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# GROWTH AND VARIABILITY IN MAJOR CROPS PRODUCTION IN CHINA

**Mohammad Pervez WASIM***

The study analyzes the growth and variability/instability in area, production and yield of major crops for two different periods in China: Period I (1976-77 to 1987-88) and period II (1988-89 to 1999-2000). The reason for dividing it into two time periods was to see the effect of rural reforms initiated in 1976 and 1988 and also to see the impact of increase in flooded and drought damaged crop areas in the late 1980s. The study reveals that the high yield growth rate of rice, maize, groundnuts and rapeseed was mainly due to favourable price incentives, expanded irrigation system, use of HYVs, application of rising level of chemical fertilizer and implementation of the production responsibility system in period I. The study also confirms that in period II not only the production of wheat, soyabean, groundnuts and rapeseed declined significantly but instability in their production also declined. The growth rate of production of maize, sweet potatoes and potatoes increased in period II and their production stabilized. Favourable prices of maize, sweet potatoes, potatoes and groundnuts played a vital role as compared to other inputs in increasing the production of these crops. The study also concludes that changes in production which cause instability, are due to a number of factors including availability of irrigation water, prices of competing crops and availability of agricultural inputs. The results also reveal that a decline in production of rice and wheat (which comprise 46 per cent of total crop area in Chinese agriculture) in period II, was mainly due to unfavourable prices of these crops and flooded and drought land area.

## I. Introduction

Instability is one of the important decision parameters in development dynamics in the context of agricultural production. An analysis of fluctuation in crop output is important for understanding the nature of food security and income stability. Wide fluctuation in crop output, not only affect prices and bring about sharp fluctuation in them but also result in wide variations in disposable income of the farmers. The magnitude of these fluctuations depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs and many other factors.

* The author is a Staff Economist at the Applied Economics Research Centre, University of Karachi, Karachi-75270, Pakistan.

The price of crude oil slumped in the world market during the first half of the 1980s. Thus, Nigeria's crude oil, which was sold at slightly above US $11 a barrel in the early 1981, fell precipitously to less than US$9 by August 1986. This triggered a series of developments in the economy. One example was the state's fiscal crisis, as reflected in the persistent and substantial budget deficit, which cumulated to approximately N17.4 billion in the five years between 1980 and 1984. Monetary policy became highly expansionary as a large part of the deficits, incurred during this period, was financed through creation of credits. Indeed, the total domestic credit to the economy recorded an average annual growth rate of 29.9 per cent in 1980-84 and most of the increase was attributable to net claims by the government. Simultaneously, two-digit inflation at a mean yearly rate of 20.2 per cent was registered, as clearly evidenced, perhaps, in support of the monetarists' proposition. But inflation in 1984, which stood at almost 40 per cent is often explained by acute shortage of imported goods and services, imposed by inadequate foreign exchange earnings, a derivative of the steep fall in crude oil prices. (see, Egwaikhide, et al. (1994).

With the deepening internal and external disequilibria, it became imperative to adopt the Structural Adjustment Programme (SAP), which was done from July 1986. The SAP, which is predicated mainly on the principle of "getting price right" has foreign exchange rate reform as its central focus [Federal Republic of Nigeria, (1986)]. In pursuit of this, the Second-Tier Foreign Exchange Market (SFEM) was introduced in late September 1986, and since then the Naira has depreciated sharply against the US dollar and other major currencies. Quantitatively, the Naira, which traded at N4.62 : $1.00 at the inception of SFEM (late September 1986), had exceeded N7.65 : $1.00 (end 1986), a change of almost 65.6 per cent. During the same period, inflation leapt from 5 per cent to almost 41 per cent.

The above development shows that government expenditure has a role to play in Nigeria's recent inflationary process. Concomitant with this is the substantial budget deficit operated annually by the Federal Government in the last decade or so. Part of the budget deficit is financed through bank credit, which directly affects the money base. This also exerts upward pressure on the general price level and suggests that there are many sources of the current inflation. One major source is the government expenditure.

As part of the attempt to fill this lacuna, this paper examines the quantitative effects of government expenditure on inflation in Nigeria, using Error Correction Method. This study covers a period of 30 years from 1970-2000. The paper is divided into four sections. Section-II examines the related literature. Section-III analyses the empirical results while Section-IV gives the policy implications and conclusions.

income were shared equally among the family members of a household. When the communists took control of China in 1949, the country's agriculture was quickly reorganized along socialist lines with a series of institutional changes. The transformation from peasant farming to People's Commune was completed within a decade. The available statistics also show that the use of labour and modern agricultural inputs increased considerably from 1952 to 1978, however there was virtually no increase in the size of cultivated land during the period.

Before 1978, the agricultural system was dominated by the People's Commune and major decisions about farming originated from appointed party – state cadres who were responsible to their superiors rather than their commune members. An unhappy relationship therefore developed between the party-state and the peasants and farmer's resistance to cooperate was inevitable.

The year 1978 marked a turning point in China's agriculture, when the Third Plenary Session of the Eleventh Central Committee proposed a number of measures to stimulate agricultural production. The first important action was a 20 per cent raise in the government purchase price of grain. This was soon followed by implementation of the production responsibility system. The growth of agricultural output regained momentum, shortly after the Chinese government implemented these agricultural reforms.

The Chinese agricultural system provides subsistence to more than one billion people and is the main source of livelihood for some 800 million agricultural workers and their dependents. Agriculture in a large part of China is severely limited by terrain and rainfall. Most of the country is too mountainous or too dry for crop farming, and some potential cropable areas are remote from main population centers and markets. China has nearly exhausted the supply of new land that can be brought under cultivation. There is intense and increasing pressure on a narrow arable land base and China has one of the world's highest man/arable land ratios, at roughly 10 persons per hectare in terms of total population and about 8 persons per hectare in terms of agricultural population. China, therefore, must look to raising yields for most of the agricultural crops to meet food requirements of its population.

