TFC data (1988-1997), demand for mineral fertilizers peaks around March and August at about 100 000 t, coinciding with rice transplanting times.

Most farmers realize that long-term storage can cause caking in fertilizers. Moreover, they do not have much storage space. The most popular means of transporting fertilizer from the farmers' associations to the farmers' residence are motorcycles, farm vehicles or pick-ups. The government subsidizes a free delivery system for fertilizer purchases.

Table 9 details recommended N rates for cultivars in the various regions. Rice fertilizer application relates closely to yield, indicating that the lower yielding areas tend to receive less fertilizer. Fertilizer expenditure is a good indicator of fertilizer use. The trends are clear in the areas such as the Northeast AEZ and the Hwutung area. In Chungchang and Central (Nantou County) AEZs, most rice farmers adopted 4-split applications of nitrogen and 2-split applications for P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O fertilizer. The average amounts of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O applied in Chungchang AEZ were around 220, 60 and 110 kg/ha, respectively. In Nantou County, the amount applied was lower (180-60-110). Popular compound fertilizers were CF1, CF5 and CF39. Compound fertilizers have widely replaced straight fertilizers.

Table 9  
Recommended N-application rates for rice (kg/ha)

Cultivar type	Region	First crop	Second crop
Japonica	Central, South, East	110-140	90-120
Japonica	North	100-120	90-110
Indica	Central, South, East	130-150	100-120

## COARSE GRAINS, PULSES AND ROOTS

Because of high production costs, the cultivated area of coarse grains and pulses is declining (Table 10). Since the government abandoned the guaranteed purchase price for soybean in 1999, the soybean area has decreased sharply. Recent changes to the guaranteed and guidance purchase programme for fodder maize have had a similar effect on the area for this crop.

Table 10  
Harvested area of various crops, 1995-99 (ha)

Year	Fodder maize	Sweet maize	Sweet potato	Groundnut	Sorghum	Adzuki	Soybean bean	Others
1995	57 360	15 407	10 627	39 164	22 964	5 645	3 844	2 358
1996	56 414	16 663	10 496	33 964	13 228	6 464	5 044	1 100
1997	45 599	16 248	10 650	33 297	12 556	5 640	1 983	1 111
1998	25 691	16 873	9 704	30 042	10 737	5 228	685	1 136
1999	19 880	14 974	9 962	26 495	6 693	5 144	163	948

Source: Central Taiwan Division, COA, 2000.

Farmers tend to apply more nitrogen fertilizer than recommended to most crops. On sweet maize, farmers' rates were about four times the recommended rate (Annex), suggesting a need for education on rational fertilization. The main fertilizers for groundnut and maize were urea, single superphosphate and CF1 (Table 11). Adzuki growers mostly used CF39 for basal application (Table 12).

**Table 11**  
Fertilizer use on groundnut and maize in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	1st crop groundnut				2nd crop groundnut				2nd crop fodder maize				2nd crop sweet maize		
	Weight	0.18	0.77	0.06	Weight	0.18	0.78	0.04	Weight	0.04	0.49	0.47	Weight	0.78	0.22
	W.A.	Changhua	Yunlin	Chiayee	W.A.	Changhua	Yunlin	Chiayee	W.A.	Yunlin	Chiayee	Tainan	W.A.	Yunlin	Chiayee
N	271	213	285	273	235	128	264	173	240	240	233	247	552	577	463
P <sub>2</sub> O <sub>5</sub>	69	114	59	75	64	104	53	90	57	46	57	58	96	87	129
K <sub>2</sub> O	87	94	84	103	89	78	92	90	88	65	83	96	180	184	169
<i>Organic fertilizer</i>															
Oilseed residue	-	-	-	-	2	11	-	-	-	-	-	-	-	-	-
Compost	94	-	-	-	52	-	67	-	-	-	-	-	-	-	-
Chicken manure	-	-	122	-	167	245	155	60	6	151	-	-	802	772	911
Others	67	-	88	-	86	34	102	-	-	-	-	-	11	14	-
<i>Mineral fertilizer</i>															
AS	141	105	157	41	124	25	154	-	63	244	109	-	547	680	79
Urea	252	159	272	270	225	127	252	139	108	128	95	121	327	313	377
SSP	175	466	112	112	175	489	105	119	74	75	89	59	136	159	54
KCl	31	58	24	30	52	76	49	12	-	-	-	-	92	112	21
CAN	-	-	-	-	-	-	-	-	3	-	5	-	275	293	211
CF1	542	585	536	493	458	321	500	250	880	649	826	956	1 063	1 161	716
CF5	87	-	104	135	59	-	75	28	-	-	-	-	12	-	54
CF39	25	6	22	131	33	-	23	363	-	-	-	-	116	-	526

Sample size: groundnut, 73-80; fodder maize, 80; sweet maize, 30.

Source: Central Taiwan Division, COA, 2001.

**Table 12**  
Fertilizer use on adzuki bean and sweet potato in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Winter crop adzuki bean					Winter crop sweet potato				1st crop sweet potato					
	Weight	0.04	0.15	0.13	0.67	Weight	0.07	0.18	0.59	Weight	0.15	0.10	0.40	0.35	
	W.A.	Chiayee	Tainan	Kaohsiung	Pingtung	W.A.	Miaoli	Changhua	Yunlin	W.A.	Taipei	Miaoli	Taichung	Yunlin	
N	123	108	120	115	127	114	97	176	92	105	224	125	82	77	
P <sub>2</sub> O <sub>5</sub>	89	109	89	71	91	60	63	73	46	26	38	65	35	-	
K <sub>2</sub> O	72	57	66	85	71	321	106	174	393	412	223	145	97	920	
<i>Organic fertilizer</i>															
Compost	-	-	-	-	-	79	1 124	-	-	-	-	-	-	-	
Chicken manure	-	-	-	-	-	-	-	-	-	725	48	-	1784	-	
Others	-	-	-	-	-	168	82	-	276	162	132	677	-	220	
<i>Mineral fertilizer</i>															
AS	43	-	45	47	44	223	60	222	153	95	502	222	-	-	
Urea	52	77	62	-	59	-	-	-	-	59	-	-	-	167	
SSP	229	292	263	-	262	245	153	170	218	14	-	144	-	-	
KCl	15	-	19	-	18	491	82	170	634	624	260	144	71	1 533	
CAN	6	73	17	-	-	100	-	-	169	-	-	-	-	-	
CF1	239	15	207	121	283	198	135	578	128	135	470	-	165	167	
CF5	66	-	75	195	43	25	358	-	-	175	124	489	272	-	
CF39	204	369	166	331	177	23	-	93	-	19	32	-	35	1 533	

Sample size: adzuki bean, 88; sweet potato, 37.

## SPECIAL CROPS

Most traditional special crops (Table 13) have lost competitiveness because of high production costs. This is particularly apparent for sugar cane and tobacco. With the share of the domestic tobacco market predicted to be less than 50 percent after WTO entry, the plan is to reduce the tobacco area gradually from 4 300 ha to about 2 000 ha within two years, in combination with the abolition of the guaranteed purchase price. Because of rice diversion programmes, other special crops such as yam, hsien-tsaio (*Mesona procumbens*) and some other medicinal herbs have become optional crops for farmers.

Table 13  
Harvested area of special crops, 1995-99 (ha)

Year	Sugar cane (refined)	Sugar cane (edible)	Tea	Tobacco	Sesame	Others
1995	58 124	2 432	19 932	4 988	666	5 526
1996	52 064	2 308	19 955	4 090	623	6 394
1997	47 780	2 435	19 622	4 061	756	6 109
1998	45 284	2 351	19 299	4 255	882	5 823
1999	40 028	1 605	19 142	4 169	838	5 684

Source: Central Taiwan Division, COA, 2000.

## Sugar cane

The major sugar cane growing areas are in the central-southern regions of Taiwan. In 2000, the total sugar cane area amounted to 31 842 ha. According to Taiwan Sugarcane Company (TSC) statistics, fertilizer use for sugar cane has been in continuous decline in recent years (Table 14). The main fertilizers used on TSC mill farms are AS, urea and CF2, whereas contracted sugar cane farmers prefer CF1, which is a high N-content compound fertilizer.

Based on a COA survey in 2000, Table 15 lists farmers' fertilizer use for edible sugar cane. Nutrient inputs in terms of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were rather high. The official recommendations for the crop are 750, 150 and 250 kg/ha, respectively. The high inputs of N fertilizers are due to the long growing period and latent viral infections of the traditional cultivar. Normal fertilizer recommendations for TSC mill farms are:

Table 14  
Fertilizer use on sugar cane on self-mill farms in the TSC, 2000 (t)

Fertilizer	1994/95	1995/96	1996/97	1997/98	1998/99
AS	17 020	17 582	17 848	17 105	16 359
CAN	348	273	235	200	-
Urea	2 124	1 803	1 498	1 577	1 250
KCl	-	2	12	-	-
CF2	8 766	8 726	10 064	9 308	8 419
CF1	584	1 068	765	406	308
Others	4 044	1 408	1	-	-

Source: Taiwan Sugar Statistics, 1999.