China's agriculture determines progress of its industries as it provides raw material and food for its workforce. Many of the country's exports are either agricultural raw materials or consumer goods – a flourishing agriculture therefore boosts exports.

The magnitude of growth and instability in crop area, production and yield has serious implication for food security in China. Information about the growth performance and instability situation in major crops production would help the policy makers in China to implement policy measures such as export-import policy for different agricultural crops.

The present study is undertaken with a view to analyze the growth and variability of crop area, production and yield of major crops in two different periods in China. The specific objectives of the study are:

1) to quantify the rate of growth in crop area, production and yield of major crops,
2) to estimate the level of variability/instability in crop area, production and yield of major crops,[1]
3) to discuss the policy implications of observed growth and variability in major crop production and yields.

## II. Data Sources

The analysis is based on secondary data on cropped area and production for major crops.[2] The analysis of growth and variability is undertaken for two different periods: period I (1976-77 to 1987-88), and period II (1988-89 to 1999-2000). The major reasons for dividing the analysis into two time periods is that rural reforms were initiated in 1976 and 1988, and the flooded and drought damaged crop area increased in late 1980s. An attempt has also been made here to bring out the trends in more recent years when agricultural technology improved.

## III. Methodology

First, the compound growth rates are estimated by using log linear functions on the time series data on crop area, production and productivity. The following equation is fitted to estimate the trend growth rate as:

$$\log Y = \alpha + bt \qquad (1)$$

where,

Y = area/production/yield of major crops,

t = time variable in year (1,2, ..... n),

[1] Major crops (rice, wheat, maize, sweet potatoes, soyabean, groundnuts, potatoes, rapeseed and seed cotton) have been taken for this analysis. China's important contribution to the world crop production is indicated by its large share in the production of several major crops. China has 20 per cent share in wheat, 34 per cent in rice, 21 per cent in maize, 39 per cent in groundnuts, 9 per cent in soyabean and 14 per cent in seed cotton. A comparison of major crops production share of China to world crops production is presented for ten years, (see, Appendix: Table A-1, Figure A-1; and Table A-2, Figure A-2). Among the developing countries China is the most, or second most, important producer of many major agricultural crops.

[2] Various issues, United Nations (1987 and 2000), and the Government of Pakistan (1999-2000).

a = constant,
b = the rate of change in crop area, production and yield of major crops.

The measurement of instability in the time-series data requires explicit assumptions about acceptable and unacceptable components. A systematic component, which can be predicted, does not constitute instability and hence, is eliminated from the data. The remaining unpredictable components represent variability.

There are a number of techniques available to measure the index of instability. Such techniques are found in Coppock (1962), Mac-Bean (1966), Massel (1970), Weber and Sievers (1985), Singh and Byerlee (1990) and Cuddy-Della Valle (1978). In the present analysis variability in crop area, production and yield of major crops is measured in relative terms by the Cuddy-Della Valle index.[3]

The instability index is given by the expression:

$$IX = CV(I - R^2)^{1/2} \quad (2)$$

where,
CV = coefficient of variation (in per cent),
$R^2$ = coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.[4]

To determine whether differences in variability/CVs between periods from the individual observation, i, are statistically significant or not, the Anderson and Hazell (1989) based on Kendall and Stewart (1969), approach are used, where a standard normal test statistic, Z, is calculated by:

$$Z = (CV_2 - CV_1)\ [\{(1+2c^2)/2]\ (1/n_1 - 1/n_2)\}^{0.5/c} \quad (3)$$

where, $CV_i$ is the CV in period i of length $n_i$ years, and $c$ is the CV in the parent population.[5]

[3] In time series data which is characterized by long-term trends, simple coefficient of variation overestimates the level of instability whereas the Cuddy-Della Valle index corrects the coefficient of variation.

[4] It may be mentioned here that some authors have estimated the CV around trend as the standard error of regression divided by mean. After estimating in both ways from the same set of data, Singh and Byerlee (1990) found that results are almost identical for both methods used. Since both methods provide same results, we decided to estimate instability index using Cuddy Della Valle Index.

[5] We have approximated $c$ by $CV_i$ following Anderson et al. (1987).

## IV. Results of the Analysis

### *a) Growth in Crop Production and Yields*

The annual compound growth rate in crop area, production and yield of major crops in China, for the two periods obtained from equation (1) are presented in Table 1.

#### *Period I*

During this period the annual production of rice increased at the rate of 3.22 per cent, wheat at 6.69 per cent, maize at 3.88 per cent, soyabean at 3.90 per cent, groundnuts at 9.85 per cent, rapeseed at 13.78 per cent and seed cotton at 8.55 per cent. The increase in the production of rice, wheat and maize was mainly due to increase in yield rather than increase in crop area, whereas in soyabean, groundnuts and seed cotton, the increase in crop area contributed more than the increase in yields. Sweet potatoes and potatoes recorded a negative growth in production, which was mainly due to decrease in crop area. The increase in the yield of rice, wheat and maize was mainly due to increase in their production rather than increase in crop area. The increase in the yield of soyabean, groundnuts, rapeseed and seed cotton was due to the increase in both crop area and production, but increase in production was higher as compared to increase in crop area. The major conclusion that emerge from an analysis of this period is that increase in the production of rice, wheat and maize was mainly due to increase in yield rather than the crop area, whereas in soyabean, groundnuts, rapeseed and seed cotton, it was due to increase in both, crop area and yield, but yield contributed more than crop area. Out of 9 crops, production of 7 crops contributed more to increase in yields, as compared to crop area. Rise in the yield of rice, wheat, maize, groundnuts and rapeseed was mainly due to favourable price incentives, expanded irrigation system, HYVs, rising chemical fertilizer application and implementation of the production responsibility system.