Table 15  
Fertilizer use on edible sugar cane, 2000 (kg/ha)

Item	Weighted average	Changhua	Nantou	Yunlin	Tainan	Taitung
N	751	798	655	831	578	792
P <sub>2</sub> O <sub>5</sub>	306	424	252	232	466	295
K <sub>2</sub> O	204	178	176	181	334	266
<i>Organic fertilizer</i>						
Oilseed residue	594	71	932	1 061	-	-
Chicken manure	888	-	3 247	101	-	260
Others	2 297	4 145	108	1 955	-	3 411
<i>Mineral fertilizer</i>						
AS	1 546	1 858	1 615	1 511	1 504	1 018
Urea	414	467	247	364	414	799
SSP	1 520	2 000	1 224	1 240	2 586	1 263
KCl	254	125	224	277	556	244
CAN	760	58	776	1 600	361	-
CF1	295	783	-	121	-	765
CF5	92	-	184	-	-	364
CF43	68	167	115	16	-	-

Sample size: 47

(kg/ha)	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Autumn planting	200-220	35	70
Spring planting, ratoon	160-180	35	70

Nitrogen applications depend on the soil productivity potential, the irrigation conditions and sugar cane yield potential. Soil analysis provides a guide for phosphorus and potassium fertilizer applications. Most TSC mill farms follow the concept of rational fertilization.

## Tea

Fertilizer use on tea varies with location, altitude and harvesting method. Machine-plucked teas come mainly from the Northeast and Northwest AEZs (Table 16), where the main mineral fertilizer applied is CF1. Hand-plucked teas receive more organic fertilizer (especially oilseed residues).

Table 16  
Tea, harvested area and made-tea yield, 1999

AEZ	Harvested area (ha)	County	Harvested area (ha)	Yield (kg/ha)	Plucked by
Northeast	586	Yeelan	586	781	Machine
Northwest	6 816	Taipei City & county	2 595	628	Hand & machine
		Taoyuan	1 236	781	Machine
		Hsinchu	1 995	1 095	Machine
Chungchang	55	Miaoli	990	1 408	Machine
		Taichung	45	880	Hand
		Changhua	10	1 042	Machine
Yuncha	2 714	Yunlin	525	1 125	Hand
		Chiayee	2 189	683	Hand
Central	7 763	Nantou	7 763	1 368	Hand & machine
South	254	Tainan	1	400	Hand
		Kaohsiung	221	1 117	Hand
		Pingtung	32	825	Hand
Hwatung	962	Hwalien	186	866	Hand
		Taitung	776	833	Hand
Total	19 150				

Source: Central Taiwan Division, COA, 2000.

The surveyed amounts of nitrogen fertilizer applied in the high mountainous areas of Central AEZ are generally lower than the recommended rates (Table 17) because of the application of 2-3.6 t/ha of oilseed residue meal as a slow-release fertilizer. The annual precipitation in the areas, about 2 500 - 4 000 mm, is rather high. Long-term inputs of organic fertilizers in the tea fields have made the soil rich in organic matter and of good structure.

## Tobacco

The main tobacco fertilizers used in Taiwan are 857 kg/ha of CF36 (7-21-21) in Taichung, Chiayee and Hwalien counties, and 667 kg/ha of CF47 (9-18-27) in Pingtung County where the soil is rich in phosphorus. As overfertilization reduces tobacco quality, most growers follow appropriate fertilization strategies and apply the recommended amounts (Annex).

## VEGETABLES

Taiwan grows more than 100 types of vegetables, the most important of which are bamboo shoots, cabbage, tomatoes, Chinese cabbage, watermelon and cantaloupe. Vegetables rank second to rice in terms of area sown. Vegetable acreage rose from 173 055 ha in 1995 to 181 882 ha in 1999. Yunlin, Chiayee and Tainan counties are important vegetable producing areas. Growers in the Silo townships harvest up to 17 crops a year of leafy vegetables. Fertilizer use in this area of about 500 ha is rather intensive.

## Bamboo shoots

Of the more popular kinds of bamboo shoots in Taiwan, green bamboo (*Leleba oldhami Munro*) yields less (0.7 kg/shoot) than Machu (*Dendrocalamus latifloxa Munro*) (1.75 kg/shoot).

Green bamboo is closely associated with lower inputs of fertilizer (Table 18). Farmers apply chicken manure to green bamboo, which grows principally in the plains under intensive cultivation, whereas Machu grows mostly in mountainous areas. Urea, CF1 and CF5 are major mineral fertilizers for the two varieties. Farmers use less fertilizer than the official recommended rates (800, 200 and 600 kg/ha of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O respectively), indicating a need to revise the recommended rates. Bamboo shoot growth appears to correlate to latitude and altitude, resulting in variations in the amounts of nitrogen fertilizer inputs.

**Table 17**  
Fertilizer use on tea in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Hand-plucked tea							Machine-plucked tea					
	W. A.	Taipei	Nantou	Yunlin	Chiayee	Kaohsiung	Taitung	W. A.	Yeelan	Taoyuan	Hsinchu	Miaoli	Nantou
N	449	578	373	824	383	277	666	651	326	179	410	304	858
P <sub>2</sub> O <sub>5</sub>	205	281	181	261	166	69	244	197	86	72	135	95	254
K <sub>2</sub> O	292	380	245	399	240	138	532	342	204	110	227	164	441
<b>Organic fertilizer</b>													
Oilseed residue	2 470	391	3 664	917	2 066	2 204	1 321	1 353	271	53	-	-	2 162
Compost	1 437	206	1 563	4 286	2 272	879	1 007	1 597	1 133	2 092	99	1 699	1 897
Chicken manure	80	-	-	-	384	-	403	-	-	-	-	-	-
Others	2 206	2 597	1 528	1 825	4 514	1 137	1 208	1 846	1 539	2 819	1 544	1 844	1 789
<b>Mineral fertilizer</b>													
AS	-	-	-	-	-	-	-	67	-	-	-	-	108
Urea	49	-	59	397	23	-	-	124	40	-	-	24	194
SSP	13	-	-	-	13	-	215	96	-	-	-	-	155
KCl	14	-	-	-	-	-	268	43	68	-	-	-	65
CAN	23	-	44	-	-	-	-	-	-	-	-	-	-
CF1	1 126	1 979	563	2 095	1 109	1 385	2 601	2 567	1 357	616	1 827	1 164	3 338
CF5	629	-	893	825	529	-	886	198	229	186	-	293	237
CF43	637	1 213	541	603	441	-	30	235	-	174	294	81	267

W. A. = weighted average by % acreage; sample size: hand-plucked tea = 100; machine-plucked tea = 88.  
Source: Central Office Division, COA, 2001.

**Table 18**  
Fertilizer use on bamboo shoots in the main producing counties, 1999 (kg/ha)

Nutrient/fertilizer	Green bamboo shoot							Machu ( <i>D. latifloxa</i> )						
	Weight	0.03	0.36	0.08	0.12	0.35	0.06	Weight	0.05	0.10	0.26	0.33	0.17	0.09
	W.A.	Yeelan	Taipei	Taoyuan	Taitung	Tainan	Pingtung	W.A.	Taitung	Nantou	Yunlin	Chiayee	Tainan	Kaohsiung
N	495	294	305	266	493	766	465	563	555	459	601	577	563	520
P <sub>2</sub> O <sub>5</sub>	134	147	156	140	58	104	293	114	121	123	171	110	43	87
K <sub>2</sub> O	161	221	189	180	116	132	181	176	181	193	202	204	80	156
<b>Organic fertilizer</b>														
Oilseed residue	255	-	534	138	462	-	-	37	681	-	-	-	-	-
Compost	8	-	-	102	-	-	-	205	245	1 915	-	-	-	-
Chicken manure	1 650	2 248	2 428	789	2 817	439	2 714	74	-	-	-	9	422	-
Others	1 603	174	1 128	3 191	789	2 244	819	359	862	370	183	265	660	325
<b>Mineral fertilizer</b>														
AS	385	-	-	10	428	779	952	89	-	-	345	-	-	-
Urea	377	-	103	39	372	809	162	489	681	339	301	425	907	532
SSP	209	-	155	-	-	214	1 219	125	-	-	488	-	-	-
KCl	21	-	26	-	-	13	114	19	-	-	73	-	-	-
CAN	3	-	-	39	-	-	-	119	-	-	440	18	-	-
CF1	833	-	736	377	1 161	986	781	1 142	-	789	1 363	1 590	591	1 003
CF5	241	1 838	194	528	-	205	-	403	1 511	778	183	379	172	465
CF39	235	-	495	526	-	-	229	14	-	141	-	-	-	-

Sample size: Machu, 60; green bamboo shoot, 49.  
Source: Central Taiwan Division, COA, 1998.

Table 19  
Fertilizer use on cabbage and strawberry in the main producing areas, 2000 (kg/ha)

Nutrient/fertilizer	2nd crop cabbage				Winter crop cabbage				Winter crop strawberry								
	Weight	W.A.	Changhua	Yunlin	Chiyayee	Weight	W.A.	Taoyuan	Changhua	Yunlin	Chiyayee	Tainan	Weight	W.A.	Hsinchu	Miaoli	Nantou
	0.50	0.50	0.45	0.05	0.05	0.04	0.04	0.37	0.41	0.09	0.09	0.09	0.09	0.03	0.03	0.93	0.04
N	500	427	598	368	368	421	248	395	442	345	345	575	345	418	356	50	
P <sub>2</sub> O <sub>5</sub>	170	160	190	168	168	158	99	160	175	81	81	172	222	262	229	50	
K <sub>2</sub> O	322	334	327	168	168	297	157	347	321	126	126	199	304	268	315	53	
<b>Organic fertilizer</b>																	
Oilseed residue	65	60	78	-	-	50	-	-	122	-	-	-	129	-	102	857	
Compost	16	-	36	-	-	-	-	-	-	-	-	-	118	-	-	2 943	
Chicken manure	354	440	-	2 598	2 598	747	1 818	584	603	1 548	867	867	5 546	2 944	5 857	-	
Others	1 039	1 251	909	83	83	448	301	716	295	459	82	82	6 657	5 398	6 534	10 321	
<b>Mineral fertilizer</b>																	
AS	919	875	1 038	315	315	716	-	759	939	251	273	273	13	507	-	-	
Urea	278	245	326	176	176	147	82	176	117	75	262	262	112	-	120	-	
SSP	554	510	644	202	202	502	-	581	587	84	402	402	142	-	152	-	
KCl	363	408	343	84	84	306	9	431	352	-	-	-	96	-	103	-	
CAN	33	-	72	30	30	5	9	-	-	50	-	-	28	113	27	-	
CF1	680	418	945	955	955	872	97	659	811	1 211	1 988	1 988	-	-	-	-	
CF5	4	-	-	72	72	41	1182	-	-	-	-	-	1 107	338	1 176	-	
CF39	242	313	179	81	81	128	-	152	192	33	-	-	721	1 563	714	332	

Sample size: cabbage, 45-46; strawberry, 30.  
Source: Central Taiwan Division, COA, 2001.

## Cabbage and strawberry

Cabbage is an important crop (Table 6) and there are three cropping seasons. The winter crop is the main crop. Major producing areas such as Yunlin and Changhua counties adopt heavy fertilization compared to the minor producing areas (Table 19). Crop nutrient requirements are high. Farmers use straight fertilizers plus compound fertilizers to enhance productivity. Chicken manure is the main organic fertilizer in most cabbage-growing areas. The main mineral fertilizers include AS, superphosphate and CF1. Most vegetable soils in Yunlin and Changhua counties have a pH value above 7.0, with a high cation exchange capacity, and are rich in calcium. Summer cabbage comes mainly from the high mountainous lands of Nantou and Taichung counties, where the main fertilizer is chicken manure.

Strawberry is a minor (Table 6) but high-value crop in Taiwan. Miaoli County is the key producer (375 ha yielding 12 134 kg/ha in 1999). Table 20 details the official recommendations for fertilizer applications on strawberry. In the north, the mostly red acidic soils require more phosphate and potash fertilizers. For low-yielding eastern areas, the recommended amounts are lower. Fertile alluvial soils in the south produce more fruits and the recommendation is for more nitrogen. Farmers apply chicken manure to strawberries (Table 19). This acts as a slow-release fertilizer as plastic-film mulching systems maintain soil moisture and control weeds.

Table 20  
Official recommended rates of fertilizers for strawberry (kg/ha)

Region	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
North	150-200	150-200	150-200
South	200-240	120-160	120-160
East	120-160	60-90	80-128

Source: COA, 2000.

## Watermelon

Most counties grow watermelon (Table 21), led by Yunlin (4 372 ha yielding 21 220 kg/ha in 1999). The first (spring planting) of the three crops a year yields 70 percent of total production.

Watermelon requires a sandy soil for satisfactory production. Farmers apply fertilizer carefully and the amounts applied fall within the range of official recommended rates. Farmers' fertilizer input is proportional to the watermelon size. Chicken manure is the main organic fertilizer used.

Table 21  
Fertilizer use on different types of watermelon in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	1st crop large				2nd crop small			2nd crop seedless							
	W.A.	Taoyuan	Miaoli	Taichung	Changhua	Yunlin	Chiayee	Tainan	W.A.	Yunlin	Tainan				
N	251	269	215	249	175	266	298	276	212	202	224	195	194	194	183
P <sub>2</sub> O <sub>5</sub>	161	159	148	175	118	162	175	189	145	177	159	101	87	101	60
K <sub>2</sub> O	255	278	266	279	204	333	175	173	213	254	239	203	160	188	105
<b>Organic fertilizer</b>															
Oilseed residue	32	-	-	-	-	-	308	-	86	-	-	202	83	125	-
Chicken manure	994	657	-	1 393	1 352	1 448	808	588	385	-	-	528	928	1 398	-
Others	969	662	2 409	920	1 298	730	-	979	777	1 011	1 084	966	1 565	647	3 377
<b>Mineral fertilizer</b>															
AS	333	-	560	97	96	576	-	491	263	126	301	422	64	96	-
Urea	15	4	-	65	-	-	-	47	5	-	-	22	-	-	-
SSP	333	65	280	407	67	483	-	632	255	162	301	373	58	88	-
KCl	221	140	280	239	136	392	-	121	158	159	193	247	70	106	-
CAN	72	45	-	32	-	-	612	-	3	-	-	396	-	-	-
CF1	344	329	-	465	325	473	-	511	333	106	369	36	690	592	882
CF5	93	763	-	258	-	-	-	-	517	863	578	72	-	-	-
CF39	511	467	650	387	597	339	1169	330	-	-	-	-	284	372	109

Sample size: Large watermelon, 74; small watermelon, 74; seedless watermelon, 19.

Source: Central Taiwan Division, COA, 2001.

## Radish, carrot and bitter gourd

The major radish producing areas are the counties with the largest fertilizer use: Changhua (976 ha yielding 39 386 kg/ha in 1999) in Chungchang AEZ and Yunlin (899 ha yielding 34 260 kg/ha in 1999) in Yuncha AEZ. In the south, radish receives less fertilizer. Superphosphate and CF1 are the main fertilizers applied because of the characteristic nutrient requirements for tuberous crops. The main carrot producing area is Tainan County (1 329 ha yielding 59 246 kg/ha in 1999) in the South AEZ. Growers prefer nitrogen fertilizer, applying about 1.5 times more than the recommended rates (Annex). CF1 is an important fertilizer for carrot production in general (Table 22), while in Changhua carrots take up more N fertilizer.

Domestic consumption of bitter gourds in Taiwan is increasing. Important producing areas are the counties of Pingtung (1 543 ha yielding 18 001 kg/ha in 1999) in the South AEZ and Changhua (576 ha yielding 26 984 kg/ha in 1999). Oilseed residue meal and chicken manure are two popular organic fertilizers for this crop.

Farmers' N application rates for the crop are about equivalent to the highest recommended rates (Annex). However, the P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O dosages are twice the recommended rates. Changhua has the highest fertilization rates compared to other counties.

## Cauliflower, onion and garlic

The main cauliflower producing areas are Changhua (2 115 ha yielding 30 694 kg/ha in 1999) and Kaohsiung (670 ha yielding 17 265 kg/ha in 1999). Cauliflower growers encounter nutrient management problems related to overdosage of N fertilizer. Improved N-use efficiency is important to farmers both for environmental reasons and for reducing production costs. Changhua County ranks highest in terms of nitrogen use for cauliflower production (Table 23).

Taiwan produces most of its onions in Pingtung County (607 ha yielding 36 202 kg/ha in 1999). Farmers do not apply organic fertilizer to the crop. While the P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O fertilizer applications are close to recommended rates (Annex), N applications are about double that recommended. Pingtung has the highest amount of N fertilizer applied. CF1 is the preferred fertilizer for onion with some CF39 as basal application.

Garlic cultivation is unlikely to continue after WTO entry. N and K<sub>2</sub>O fertilizer inputs are much higher than the recommended rates. Yunlin County is the main garlic producing area (594 ha yielding 23 146 kg/ha in 1999), where farmers apply large amounts of fertilizers. Common fertilizers are chicken manure, CF1 and traditional straight fertilizers.