#### *Period II*

In the case of sweet potatoes acceleration in the growth of production came through improvement in yields, while in the case of maize and potatoes it came through both increase in yield and expansion in crop area. But increase in yield contributed more as compared to expansion in crop area. In case of wheat, sweet potatoes and seed cotton, decline in the growth of production occurred through decrease in growth of crop area only, while in the case of rapeseed and groundnuts, decline occurred through decrease in growth of both the crop area and yield per hectare.

**TABLE 1**

Period-Wise Compound Growth Rates of Area, Production and Yield of Major Crops in China

(per cent per annum)

| Crops | Period I (1976-77 to 1987-1988) | | | Period II (1988-89 to 1999-2000) | | |
|---|---|---|---|---|---|---|
| | Area | Production | Yield | Area | Production | Yield |
| Rice | –1.02 | 3.22 | 4.24 | –0.61 | 0.97 | 1.58 |
| | (9.31)* | (9.48)* | (11.96)* | (3.02)** | (3.13)** | (9.50)* |
| Wheat | 0.22 | 6.69 | 6.47 | –0.41 | 2.29 | 2.70 |
| | (1.39) | (7.88)* | (8.33)* | (0.59) | (6.46)* | (3.26)* |
| Maize | –0.42 | 3.88 | 4.30 | 2.40 | 4.86 | 2.46 |
| | (1.19) | (7.53)* | (10.66)* | (8.48)* | (8.67)* | (4.59)* |
| Sweet Potatoes | –1.84 | –0.03 | 1.81 | –0.28 | 1.01 | 1.29 |
| | (1.70) | (0.03) | (2.82)** | (1.36) | (2.25)** | (2.53)** |
| Soyabean | 2.03 | 3.90 | 1.87 | 3.61 | 3.26 | –0.35 |
| | (4.44)* | (3.45)* | (1.46) | (3.54)* | (3.31)* | (0.32) |
| Groundnuts | 6.01 | 9.85 | 3.84 | 3.33 | 8.05 | 4.69 |
| | (6.50)* | (6.69)* | (2.18)*** | (7.89)* | (8.91)* | (8.22)* |
| Potatoes | –4.53 | –3.61 | 0.92 | 2.25 | 6.38 | 4.13 |
| | (4.40)* | (2.74)** | (1.50) | (4.65)* | (9.62)* | (6.72)* |
| Rapeseed | 7.38 | 13.78 | 6.40 | 2.46 | 4.26 | 1.80 |
| | (8.48)* | (5.44)* | (2.77)** | (4.15)* | (4.98)* | (3.77)* |
| Seed Cotton | 6.43 | 8.55 | 2.12 | –3.25 | –0.28 | 2.97 |
| | (3.89)* | (4.93)* | (1.50) | (3.26)* | (0.29) | (3.62)* |

*Note:* *, **, *** Significant at 1, 5 and 10 per cent level, respectively.
Figures in parenthesis are t-values.

The decrease in the production growth of rice occurred through decrease in both the growth of crop area and yield. In soyabean decline in growth of production occurred through decrease in the growth of yield per hectare only.[6]

The major conclusion that emerged from the analysis of this period is that out of 9 crops[7] the yield growth of 6 crops (rice, wheat, maize, sweet potatoes, soyabean and rapeseed) decelerated, while that of groundnuts, potatoes and seed cotton, accelerated as compared to period I. This means that rice, wheat, sweet potatoes and seed cotton were pushed to marginal lands as irrigated and fertile lands was diverted to groundnuts, potatoes, seed cotton and sugarcane where price incentive, extensive use of irrigation water, rising chemical and manurial application of fertilizers, and high man/land ratio, made these crops more profitable. The decrease in the yield growth of rice, wheat, maize, sweet potatoes, soyabean and rapeseed occurred at a time when expansion of chemical inputs, irrigated crop area, and high-yielding rice, wheat and maize varieties were also occurring. Could it be that the high growth in the earlier years was in part due to the adoption of household production responsibility system and the mining of the rural sector's natural resource base? Can the slowdown in yield growth be explained by increased environmental stress or unfavourable weather conditions?[8] Land and water resources in China have been subjected to serious stress [World Bank, (2000)]. The accumulation of these pressures may be partially responsible for the slowdown of grain yields. Changes in fertilizer use, irrigated crop area, and modern technologies may be associated with the slower growth in yields for most crops in period II. Other factors that might have caused the growth rates to fall are drag yield growth, intensification of China's agricultural practices and other rural activities. Some researchers associate the slowdown with problems in implementing the household production responsibility (HRS) system [Wen, (1989)]. Land tenure insecurities are believed to have also caused farmers to reduce their investment in agriculture, causing grain yields to fall. Others blame the decline on the fall of price of grain, relative to other crops [Sicular, (1991)].

[6] The growth of yield of rice, wheat, maize, sweet potatoes, soyabean, and rapeseed declined from 4.24, 6.47, 4.30, 1.81, 1.87, and 6.40 per cent to 1.58, 2.70, 2.46, 1.29, -0.35 and 1.80 per cent per annum, respectively, and that of groundnuts, potatoes, and seed cotton accelerated from 3.84, 0.92 and 2.12 per cent to 4.69, 4.13 and 2.97 per cent per annum, respectively. The growth of crop area of rice, maize, sweet potatoes, soyabean and potatoes accelerated from -1.02, -0.42, -1.84, 2.03, -4.53 per cent to -0.61, 2.40, -0.28, 3.61 and 2.25 per cent per annum, respectively, and that of wheat, groundnuts, rapeseed and seed cotton decreased from 0.22, 6.01, 7.38 and 6.43 per cent to -0.41, 3.33, 2.46 and -3.25 per cent per annum, respectively.

[7] We have not included sugarcane crop in our study because it has less than 1 per cent area (1999-2000) in total crop area for China. Good sugar prices in 2001 encouraged Chinese farmers to grow more crops in 2002 with acreage rising 11 per cent to 1.61 million hectares (3.9 million acres). See, Statistical Yearbook of China (2003).