**Table 22**  
Fertilizer use on carrot, radish and bitter gourd in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Winter crop radish					Winter crop carrot				1st crop bitter gourd			
	Weight	0.20	0.27	0.26	0.27	Weight	0.21	0.29	0.50	Weight	0.31	0.06	0.50
	W.A.	Changhua	Yunlin	Chiayee	Tainan	W.A.	Changhua	Yunlin	Tainan	W.A.	Changhua	Kaohsiung	Pingtung
N	328	419	368	223	325	412	467	409	391	367	477	369	290
P <sub>2</sub> O <sub>5</sub>	124	176	101	117	116	111	85	83	138	291	304	331	299
K <sub>2</sub> O	104	98	127	76	111	193	183	230	176	354	587	359	224
<i>Organic fertilizer</i>													
Oilseed residue	-	-	-	-	-	16	27	-	22	540	436	408	665
Compost	-	-	-	-	-	117	-	-	233	456	366	-	695
Chicken manure	158	-	268	329	-	628	-	918	719	1 707	1 062	2 806	2 087
Others	6	22	-	-	5	580	422	237	847	2 577	1 941	3 191	2 860
<i>Mineral fertilizer</i>													
AS	530	342	741	527	461	303	178	104	223	330	608	367	143
Urea	180	430	205	-	148	69	-	163	42	161	132	245	128
SSP	487	773	398	494	362	175	52	30	311	811	703	980	949
KCl	57	39	113	33	39	57	52	123	21	314	615	327	145
CAN	-	-	-	-	-	-	-	-	-	115	-	-	231
CF1	653	748	592	560	731	1 579	1 518	1 561	1 615	351	744	163	177
CF5	-	-	-	-	-	-	-	-	-	38	-	980	-
CF39	26	-	-	-	95	6	-	-	11	829	934	980	795

Sample size: radish, 42; carrot, 43; bitter gourd, 49.

**Table 23**  
Fertilizer use on cauliflower, onion and garlic, 2000 (kg/ha)

Nutrient/fertilizer	Winter crop cauliflower				2nd crop cauliflower			Winter crop onion				Winter garlic			
	W.A.	Miaoli	Changhua	Kaohsiung	W.A.	Miaoli	Changhua	W.A.	Changhua	Kaohsiung	Pingtung	W.A.	Changhua	Yulin	Tainan
N	407	374	444	325	426	398	430	389	313	346	406	485	472	491	449
P <sub>2</sub> O <sub>5</sub>	134	125	148	104	164	124	171	167	106	158	179	161	118	164	150
K <sub>2</sub> O	253	188	287	168	288	251	294	191	163	177	198	333	264	358	201
<i>Organic fertilizer</i>															
Oilseed residue	-	-	-	-	-	-	-	50	329	-	-	81	120	93	-
Compost	-	-	-	-	-	-	-	288	-	-	360	103	44	122	-
Chicken manure	50	-	-	-	67	-	77	42	273	-	-	2 144	118	2 078	307
Others	834	878	794	954	1 545	1 385	1 570	1 208	520	962	1 353	526	1 672	509	324
<i>Mineral fertilizer</i>															
AS	400	149	539	-	518	448	530	278	223	459	279	400	391	442	148
Urea	241	331	336	21	361	295	372	284	210	37	311	185	187	186	176
SSP	348	95	483	53	346	306	352	620	319	365	692	264	231	293	95
KCl	225	81	312	-	280	219	290	157	124	64	168	269	187	317	-
CAN	2	-	-	-	10	-	11	97	-	-	121	137	-	166	-
CF1	931	405	765	1 471	259	295	254	832	806	940	831	1 149	1 522	1 098	1 363
CF5	8	270	-	-	93	683	-	8	-	-	10	37	-	45	-
CF39	159	442	154	138	545	-	631	87	53	299	82	351	-	353	430

Sample size: Cauliflower, 42; Onion, 32; garlic, 82.

Source: Central Taiwan Division, COA, 2001.

## FRUITS AND FLOWERS

Taiwan produces more than 28 kinds of tropical, subtropical and temperate fruits in large quantities. Fruit tree acreage has remained stable (planted area of 224 426 ha in 1999). Important fruit producing areas are Pingtung (41 799 ha), Nantou (32 911 ha) and Tainan (26 996 ha) counties. The South AEZ is a particularly important zone for tropical fruit, while the Central AEZ is important for fruits suited to temperate conditions. In 1999, Taiwan had 10 848 ha devoted to flower production (5 082 ha in Changhua County).

### Fruits

#### Betel nut

In 1999, Nantou County was the main producer of betel nuts (16 605 ha yielding 3 151 kg/ha), followed by Pingtung County (13 150 ha yielding 2 487 kg/ha). Most betel nuts are under rainfed cultivation, especially in the mountainous areas. Fluctuation in betel nut prices may affect farmer's fertilization practices. The average N use was 300 kg/ha in 1999. Key fertilizers in Nantou and Chiayee counties are compost, chicken manure, urea and CF1 (Table 24). Fertilizer rates were highest in the plains of Pingtung County, with growers applying more AS, superphosphate simple and KCl to the crop.

#### Mango

For mango trees over 11 years old with a plant density of about 200 plants/ha, the recommended fertilizer rates are 70, 50 and 110 kg/ha of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively, with 2-split applications, one after harvest as a basal application (50 percent) and one for topdressing (50 percent).

In 1999, the main mango-producing counties were Tainan (7 861 ha yielding 14 569 kg/ha) and Pingtung (7 562 ha yielding 7 136 kg/ha), making the South AEZ the island's key production area. Mango fertilizer application in Pingtung is not as high as in Tainan. Table 24 shows that farmers' applications rates are far higher than the recommended rates (Annex). Common compound fertilizers are CF1, CF5 and CF43.

#### Guava

Guava production is all-year-round. In 1999, the main producing counties were Changhua (1 268 ha yielding 34 789 kg/ha), Kaohsiung (2 518 ha yielding 28 082 kg/ha) and Tainan (1 330 ha yielding 20 681 kg/ha), which together accounted for 77 percent of total guava acreage.

Except for potassium, fertilizer applications in Changhua are higher than in other counties. The main compound fertilizer for guava is CF43, which contains magnesium, though some farmers in Yeelan and Changhua favour CF5.

Table 24  
Fertilizer use on betel nut, mango and guava in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Betel nut			Mango			Guava					
	W.A.	Nantou	Chiayee	Pingtung	W.A.	Tainan	Pingtung	W.A.	Yeelan	Changhua	Tainan	Kaohsiung
N	608	592	567	657	268	326	163	381	160	543	319	351
P <sub>2</sub> O <sub>5</sub>	168	129	176	210	115	132	83	429	485	510	387	404
K <sub>2</sub> O	270	204	254	359	182	205	141	552	1 020	723	354	529
<b>Organic fertilizer</b>												
Oilseed residue	-	-	-	-	101	-	282	473	-	1 135	758	-
Compost	906	133	1 588	1 399	145	225	-	834	-	632	139	1 429
Chicken manure	525	960	266	191	-	-	-	-	-	-	-	-
Others	1 444	1 881	984	1 253	2 442	2 230	2 824	4 714	3 898	3 770	4 167	5 619
<b>Mineral fertilizer</b>												
AS	188	27	-	515	-	-	-	125	-	514	-	-
Urea	393	549	348	241	77	110	19	49	-	147	51	-
SSP	170	18	-	471	15	10	24	1 027	2 250	1 457	758	829
KCl	86	9	-	238	28	10	61	388	1 500	695	152	248
CAN	71	-	-	205	-	-	-	53	-	-	202	-
CF1	1 487	1 229	1 493	1 790	679	775	506	383	-	383	-	643
CF5	157	301	94	32	228	354	-	246	1 000	775	51	-
CF43	339	265	625	222	399	422	358	1 370	-	1 112	1 646	1 486

Sample size, betel nut, 52; mango, 47; Guava, 50.  
Source: Central Taiwan Division, COA, 2001.

Table 25  
Fertilizer use on longan and banana in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Longan						Banana					
	W.A.	Taichung	Changhua	Nantou	Chiayee	Tainan	Kaohsiung	W.A.	Taichung	Nantou	Kaohsiung	Pingtung
N	202	111	175	186	179	330	91	496	487	561	373	534
P <sub>2</sub> O <sub>5</sub>	45	35	54	62	47	38	60	242	128	257	251	246
K <sub>2</sub> O	76	70	80	88	94	79	56	363	258	370	373	373
<b>Organic fertilizer</b>												
Oilseed residue	-	-	-	-	-	-	-	304	-	-	719	383
Compost	47	-	590	-	-	-	-	1 050	-	-	3 861	-
Chicken manure	85	-	-	-	100	111	213	1 312	-	1 143	894	2 293
Others	1 804	3 288	1 102	1 589	1 587	112	2 021	2 490	4 629	2 664	1 833	2 307
<b>Mineral fertilizer</b>												
AS	4	-	-	-	40	-	-	245	673	121	312	223
Urea	172	32	118	95	67	417	-	105	33	68	119	160
SSP	12	26	-	-	80	-	-	344	67	53	734	424
KCl	7	26	-	-	27	-	-	158	100	21	339	178
CAN	-	-	-	-	-	-	-	-	-	-	-	-
CF1	444	363	223	428	617	549	357	841	983	817	668	997
CF4	-	-	-	-	-	-	-	-	-	-	416	1 178
CF5	144	150	479	310	-	116	-	1 126	833	1 676	-	-
CF43	64	-	-	50	110	69	132	310	-	455	350	169

W.A. = weighted average based on % share of acreage; sample size: longan, 64; banana, 59.  
Source: Central Taiwan Division, COA, 2001.

### Longan and banana

Longan is a subtropical fruit. In 1999, the main producing counties were Tainan (3 717 ha yielding 10 614 kg/ha), Taichung (2 107 ha yielding 3 151 kg/ha) and Kaohsiung (1 986 ha yielding 13 317 kg/ha). Longan is mainly produced on marginal land (especially slopes). Suitable nitrogen management is important for inducing flower bud initiation. Official recommended fertilizer rates for longan are not available in Taiwan. Tainan County has the highest rates for nitrogen application (Table 25). Urea and CF1 are the main fertilizers used in longan producing areas.

Although Nantou County has the largest banana acreage (2 939 ha yielding 19 287 kg/ha in 1999). Banana cultivation in central Taiwan has a ratoon cultivation system. There are usually three crops within two years. The specialized banana areas are in the counties of Kaohsiung (2 068 ha yielding 28 259 kg/ha in 1999) and Pingtung (1 792 ha yielding 26 880 kg/ha). Some areas rotate banana with rice every 3-4 years to suppress Panama disease pathogens. Nitrogen and phosphorus fertilizer applications by banana growers far exceed the recommended rates (Annex), while potash fertilizer applications are less than the recommended rate. Most banana soils have high P accumulation levels. Growers in Kaohsiung and Pingtung favour CF4, while those in other areas prefer CF5.

### Litchi and pineapple

The Central, Chungchang and South AEZs are Taiwan's main litchi-producing areas. Nutrient applications are important for litchi cultivation, and occasional biennial bearing leads litchi to be fertilized in different ways in different years. Moreover, farmers in the various regions have adopted different cultivars. Table 26 lists recommended fertilizer rates for litchi. The rates are higher for the South because of the larger plant canopy.

Table 26  
Official recommended fertilizer rates for litchi for a density of 200 plants/ha (kg/ha)

Region	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Remark
Central	60-72	40-48	54-72	9-year-old tree
South	50-112	50-100	50-100	5-9 year-old tree

Fertilizer use for litchi in the South and Yuncha AEZs is within the recommended rates (Table 27). Actual fertilizer rates in Changhua and Nantou for litchi are much higher than in other areas. Farmers favour CF1 and CF5.

In 1999, the most important pineapple producing counties were Pingtung (2 262 ha yielding 46 924 kg/ha) and Tainan (1 849 ha yielding 44 922 kg/ha).

Table 27  
Fertilizer use on litchi and pineapple in the main producing counties, 2000 (kg/ha)

Nutrient/fertilizer	Litchi					Pineapple							
	W.A.	Taichung	Changhua	Nantou	Chiayee	Tainan	Kaohsiung	W.A.	Nantou	Chiayee	Tainan	Kaohsiung	Pingtung
N	134	78	256	206	97	107	99	890	1 310	787	993	1 163	574
P <sub>2</sub> O <sub>5</sub>	64	47	130	80	48	35	56	251	208	325	203	263	270
K <sub>2</sub> O	115	160	183	130	66	61	89	623	672	706	388	1 162	495
<b>Organic fertilizer</b>													
Compost	354	-	1 948	-	2 897	2 897	-	-	-	-	-	-	-
Chicken manure	141	76	-	-	259	259	284	2175	2 177	1 026	1312	-	4 320
Others	1 257	1 884	826	1 613	-	-	-	-	-	-	-	-	-
<b>Mineral fertilizer</b>													
AS	43	14	234	-	-	-	45	1890	2 993	827	1958	3 014	1 306
Urea	18	-	54	2	-	-	23	547	1 323	335	743	457	264
SSP	66	101	184	43	-	-	64	895	1 037	1 036	583	875	1 054
KCl	63	189	72	21	-	-	53	807	1 049	773	406	1 647	636
CAN	5	17	-	12	-	-	-	17	-	41	12	54	-
CF1	309	152	-	810	262	377	234	987	427	2 085	933	1 357	652
CF5	218	258	1 061	110	124	197	-	-	-	-	-	-	-
CF43	131	3	81	152	166	-	217	268	-	226	341	250	320

Cultivar surveyed for litchi: black leaf; sample size: litchi, 21; pineapple, 61.  
Source: Central Taiwan Division, COA, 2001.

Pineapple acreage has increased significantly in the last five years following the introduction of better quality cultivars. Nearly all pineapples are planted on red acidic soils mulched with plastic film. In the north pineapples occasionally suffer from frost damage. Uneven rainfall distribution in the South AEZ leads to insufficient soil moisture for pineapple growth in the dry season; whereas summer rainfall (May-September) is too high for the crop. Recommended fertilizer rates for the main crop are: N = 550-650 kg/ha, P<sub>2</sub>O<sub>5</sub> = 100-120 kg/ha and K<sub>2</sub>O = 300-600 kg/ha; and for the ratoon crop: N = 250-300 kg/ha, P<sub>2</sub>O<sub>5</sub> = 0 kg/ha and K<sub>2</sub>O = 100-150 kg/ha. Apart from Pingtung, other counties use heavy fertilizer applications on this crop. An unusual amount of fertilization in Nantou County probably reflects farmers' habitual heavy fertilization of most crops in adjacent areas.

### Flowers

Strong government promotion of flower cultivation helped boost crop acreage from 9 661 ha in 1995 to 10 848 ha in 1999. In 1999, the main flower producing counties were Taichung and Changhua, with Chungchang AEZ accounting for about 70 percent of the total acreage. Overall, the area planted to chrysanthemum was 1 625 ha, followed by gladiolus (842 ha), roses (289 ha) and lilies (245 ha). Flower cultivation requires considerable quantities of water and nutrients.

Nutrient inputs for chrysanthemum (2-3 crops per year) and roses are rather high, suggesting a need for education on fertilizer rationalization (Table 28). The main nitrogen fertilizer is AS, while the common compound fertilizers are CF1, CF5 and CF39. Roses receive some organic fertilizers. In Changhua, roses receive large amounts of fertilizer and their production is all-year-round. Changhua can harvest more roses than other areas. Growers in Nantou County produce more roses under vinyl houses and apply more organic fertilizers to their fields.

Appropriate NPK fertilizer ratios are generally necessary for full-bloom gladiolus and lily cultivation. Farmers tend to use organic fertilizers to maintain good soil fertility and soil physical properties, especially for lilies. Table 29 shows the differing fertilization approaches adopted in the two counties surveyed.

**Table 28**  
Fertilizer use on flowers in the main producing counties, 2000

Nutrient/ fertilizer	Winter chrysanthemum			Rose			Gladiolus						
	Weight W.A.	0.90 Changhua	0.05 Chiayee	0.03 Kaohsiung	Weight W.A.	0.22 Changhua	0.72 Nantou	Weight W.A.	0.04 Miaoli	0.59 Taichung	0.17 Changhua	0.08 Yunlin	0.11 Yunlin
Pingtung													
N	740	741	909	494	806	1 487	587	293	370	281	411	257	170
P <sub>2</sub> O <sub>5</sub>	324	335	247	207	317	810	168	170	145	156	248	123	170
K <sub>2</sub> O	492	502	463	214	574	1 149	423	205	347	185	295	135	170
<b>Organic fertilizer</b>													
Oilseed residue	-	-	-	-	1 367	-	1 605	-	-	-	-	-	-
Compost	-	-	-	-	7 205	7 081	7 897	265	-	446	-	-	-
Chicken manure	8	-	-	278	3 015	-	4 196	196	-	268	72	313	-
Others	2 562	2 497	2 867	3 647	9 333	9 316	9 408	1 315	1 336	1 240	1 054	1 890	1 687
<b>Mineral fertilizer</b>													
AS	1 749	1 813	1 333	753	695	2 097	336	156	914	-	676	-	-
Urea	453	443	800	306	549	577	467	116	229	104	149	239	-
SSP	1 106	1 159	833	141	569	2 108	158	154	400	32	688	-	-
KCl	591	611	500	47	497	1 009	388	63	457	-	252	-	-
CAN	15	17	-	-	207	72	266	16	-	-	92	-	-
CF1	210	152	667	94	859	2 205	532	239	-	293	384	-	-
CF5	63	28	800	-	276	79	361	314	-	489	-	299	-
CF39	727	775	-	1 176	999	2 090	563	702	486	643	699	663	1 134

Sample size, chrysanthemum, 50; rose, 45; gladiolus, 43.  
Source: Central Taiwan Division, COA, 2001.

**Table 29**  
Fertilizer use on lily in the main producing counties, 2000

County	Weight	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Others	Urea	SSP	KCl	CF43
Taichung	0.36	134	134	134	12 800	-	-	-	893
Nantou	0.64	191	27	395	11 111	415	148	637	-
W.A.		170	66	300	11 725	264	94	405	325

Sample size: 20.  
Central Taiwan Division, COA, 2001.

## FERTILIZER USE BY AGRO-ECOLOGICAL ZONE

In 1999, the government procured about 70 percent of the mineral fertilizers consumed in the various AEZs (Table 30). Fertilizer consumption in the major important agricultural regions of the Chungchang, Yuncha and South AEZs is high and accounts for 75 percent of total fertilizer use. Upland crops use large amounts of fertilizers as the rainfall is high and most farmers place their fertilizers without incorporating them into soils when topdressing. Marketing competitions that prize certain crop qualities, especially appearance, are an important factor in inducing heavy fertilization by local farmers. In 1996, the government launched a national project called Rational Fertilization to try to reduce fertilizer use by 20 percent. This strategy, undertaken partly for coping with privatization of the TFC and liberalization of the fertilizer market, will become fully operational in 2003.