[8] Environmental factors are soil erosion, increasing natural disasters, salinization of land, and deterioration of soil quality.

It is possible that all of the above factors contributed to a decline in yield growth in period II.

It will be seen that high growth in crop production and yield in period I is accompanied by high or low instability. Similarly the low growth in crop production and yield in period II is accompanied by high instability. A moderate growth in production and yield accompanied by low level of instability for any crop is desired for sustainable development of agriculture, as compared to high growth in production and yield, and high level of instability.

The association between growth in major area and yield of major crops is presented in Table 2. Four types of associations are discussed. First, AA-positive growth of crop area associated with positive growth of yield. This would indicate that one crop is either replacing the other or is grown in the newly cultivated area, and that the overall yield of crop(s) is increasing. Second, AB-positive growth of crop area is associated with negative growth of yield. Third, BA-negative growth of crop area associated with positive growth of yield. This would indicate that one major crop area has been replaced by another or has gone out of cultivation and the yield on the remaining crop area has increased. Fourth, BB-negative growth of crop area is associated with negative growth of yield. It is seen from Table 2 that in

**TABLE 2**

Association between Growth in Major Crops Area and yield in China

| Types of Association | | Crops under two different periods | |
|---|---|---|---|
| | | Period I | Period II |
| AA: | Positive area, positive yield | Wheat, Soyabean, Groundnuts, Rapeseed, Seed Cotton | Maize, Groundnuts, Potatoes, Rapeseed |
| AB: | Positive area, negative yield | nil | Soyabean |
| BA: | Negative area, positive yield | Rice, Maize, Potatoes, Sweet Potatoes | Rice, Wheat, Sweet Potatoes, Seed Cotton |
| BB: | Negative area, negative yield | nil | nil |

period I, 5 crops fall in the AA category, no crops fall in AB and BB category, 4 crops fall in category BA.[9]

***b) Variability in Crop Production***

The relative variability in major crops production are estimated using equation (2) and results are presented in Table 3. Variability in crop area, production and yield is estimated for periods I and II. It is observed that in period I the production of sweet potatoes, soyabean, groundnuts, potatoes, rapeseed and seed cotton has registered the highest degree of instability and that of rice, wheat and maize the lowest. These fluctuations in production are the compound result of fluctuations in crop acreage and crop yield. For soyabean, groundnuts and rapeseed, yield contributed more to these fluctuations compared to crop area. Fluctuations in sweet potatoes production occurred due to changes in crop area and yield, but crop area contributed more than yield. Both area and yield fluctuations were behind changes in production of potatoes. The magnitude of instability in the production of wheat, maize, sweet potatoes, soyabean, groundnuts, potatoes and rapeseed declined during period II relative to period I. The synchronized movement in both the crop area and yield was responsible for low instability in rice, wheat and maize production in period I.

The instability in rice and seed cotton production increased in period II as compared to period I; fluctuations in both the crop area and yield contributed to this high variability but crop area instability contributed more as compared to yield instability. The magnitude of instability in the production of wheat, maize, sweet potatoes, soyabean, groundnuts, potatoes and rapeseed declined during period II relative to period I. Table 3 further reveals that in period II the magnitude of fluctuations in production was highest in case of seed cotton and lowest for wheat. In majority of the crops instability in yield was lower than instability in production in period I, which indicates the importance of area instability in this period. In period II instability in production was lower than the instability in yield, which indicates the importance of yield variability. Increasing of crop area and yield instability of wheat in period II, can be attributed to fluctuation in its price vis-à-vis those of its competing crops (groundnuts, and potatoes). More crop area was diverted to production of groundnuts and potatoes away from wheat.

The table also reveals that instability in yield in all the crops (except wheat and maize) declined in period II as compared to period I. During period II, 5 crops (maize, sweet potatoes, groundnuts, potatoes and seed cotton) experienced decrease in variability in crops area, while 2 crops (wheat and soyabean) faced a

[9] Number of regions under category AA, AB, BA and BB in period II were 4, 1, 4 and zero, respectively.

statistically significant increase in crop area variability. Other crops had no statistically significant change in crop area variability though they experienced an increase in crop area variability. The decrease in relative variability in production in period II, compared to period I, was statistically significant for sweet potatoes, soyabean, groundnuts, potatoes and rapeseed (at one per cent level of significance) and wheat (5 per cent level of significance).[10]

**TABLE 3**

Period-Wise Relative Variability/Instability Index in Major Crops Output in China

| Crops | Period I (1976-77 to 1987-88) | | | Period II (1988-89 to 1999-2000) | | | 'Z' Statistics II over I | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| Rice | 0.20 | 0.60 | 0.50 | 0.84 | 1.25 | 0.29 | 0.34 | 0.55 | –0.15 |
| Wheat | 0.84 | 1.72 | 1.50 | 4.32 | 0.90 | 3.18 | 4.18* | –2.83** | 4.62* |
| Maize | 1.87 | 1.13 | 0.64 | 0.57 | 1.10 | 1.72 | –5.19* | –0.05 | 0.98 |
| Sweet Potatoes | 5.27 | 4.58 | 2.76 | 1.06 | 2.08 | 2.29 | –119.02* | –53.71* | –3.81* |
| Soyabean | 1.46 | 4.57 | 6.74 | 3.92 | 3.79 | 6.50 | 4.15* | –16.68* | –11.02* |
| Groundnuts | 2.40 | 3.46 | 7.89 | 0.90 | 1.67 | 1.13 | –9.39* | –22.32* | –424.20* |
| Potatoes | 3.06 | 4.82 | 3.11 | 1.54 | 1.13 | 1.48 | –14.99* | –87.57* | –16.58* |
| Rapeseed | 1.66 | 5.76 | 10.13 | 1.99 | 2.48 | 1.73 | 1.07 | –110.46* | –866.18* |
| Seed Cotton | 6.24 | 5.55 | 7.08 | 3.91 | 5.80 | 3.16 | –91.9* | 7.82 | –198.45* |

*Note*:
The values of Z are computed using equation (3) to see whether there was a statistically significant difference of variability in major crops output in China [computed as in equation (2)] between periods.
* ** = Significant at 1 and 5 per cent level, respectively.

[10] These 6 crops together contributed 42 per cent of total crops production in China during period II.

On the other hand seed cotton experienced one per cent statistically significant increase in production variability in period II, when compared to period I.[11] Rice crop had no statistically significant change in production variability in period II compared to period I, though it experienced an increase in production variability.[12] Sweet potatoes, soyabean, groundnuts, potatoes, rapeseed and seed cotton recorded one per cent decrease in yield variability in period II as compared to period I. Wheat crop also recorded a one per cent increase in relative yield variability in period II as compared to period I.[13] Rice and maize had no significant change in yield variability. Implication of these findings is that reduction in yield fluctuation has increased the stability in most of the crop yield (except wheat and maize) and thereby food security.

Growth and instability in the production of major crops is presented in Table 4. In period I most of the crops have high growth rates in production but they have

**TABLE 4**

Period-wise Growth and Instability in the Production of Major Crops in China

| Crops | Period I | | Period II | |
|---|---|---|---|---|
| | Growth (%) | Insta-bility | Growth (%) | Insta-bility |
| Rice | 3.22* | 0.60 | 0.97** | 1.25 |
| Wheat | 6.69* | 1.72 | 2.29* | 0.90 |
| Maize | 3.88* | 1.13 | 4.86* | 1.10 |
| Sweet Potatoes | -0.03 | 4.58 | 1.01** | 2.08 |
| Soyabean | 3.90* | 4.57 | 3.26* | 3.79 |
| Groundnuts | 9.85* | 3.46 | 8.05* | 1.67 |
| Potatoes | -3.61** | 4.82 | 6.38* | 1.13 |
| Rapeseed | 13.78* | 5.76 | 9.26* | 2.48 |
| Seed Cotton | 8.55* | 5.55 | -0.28 | 5.80 |

*Note:* Taken from Table 1 and 3
*, ** = Significant at 1 and 5 per cent level, respectively.

[11] This crop contributed only one per cent to total crop production of China in period II.

[12] Rice contributed 26 per cent of production in China's total production.

[13] Wheat crop contributes 15 per cent in total China's production and 22 per cent in total crop acreage.

also high instability as compared to period II. In period II, though the production growth of most of the crops has declined (due to increase in flooded and drought crop areas in late 1980s) but at the same time their instability has also declined. Rapeseed has highest growth in production along with highest instability, while in period II it has negative growth with highest level of instability. Sweet potatoes and potatoes which had negative growth in production with high level of instability in period I changed to positive growth with a low level of instability in period II. Changes in production growth which causes instability can be due to a number of factors which include erratic availability of irrigation water, changes in prices of competing crops and timely unavailability of agricultural inputs. Favourable prices for maize, sweet potatoes, groundnuts and potatoes played a vital role as compared to other inputs in increasing the growth of these crops as compared to other crops in period II. The decline in the growth rate of rice and wheat[14] was mainly due to unfavourable prices and flooded and drought land area. The crop area of under these crops remained more or less stagnant.

The association between yield and variability in yield of major crops in China is presented in Table 5. Four different types of association were found. AA: increase in yield associated with decrease in relative variability; AB: increase in yield associated with increase in relative variability; BA: decrease in yield associated with decrease in relative variability; BB: decrease in yield associated with increase in relative variability. From the view point of development, AA is the best situation

**TABLE 5**

Association between Yield and Variability in Yield of Major Crops in China

| Types of Association | Crops Period II Compared to Period I |
|---|---|
| AA: Increase in yield with decrease in variability. | Rice, Sweet Potatoes, Soyabean, Groundnuts, Potatoes, Rapeseed |
| AB: Increase in yield with increase in variability. | Wheat, Maize |
| BA: Decrease in yield with decrease in variability. | Seed Cotton |
| BB: Decrease in yield with increase in variability. | |

14 These comprised 46 per cent of total crop area in Chinese agriculture.

whereas BB indicates the worst situation. AB would be preferred to BA. The distribution of crops, according to the type of association between yield and relative variability in yield shows that 6 crops (rice, sweet potatoes, soyabean, groundnuts, potatoes and rapeseed) experienced an increase in yield accompanied by decrease in variability, while wheat and maize experienced increase in yield associated with increase in variability in period II as compared to period I. Seed cotton crop faced decrease in yield associated with decrease in variability.

## V. Conclusions

The paper analyzes the growth and variability/instability in major crops area, production and yield for two different periods in China. Period I (1976-77 to 1987-88) and period II (1988-89 to 1999-2000). The study reveals that in period I, most crops (wheat, maize, soyabean, groundnuts, seed cotton) have high growth with high instability in production. The high yield growth of rice, maize, groundnuts and rapeseed was mainly due to favourable price incentives, expanded irrigation system, HYVs, rising chemical fertilizer application and implementation of the production responsibility system in period I. The study also shows that in period II the production growth of wheat, soyabean, groundnuts and rapeseed declined significantly but its instability also declined. Also the growth of maize, sweet potatoes and potatoes increased in period II (sweet potatoes and potatoes had negative growth earlier) with declining instability. Favourable prices for maize, sweet potatoes, potatoes and groundnuts played a vital role as compared to other inputs in increasing the growth of these crops in period II. The decline in the growth rate of rice and wheat was mainly due to unfavourable prices of these crops and flooded and droght land areas. The crop area under these crops remained stagnant.