Table 30  
Quantities of fertilizers procured by the government for various AEZs, 1999 (t)

AEZ	Total	AS	Urea	CAN	KCI	SSP	SSP (gran.)	CF1	CF2	CF4	CF5	CF39	CF42	CF43	K <sub>2</sub> SO <sub>4</sub>
Northeast	22 148	2 539	3 079	-	1 636	1 581	975	3 180	-	-	7 570	416	32-	1 127	13
Northwest	83 610	10 923	14 233	1 047	4 024	2 737	5 740	17 767	396	164	19 255	2 973	93	4 238	20
Chung.	156 844	24 743	26 508	2 468	15 516	14 374	8 561	34 042	2 221	428	17 307	2 164	4	7 910	598
Yuncha	201 437	20 241	30 695	7 327	18 394	25 594	12 966	85 278	1 660	1 330	6 989	2 313	777	5 651	222
South	227 101	30 045	33 802	3 181	18 071	23 451	8 942	78 660	458	8 554	8 434	2 401	25	10 692	385
Hwatumg	55 800	8 098	7 594	1 068	3 258	3 085	3 175	14 020	254	673	10 193	747	60	1 691	1 884
Central	45 295	3 152	8 938	461	1 304	3 497	1 216	13 628	2	866	5 570	2 002	1 191	3 118	350

Source: compiled from Taiwan Food Statistics Book (COA, 2000).

## Chapter 6 Crop and fertilizer prices

### MINERAL FERTILIZER PRICES ASSOCIATED WITH GOVERNMENT DISTRIBUTION

From the beginning of 2003, fertilizer distribution will be open to free competition and the forecast is for fertilizer prices to increase to 125 percent of current prices in 2003.

With the government still establishing fixed and consolidated fertilizer prices for all locations in every AEZ, there have been no price changes in mineral fertilizers associated with government distribution for the last six years. Table 31 lists the prices that farmers pay when purchasing the fertilizers from their farmers' associations.

Table 31  
Fertilizer prices associated with government distribution, January 1991-May 2001 (US\$/bag)

Item	Price
Ammonium sulphate	4.22
Urea	6.47
Calcium ammonium nitrate	5.94
Superphosphate simple (powder)	3.98
Superphosphate simple (granules)	4.33
Muriate of potash	5.62
CF1 (20-5-10)	7.73
CF2 (11-9-18)	7.50
CF4 (11-5.5-22)	7.26
CF5 (16-8-12)	7.61
CF39 (12-18-12)	9.69
CF42 (23-5-5)	7.73
CF43 (15-15-15-15)	11.68

As of June 2001, the prices for fertilizers sold to farmers are: urea, US\$182/t; KCl, US\$161/t; CF1: US\$187/t; CF5: US\$187/t; and CF42: US\$182/t; representing price changes of +12.3, +14.6, -3.4, -1.5 and -6.1 percent over the previous prices, respectively. The changes reflect increases in import costs, expanded production capacity in one private fertilizer company, and improved marketing.

### ORGANIC FERTILIZER PRICES

Organic fertilizer (compost) in Taiwan generally sells for about US\$0.14/kg, including transportation costs. This price means the unit price of organic fertilizer product is similar to that of mineral fertilizer. There are almost 200 brands of organic fertilizers in the local market and their nutrient content varies. In view of the nutrients that the organic fertilizers can supply, they are several times more expensive than mineral fertilizer. Moreover, there is no mechanism to regulate the marketing prices of organic fertilizers.

### FERTILIZER USE PROFITABILITY

The most common measures of fertilizer use profitability are the crop/fertilizer price ratio, the value/cost ratio and the benefit/cost ratio (FAO/IFA, 1999). Owing to data availability issues, this report uses the crop/fertilizer price ratio (based on a urea price of US\$0.16/kg) to assess fertilizer use profitability (Table 32).

Through long-term application of superphosphate, most soils in Taiwan, particularly orchards and vegetable groves, have high levels of available P. Crops have passed the stage of a good response to phosphate fertilizer.

In the period 1995-99, the crop/fertilizer price ratio varied from a minimum of 0.63 (gladiolus) to a maximum of 43.96 (hand-plucked tea). The crop/fertilizer price ratio varied with crop type. Fruit trees generally had higher ratios than vegetables. For longan and litchi, the ratio varied in every other year, mainly due to the alternating nature of fruit bearing. The routine overproduction of vegetables results in low crop/fertilizer price ratios. Summer vegetables tend to have better ratios.

Rice production has problems of glut and its price fluctuations may warrant government attention, as it is an important staple food. Most rice farmers are not full-time growers. There are no marketing problems as the government authorizes farmers' associations to buy the rice from the farmers, who are also free to sell rice to local private buyers.

Table 32  
Crop/fertilizer price ratios, 1995-99

Crop	Crop/fertilizer price ratio				
	1995	1996	1997	1998	1999
Japonica paddy	3.41	3.61	3.25	3.39	3.55
Indica paddy	3.44	4.29	3.41	3.11	3.34
Peanut (with husk)	8.51	6.39	7.98	7.11	7.99
Mung bean	9.61	10.87	10.87	10.87	11.52
Adzuki bean	8.03	8.58	8.36	8.65	10.19
Sesame (domestic)	24.75	24.28	27.93	24.08	23.62
Sweet potato	1.45	1.43	1.47	1.97	1.49
Hand-plucked tea leaves	38.21	40.22	38.92	34.12	43.96
Machine-plucked tea leaves	4.59	6.47	9.80	3.61	4.66
Assam tea leaves	2.66	2.67	2.82	2.39	-
Chrysanthemum	0.67	0.85	0.73	0.74	0.59
Gladiolus	0.77	0.72	0.63	0.63	0.71
Radish	1.31	1.43	1.91	2.11	1.38
Carrot	2.86	1.09	0.91	2.53	1.53
Potato	2.27	2.06	1.70	2.36	2.88
Onion (domestic)	2.67	1.10	0.85	2.29	2.18
Scallion bulb	4.57	5.52	4.98	-	-
Leek	3.71	3.35	3.10	4.57	3.98
Garlic	5.28	6.75	3.58	8.90	9.27
Garlic bulb	24.77	6.47	6.25	14.43	10.19
Cabbage	1.64	1.91	1.86	3.04	1.82
Chinese cabbage	1.84	2.25	1.97	2.56	1.74
Water convolvulus	2.34	2.42	2.83	3.28	3.43
Leaf mustard	2.07	2.27	2.03	2.86	2.29
Celery	3.95	3.99	4.75	4.61	4.87
Spinach	2.46	3.43	3.83	6.42	3.80
Cauliflower	3.13	3.74	3.14	4.26	2.90
Cucumbers (small)	5.43	5.11	4.91	4.84	4.42
Cucumbers (large)	3.12	3.06	2.56	3.28	2.74
Wax gourd	1.39	1.32	1.51	1.60	1.03
Rag gourd	2.55	3.44	2.59	3.03	2.71
Bitter gourd	4.94	6.39	5.16	5.28	5.05
Bottle gourd	2.00	2.21	1.98	2.31	1.61

Crop	Crop/fertilizer price ratio				
	1995	1996	1997	1998	1999
Eggplant	3.25	3.87	3.12	3.72	2.88
Tomato	3.23	4.16	3.04	5.24	3.51
Green pepper	4.82	4.82	3.02	7.86	4.38
Pea	15.63	14.18	10.27	13.04	11.49
Kidney bean	8.25	7.99	7.50	8.46	6.60
Cowpea	5.22	7.13	4.59	5.20	5.18
Banana	3.09	4.49	2.41	1.63	2.36
Pineapple	3.91	5.04	3.59	3.60	3.52
Citrus (Ponkan)	4.09	5.74	5.24	4.91	4.88
Citrus (Tankan)	4.66	5.22	6.00	4.75	4.88
Citrus (Liu Cheng)	5.36	5.56	4.02	3.91	5.28
Watermelon (big)	3.34	2.48	1.89	3.03	2.15
Wentan pomelo	4.22	8.01	5.38	6.30	4.45
Melon	4.11	3.51	3.28	4.83	3.11
Longan	3.14	13.48	4.59	11.59	5.22
Litchi	7.46	3.47	6.55	12.18	5.40
Guava (Thai-type)	2.59	3.33	3.23	2.75	2.63
Papaya	3.61	3.51	4.66	3.98	3.56
Grape (Kyoho)	8.55	8.90	9.12	10.31	11.00

## Chapter 7

### Fertilizer distribution and payment

#### FERTILIZER DISTRIBUTION

Fertilizer distribution systems involve many and diverse actors: government, private and state fertilizer manufacturing companies, importers, farmers' associations, agricultural cooperatives, the TSC, the Taiwan Tobacco and Wine Monopoly Bureau (TTWMB), fertilizer wholesalers and local fertilizer dealers.