The study also reveals that instability in yield in all crops (except wheat and maize) declined in period II as compared to period I. In majority of the crops instability in yield was lower than instability in production in period I, which indicates the importance of area instability, while in period II, instability in production was lower than instability in yield, which indicates the importance of yield variability.

## VI. Policy Recommendations

Some policy recommendations to improve the growth and stability are outlined below:

1) The result of the study indicate that in period II the production growth rate of wheat, soyabean, groundnuts and rapeseed declined as compared to other crops. Therefore, there is a need to increase their growth. This is only possible through increase in production because China has nearly exhausted the supply of new

land that can readily be brought under cultivation. The growth rate of production can be increased through favourable price incentives, expanded irrigation system, HYVs, rising chemical fertilizer application, better implementation of production responsibility system and better control of flooded and drought land. Due to environmental stress, China has to import many crops. Therefore, an intensive research effort is needed to understand how production practices can be modified to minimize the deleterious environmental effects. Investment may also be required in key areas of the rural sector to protect the resource base. Since investment capital is scarce in many regions, particularly in the agricultural sector, leaders may consider expanding the use of labour mobilization schemes. By creating new technologies and crop varieties, and improving agronomic practices, Chinese agricultural research can expand crop production. Thus, the Chinese government must increase its investment in research and development.

2) The study also shows high instability in some of the crops in period II. This instability can be reduced through controlling the price of these crops and those of competing crops, timely availability of agricultural inputs (HYVs and fertilizer), and continuity in the supply of irrigation water.

3) China faces an inappropriate land and labour resource combination. Therefore, various land-use experiments, including shareholding and leasing village land, need to be expanded to facilitate the development of a land use market.

4) New thrust on research must be made in the direction of evolving HYVs suitable for rain-fed as well as irrigated crop area.

*Applied Economics Research Centre*
*University of Karachi, Pakistan*

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## APPENDIX

### TABLE A-1

Some Major Crops Production Share of China in World Production 1976-77 to 1980-81*

| Crops / Year | 1976-77 | 1977-78 | 1978-79 | 1979-80 | 1980-81 |
|---|---|---|---|---|---|
| **Wheat** ('000 tonns) | | | | | |
| World Production | 425325 | 369353 | 385885 | 376378 | 399779 |
| Local Production | 50386 | 41076 | 53842 | 62733 | 55213 |
| World Share (% age) | 11.8 | 11.2 | 13.9 | 16.7 | 13.8 |
| **Rice** ('000 tonns) | | | | | |
| World Production | 350340 | 391344 | 449372 | 428065 | 444534 |
| Local Production | 129359 | 132035 | 140132 | 146959 | 142993 |
| World Share (% age) | 36.9 | 33.7 | 31.2 | 34.3 | 32.2 |
| **Maize** ('000 tonns) | | | | | |
| World Production | 354451 | 369995 | 390104 | 418598 | 392249 |
| Local Production | 48160 | 49390 | 55950 | 60040 | 62600 |
| World Share (% age) | 13.6 | 13.3 | 14.3 | 14.3 | 15.9 |
| **Groundnuts** ('000 tonns) | | | | | |
| World Production | 17476 | 17716 | 18660 | 18648 | 18901 |
| Local Production | 1873 | 1978 | 2377 | 2822 | 3600 |
| World Share (% age) | 10.7 | 11.2 | 12.7 | 15.1 | 19.0 |
| **Soyabean** ('000 tonns) | | | | | |
| World Production | 60719 | 74807 | 76723 | 91449 | 83481 |
| Local Production | 6640 | 7260 | 7570 | 7482 | 7966 |
| World Share (% age) | 10.9 | 9.7 | 9.9 | 8.2 | 9.5 |
| **Seed Cotton** ('000 tonns) | | | | | |
| World Production | 24067 | 26858 | 26231 | 28302 | 28391 |
| Local Production | 4110 | 4099 | 4335 | 4414 | 5414 |
| World Share (% age) | 17.0 | 15.0 | 16.0 | 15.0 | 19.0 |

*Source:* Statistical Yearbook 1979-80, United Nations.

*World production between 1981-82 to 1991-92 were not available, therefore we have taken the years 1976-77 to 1980-81.

## TABLE A-2

Some Major Crops Production Share of China to World Crops Production
1995-96 to 1999-2000

| Crops / Year | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-2000 |
|---|---|---|---|---|---|
| **Wheat** ('000 tonns) | | | | | |
| World Production | 543614 | 586036 | 612624 | 589269 | 578337 |
| Local Production | 107005 | 110569 | 123290 | 109726 | 113880 |
| World Share (% age) | 19.7 | 18.9 | 20.1 | 18.6 | 19.6 |
| **Rice** ('000 tonns) | | | | | |
| World Production | 550600 | 567781 | 578935 | 567883 | 586787 |
| Local Production | 187192 | 195103 | 200735 | 198713 | 198487 |
| World Share (% age) | 34.0 | 34.4 | 34.6 | 34.9 | 33.8 |
| **Maize** ('000 tonns) | | | | | |
| World Production | 515046 | 590214 | 584945 | 604858 | 599708 |
| Local Production | 112331 | 12639 | 104309 | 132954 | 128086 |
| World Share (% age) | 21.8 | 21.6 | 17.8 | 21.9 | 21.3 |
| **Groundnuts** ('000 tonns) | | | | | |
| World Production | 29277 | 31595 | 29457 | 32282 | 32219 |
| Local Production | 10316 | 127471 | 9728 | 11886 | 12639 |
| World Share (% age) | 35.2 | 40.0 | 33.0 | 36.8 | 39.2 |
| **Soyabean** ('000 tonns) | | | | | |
| World Production | 126868 | 130343 | 144500 | 158220 | 157744 |
| Local Production | 13518 | 14250 | 14738 | 15150 | 14250 |
| World Share (% age) | 10.6 | 10.9 | 10.1 | 9.5 | 9.0 |
| **Seed Cotton** ('000 tonns) | | | | | |
| World Production | 58534 | 56622 | 56782 | 53195 | 55573 |
| Local Production | 9536 | 7660 | 9206 | 9002 | 7660 |
| World Share (% age) | 16.3 | 13.5 | 16.2 | 16.9 | 13.7 |

*Source*: Statistical Yearbook for Asia and the Pacific, 2000, United Nations.
Agricultural Statistics of Pakistan, 1999-2000, Government of Pakistan.