#### Private fertilizer companies

Nearly all private fertilizer companies in Taiwan use district representatives to sell their manufactured fertilizer to local fertilizer dealers. The private fertilizer companies can also sell inorganic and organic fertilizers directly to farmers' associations as the associations are important fertilizer dealers. The TFC has two business branches (north and south) and markets fertilizer throughout the island. Some small companies sell organic fertilizer directly to farmers, so reducing transaction costs. Details of the transaction costs of fertilizer distribution are not available. The estimated average government procurement cost for fertilizer was about US\$26/t in 1999.

#### State fertilizer company

The KASC markets its produce through an exclusive agency (the Weidi Company), with nine district representative consignees. The KASC also sells the TSC's organic fertilizer.

#### Importers

Most fertilizer importers use wholesale/retail systems. Some importers have obtained contracted supplies of imported fertilizer from the COA. They are scheduled to transfer the fertilizer directly to farmers' associations or intermediate warehouses through the arrangement of the 2nd Division Office of COA.

#### Farmers' associations

Figure 3 illustrates the public fertilizer distribution flow. There are provincial, city and county-level farmers' associations. Each county is responsible for its

agricultural produce. The administrative unit under the county is the township. Several frontier townships may jointly establish a district farmers' association. Farmers' associations provide extension, marketing, banking, credit and insurance services. They assist the government in carrying out rural development projects. The township farmers' association plays an important role in distributing fertilizers to its members.

Taiwan's 278 farmers' associations have been successful in assisting the government allocate fertilizer to individual farmers over the past 53 years.

Because of government support, fertilizer selling prices are low compared to other inputs such as pesticides. With a steady fertilizer supply and falling fertilizer prices in the international and domestic markets, fertilizer allocation in Taiwan is flexible and farmers can readily obtain their fertilizers from any of the designated organizations or from private fertilizer dealers.

Assisted fertilizer delivery to individual farmers can save them time, labour and transportation fees. This is especially convenient for farmers who do not own transportation vehicles. The individual farmers' association handles the delivery, usually with a car pool. In 1972, Taoyuan County initiated a project to develop a free delivery service. This service has since expanded to cover the whole island. Some farmers use their own cars to pick up fertilizers and they receive a reimbursement of about US\$0.29 per bag (40 kg) from the COA-controlled Agricultural Development Foundation. (Figure 3)

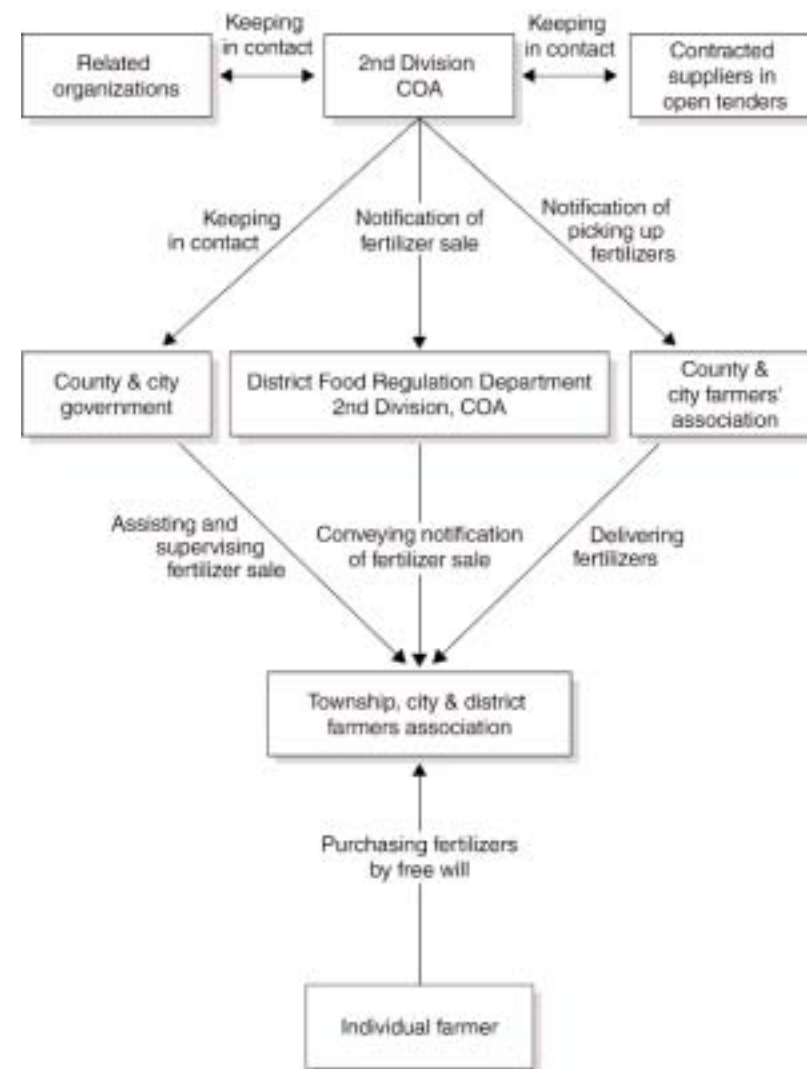
### Taiwan Fruit Marketing Cooperative

The Taiwan Fruit Marketing Cooperative (TFMC) distributes fertilizer procured from the 2nd Division Office, COA. Therefore, there are certain elements of subsidies within the fertilizer sold. The TFMC sells mainly urea and CF4 (11-5.5-22) to banana growers. Its turnover from fertilizer sales is falling as banana acreage declines. Although its number of points of sale is also decreasing, banana growers can readily obtain fertilizers from their farmers' associations.

### Service Cooperative for Sugarcane Growers

The Service Cooperative for Sugarcane Growers (SCSG) also acquires fertilizers from the 2nd Division, COA, and then sells them to the growers. Its role has declined as sugar cane production has become less profitable. The SCSG sells more superphosphate compared to the TSC. Individual growers prefer to apply more superphosphate and CF1 (high N fertilizer content) to their fields. Both the TFMC and SCSG have been unsuccessful in their attempts to obtain delivery subsidies.

**Figure 3**  
**Public fertilizer marketing procedure**



### Taiwan Tobacco and Wine Monopoly Bureau

The Taiwan Tobacco and Wine Monopoly Bureau (TTWMB) buys tobacco leaves from farmers under contract through its district tobacco manufacturing factories. The TTWMB buys fertilizers on an open market and provides them directly free of charge to individual farmers growing tobacco based on a contracted acreage. The TTWMB supplies CF47 (9-18-27) to the Pingtung area and CF36 (7-21-21) to other areas where the soil available P is generally lower. Both fertilizers contain potassium sulphate. Local TFC marketing representatives deliver the fertilizers directly. Farmers' associations do not sell tobacco fertilizer to farmers. Some tea growers prefer to apply the more expensive CF36 as they believe it produces better aromatic made-tea.

### Taiwan Sugar Company

The Taiwan Sugar Company (TSC) owns about 30 000 ha of sugar cane farms and uses large quantities of fertilizer. It purchases the inputs directly from local suppliers for company-run farms. Many sugar cane factories have closed down and local farmers are leasing many company-run farms and planting other crops such as watermelon, banana and vegetables. The main fertilizers that the TSC purchases from the TFC for own-farm use are CF2 (11-9-18) and straight fertilizers such as urea and AS. Sugar cane farms use tractors to apply nearly all fertilizers.

### FERTILIZER PAYMENT ARRANGEMENTS

Fertilizer costs do not represent a large share of total crop production costs (Table 33). Nearly all farmers use cash or bank transfers to buy mineral fertilizers from farmers' associations. Some farmers use long-term cheques (up to three months) to buy organic fertilizers from private dealers.