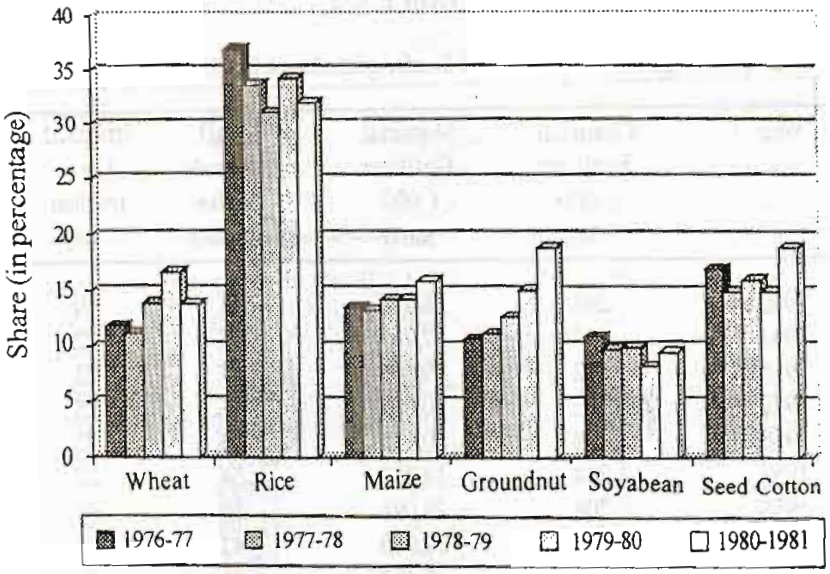


**Figure A-1**

China's Share in Production of Major Crops in Period-I (1976-77 to 1980-81)

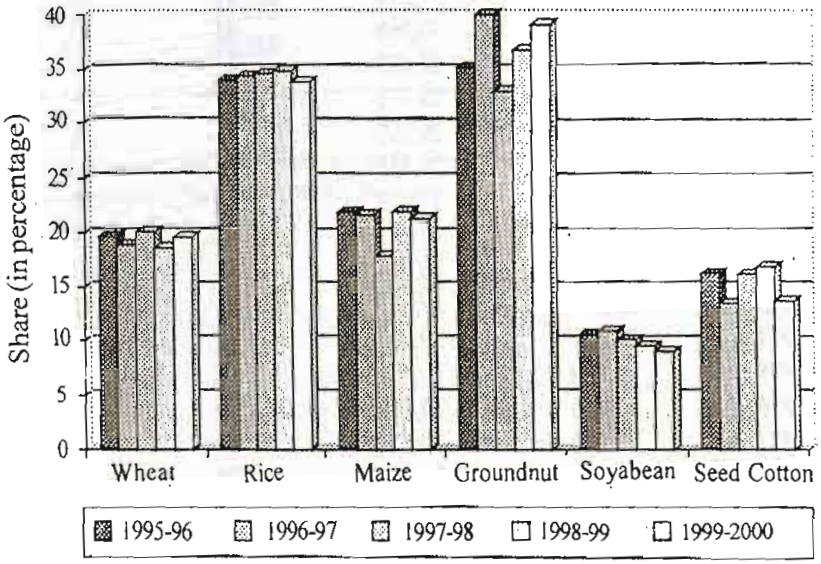


**Figure A-2**

China's Share in Production of Major Crops in Period-II (1995-96 to 1999-2000)

**TABLE A-3**

Trend of Irrigation, Fertilizer and Draft Animals use in China, 1976-95

| Year | Chemical Fertilizer ('000 tons) | Manurial Fertilizer ('000 tons) | Draft Animals (million heads) | Irrigated Areas (million ha) |
|---|---|---|---|---|
| 1952 | 295 | 26,376 | 51 | 20 |
| 1953 | 592 | 27,753 | 55 | 22 |
| 1954 | 802 | 29,206 | 57 | 23 |
| 1955 | 1,255 | 30,009 | 56 | 25 |
| 1956 | 1,608 | 30,433 | 55 | 32 |
| 1957 | 1,794 | 30,237 | 54 | 27 |
| 1958 | 2,708 | 29,091 | 50 | 67 |
| 1959 | 2,533 | 30,000 | 47 | 55 |
| 1960 | 3,164 | 28,677 | 41 | 45 |
| 1961 | 2,242 | 28,478 | 38 | 37 |
| 1962 | 3,105 | 29,573 | 40 | 31 |
| 1963 | 4,483 | 30,948 | 40 | 31 |
| 1964 | 5,363 | 31,718 | 41 | 32 |
| 1965 | 8,812 | 33,068 | 43 | 33 |
| 1966 | 12,582 | 27,629 | 45 | 34 |
| 1967 | 13,128 | 28,375 | 47 | 35 |
| 1968 | 10,129 | 29,092 | 48 | 36 |
| 1969 | 13,611 | 29,535 | 50 | 37 |
| 1970 | 15,811 | 37,017 | 49 | 38 |
| 1971 | 18,142 | 37,713 | 50 | 39 |
| 1972 | 20,931 | 38,076 | 51 | 40 |
| 1973 | 25,553 | 39,009 | 51 | 41 |
| 1974 | 24,051 | 39,503 | 52 | 42 |
| 1975 | 26,579 | 39,709 | 51 | 43 |
| 1976 | 28,850 | 39,315 | 50 | 44 |
| 1977 | 31,920 | 39,413 | 50 | 45 |
| 1978 | 43,681 | 39,966 | 50 | 45 |
| 1979 | 52,476 | 40,703 | 50 | 45 |
| 1980 | 58,649 | 41,112 | 51 | 45 |