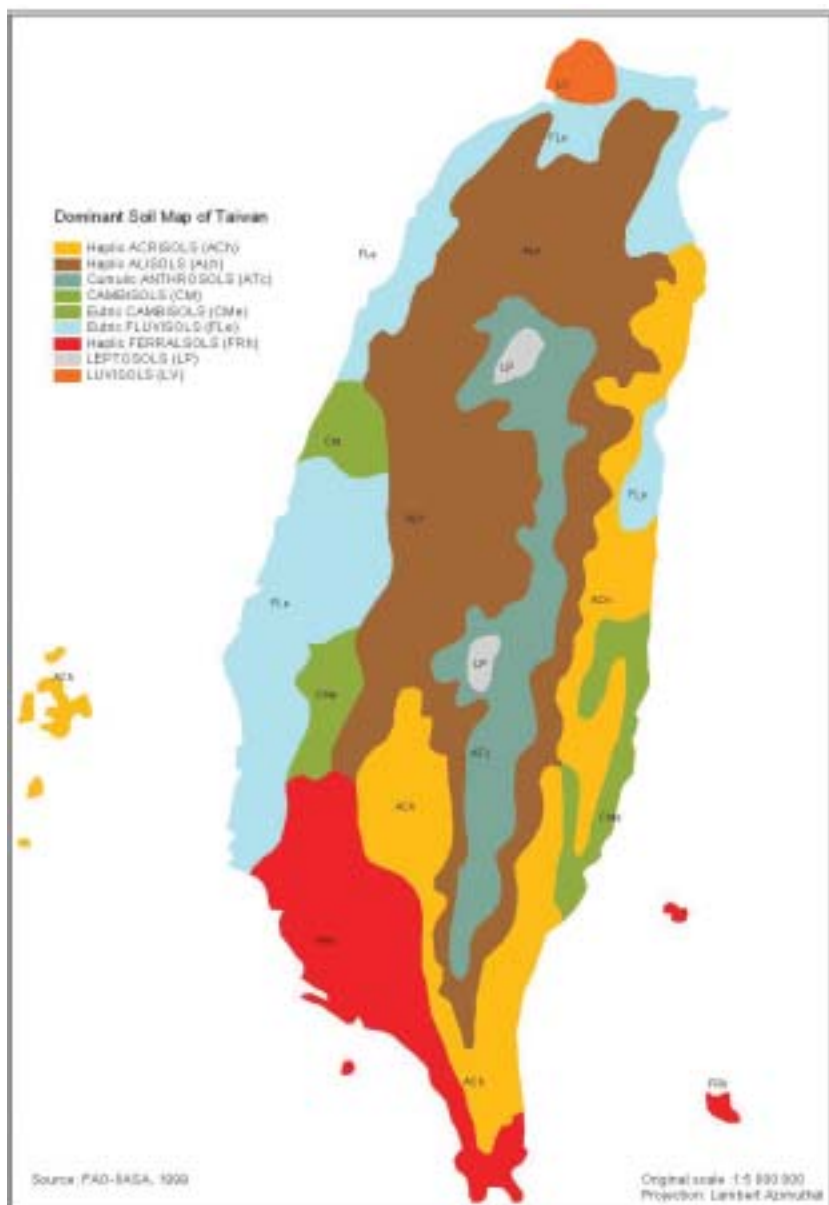
Overall, fertilizer supply in Taiwan is sufficient and prices are reasonable. There are no particular problems for suppliers and buyers in accessing inputs.

Table 33  
Mineral fertilizer cost as a percentage of total production cost, 2000

Crop	Fertilizer cost as a percentage of total production cost
Rice	7
Fodder maize	11
Sweet maize	15
Peanut	7
Sweet Potato	6
Hand-plucked tea	13
Machine-plucked tea	20
Radish	11
Cabbage	11
Chinese cabbage	11
Watermelon	13
Strawberry	10
Ginger	10
Cauliflower	9
Grapes Kyoho	9
Japanese Apricot	12
Pear (Shinko)	14
Guava	9
Plum	13
Peach	12
Banana	12
Pineapple	13
Ponkan	15
Liucheng	13
Tankan	12
Wentan Pomelo	14
Grapefruit	12
Haili	13
Longan	9
Mango (Irwin)	9
Litchi	9
Wax-apple	15
Pear	12
Sugar apple	23
Chrysanthemum	5
Rose	9
Stargazer	2
Gladiolus	3

Source: Central Taiwan Division, COA, 2001.

## Annex 1



## Annex 2

Official fertilizer recommendations per crop, 1999 (kg/ha)

	Recommended rate		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
<i>Rice</i>			
First crop	100-150	40-60	30-50
Second crop	90-120	30-40	50-60
<i>Coarse grains, pulses &amp; roots.</i>			
Fodder maize	100-170	70-120	50-100
Food maize	100-140	70-120	50-100
Sweet potato	30-80	30-60	120-180
Groundnut	20-40	45-60	40-80
Sorghum	100-160	40-80	40-60
Adzuki bean	40-60	40-70	30-40
Soybean	0-20	60-90	30-75
<i>Special crops</i>			
Sugar cane	200-220	35	70
Sugar cane (ed.)	750	150	250
Tea	360-480	140	140
Tobacco	60	120-180	180
Sesame	20-40	25-55	50-80
<i>Ornamental plants</i>			
Chrysanthemum	200-400	150-300	200-400
Gladiolus	150-225	75-225	75-225
Lily	250-400	100-200	300-400
Rose	400-550	120-400	350-450
Anthurium	100-200	50-100	60-120
<i>Vegetables</i>			
Radish	140-160	80-100	110-130
Carrot	180-250	120-180	120-180
Ginger	160-220	100-140	160-220
Taro	700	100	500

	<i>Recommended rate</i>		
	<i>N</i>	<i>P<sub>2</sub>O<sub>5</sub></i>	<i>K<sub>2</sub>O</i>
Scallion	240-275	95-105	90-120
Potato	150-225	150-200	200-360
Onion	150-200	150-200	120-240
Leek	80-150	30-50	60-80
Asparagus	700-900	100-150	200-300
Leaf-mustard	160-180	90-120	150-180
Water morning glory	120-180	50-90	100-150
Celery	150-230	60-90	150-180
Chinese cabbage	200-250	90-150	120-180
Cauliflower	180-220	70-130	130-190
Lily flower	100-150	90	60-150
Ori. pick. melon	220-260	120-160	180-220
Green garlic	200-300	90-120	120-180
Water bamboo	200-250	100-140	100-200
Bamboo shoot	800	200	600
Cabbage	250-350	70-90	120-180
Cucumber	250-350	120-180	300-400
Bitter gourd	250-350	100-150	150-300
Eggplant	610	800	630
Tomato	150-250	100-150	100-150
Pepper	120-150	120-150	150-180
Kidney bean	90-120	60-90	100-120
Pea	20-40	50-80	60-90
Vegetable soybean	60	60-80	60
Watermelon	180-240	120-240	200-240
Muskmelon	150-180	0-120	100-150
Cantaloupe	120-150	180-220	180-220
Strawberry	150-200	150-200	150-200
<b>Fruits</b>		<b>g/plant</b>	
Banana	110-165	55-80	220-330
Pineapple	(kg/ha) 550-650	(kg/ha) 100-120	(kg/ha) 300-600
Pineapple (ratoon)	(kg/ha) 250-300	0	(kg/ha) 100-150
Citrus-ponkan	600	300	450
Citrus-tankan	600	300	450
Wentan pomelo	1000	500	750
Pai pomelo	600	300	450
Liucheng	600	300	450

	<i>Recommended rate</i>		
	<i>N</i>	<i>P<sub>2</sub>O<sub>5</sub></i>	<i>K<sub>2</sub>O</i>
Grapefruit	600	300	450
Lemon	600	300	450
Mango	240	160	360
Guava	250	140	140
Wax apple	1 000-1 600	1 000-1 800	1 000-1 800
Grape	120-160	100-150	120-180
Loquat	500	250	3 750
Plum	120	80	120
Peach	160	90	140
Persimmon	120	40	200
Japanese apricot	200	100	200
Litchi	300-360	200-240	270-360
Litchi (S. Tai.)	250-560	250-500	250-500
Carambola	300	250	400
Pear	900	500	720
Apple	800	500	600
Papaya	70	130	80
Jujube	300	160	360
Sugar apple	700-1 000	400-500	700-1 000
Passion fruit	250-300	100-150	600-800
Coconut	300	120	600
<b>Green manure &amp; forage crops</b>		<b>(kg/ha)</b>	
Soybean (g. manure)	20	60-90	30-75
Field pea	20-40	50-80	60-90
Rape	10-20	18-27	0
Pangola grass	320-480	140-160	140-180
Napier grass	680-920	140-200	300-600

## References

- Central Taiwan Division Office, COA. 1997. Surveyed report on producing costs of Taiwan agricultural products, 1996.
- Central Taiwan Division Office, COA. 1998. Surveyed report on producing costs of Taiwan agricultural products, 1997.
- Central Taiwan Division Office, COA. 1999. Surveyed report on producing costs of Taiwan agricultural products, 1998.
- Central Taiwan Division Office, COA. 2000. Surveyed report on producing costs of Taiwan agricultural products, 1999.
- Central Taiwan Division Office, COA. 2001. Surveyed report on producing costs of Taiwan agricultural products, 2000.
- COA. 1996. Agricultural statistics yearbook, 1995. Compiled by Council of Agriculture, Executive Yuan.
- COA. 1997. Agricultural statistics yearbook, 1996. Compiled by Council of Agriculture, Executive Yuan.
- COA. 1998. Agricultural statistics yearbook, 1997. Compiled by Council of Agriculture, Executive Yuan.
- COA. 1999. Agricultural statistics yearbook, 1998. Compiled by Council of Agriculture, Executive Yuan.
- COA. 2000. Agricultural statistics yearbook, 1999. Compiled by Council of Agriculture, Executive Yuan.
- COA. 2000. Crop fertilization manual. Taipei.
- COA. 2000. Taiwan food statistics book. Compiled by the 2nd Division Office, COA.
- FAO/IFA 1999. Fertilizer strategy. Rome.
- Fertilizer Marketing Dept. 1996. Fertilizer handbook. Compiled by Fertilizer Marketing Dept., Food Bureau, Taiwan Provincial Government.
- Kuo Wen-Shuo. 1980. Further studies on agricultural-climate division in Taiwan. Central Weather Bureau.
- Shih, C.T. 1987. Introduction to Taiwan geography. Taiwan, Chunghwa Book Company.
- Taiwan Sugar Company. 1999. Taiwan sugar statistics.