continued

**TABLE A-3**

(continued)

| Year | Chemical Fertilizer ('000 tons) | Manurial Fertilizer ('000 tons) | Draft Animals (million heads) | Irrigated Areas (million ha) |
|---|---|---|---|---|
| 1981 | 61,768 | 41,633 | 55 | 45 |
| 1982 | 68,120 | 42,051 | 58 | 44 |
| 1983 | 73,845 | 41,912 | 61 | 45 |
| 1984 | 74,959 | 42,341 | 64 | 44 |
| 1985 | 73,105 | 43,297 | 66 | 44 |
| 1986 | 79,960 | 44,783 | 69 | 44 |
| 1987 | 83,772 | 46,059 | 71 | 44 |
| 1988 | 89,311 | 47,802 | 72 | 44 |
| 1989 | 97,091 | 48,904 | 74 | 45 |
| 1990 | 105,514 | 49,412 | 76 | 47 |
| 1991 | 112,503 | 49,628 | 77 | 48 |
| 1992 | 114,799 | 49,537 | 78 | 49 |
| 1993 | 123,419 | 49,607 | 81 | 49 |
| 1994 | 130,079 | 49,679 | 85 | 49 |
| 1995 | 140,658 | 49,755 | 88 | 49 |

*Source*:
Fan, Shenggen (1997) "Production and productivity growth in Chinese agriculture: New measurement and evidence", Food Policy, Vol.22, No.3, pp:213-228.

**TABLE A-4**

Area, Production and Yield of Major Selected Crops in China, 1976-2000

| Crops | Average Area (Thousand hectares) | | Average Production (Thousand metric tons) | | Average Yield (Kgs. per hectare) | | Percentage Change in Average Yield During Period |
|---|---|---|---|---|---|---|---|
| | Period I | Period II | Period I | Period II | Period I | Period II | II over I |
| Rice | 34241 (28.97) | 31903 (24.15) | 156843 | 188325 | 4580 | 5903 | 28.89 |
| Wheat | 28898 (24.45) | 29710 (22.49) | 68509 | 103922 | 2371 | 3498 | 47.53 |
| Maize | 19318 (16.34) | 22264 (16.86) | 62721 | 102681 | 3247 | 4612 | 42.04 |
| Sweet Potatoes | 5724 (4.84) | 6196 (4.69) | 97336 | 111284 | 17005 | 17961 | 5.62 |
| Soyabean | 7531 (6.37) | 9589 (7.26) | 8650 | 13062 | 1148 | 1362 | 18.64 |
| Groundnuts | 2461 (2.08) | 3489 (2.64) | 3763 | 8558 | 1529 | 2453 | 60.43 |
| Potatoes | 4038 (3.42) | 3232 (2.45) | 44428 | 44940 | 11002 | 13905 | 26.39 |
| Rapeseed | 3757 (3.18) | 6177 (4.68) | 4097 | 8158 | 1090 | 1321 | 21.19 |
| Seed Cotton | 3162 (2.67) | 5234 (3.96) | 7150 | 8799 | 2261 | 1681 | -25.65 |

*Note:*

1. Period I refers crop years 1976-77 to 1987-88 and period II refers years 1988-89 to 1999-2000.
2. Figures in parenthesis are the percentage of total area in China.

**TABLE A-5**

Maximum and Minimum Yield Rates (Kgs./hectares)
Per Hectare of Major Crops in China

| Crop | | Period – I 1976-77 to 1987-88 | Period – II 1988-89 to 1999-2000 |
|---|---|---|---|
| Rice | Maximum | 5412 | 6366 |
| | Minimum | 3499 | 5281 |
| | Difference | 1913 | 1085 |
| | Percentage | 35.35 | 17.04 |
| Wheat | Maximum | 3047 | 4102 |
| | Minimum | 1464 | 2547 |
| | Difference | 1583 | 1555 |
| | Percentage | 51.95 | 37.91 |
| Maize | Maximum | 3960 | 5268 |
| | Minimum | 2505 | 3875 |
| | Difference | 1455 | 1393 |
| | Percentage | 36.74 | 26.44 |
| Sweet Potatoes | Maximum | 19667 | 20422 |
| | Minimum | 15125 | 16246 |
| | Difference | 4542 | 4176 |
| | Percentage | 23.09 | 20.45 |
| Soyabean | Maximum | 1493 | 1735 |
| | Minimum | 895 | 1147 |
| | Difference | 598 | 588 |
| | Percentage | 40.05 | 33.89 |
| Groundnuts | Maximum | 2036 | 2961 |
| | Minimum | 987 | 1821 |
| | Difference | 1049 | 1140 |
| | Percentage | 51.52 | 38.50 |

continued

**TABLE A-5**

(continued)

| Crop | | Period – I 1976-77 to 1987-88 | Period – II 1988-89 to 1999-2000 |
|---|---|---|---|
| Potatoes | Maximum | 12003 | 17286 |
| | Minimum | 9575 | 10566 |
| | Difference | 2428 | 6720 |
| | Percentage | 20.23 | 38.87 |
| Rapeseed | Maximum | 2111 | 1479 |
| | Minimum | 527 | 1089 |
| | Difference | 1584 | 390 |
| | Percentage | 75.03 | 26.37 |
| Seed Cotton | Maximum | 2765 | 2056 |
| | Minimum | 1548 | 1319 |
| | Difference | 1217 | 737 |
| | Percentage | 44.01 | 35.85 |

*Source:* Statistical Year Book for Asia and the Pacific, 1987 and 2000, United Nations.