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# A Continental Method for Estimating the Supply and Import/Export of Wheat

## Masayoshi Kubo and Jingci Xie

Wheat is the principal food of about half of the world's population. In the 21st century, a steep increase in the global population is expected, mostly in Asia and Africa. While there is a saturation of food in developed countries, many developing countries suffer from a food shortage. We examine the production and supply of wheat by continent, focusing mainly on wheat shortages in Asia and Africa. We also drew conclusions about wheat distribution.

Wheat, the principal food of about half of the world's population, is grown in most areas of the world. Even populations who eat mostly rice also eat some forms of wheat. The global population has increased since World War II, and it is anticipated that it will increase rapidly in the 21st century (National Institute for Research Advancement 1982). Currently, about 4.4 billion of the world's 6.3 billion people live in developing countries. The population is increasing most rapidly in developing countries that attained political independence after World War II. In developing countries, about 800 million people do not receive enough food or adequate nutrition for daily life. Meanwhile, developed countries are saturated with food. The food-shortage problem is becoming increasingly serious.

Across the globe, the issue of human survival in the face of food and population crises is being discussed actively. Many international organizations, such as the Food and Agriculture Organization of the United Nations (FAO 2002) are attempting to quantify the gap between the food supply and the demand. To evaluate this gap, the FAO used a single-equation model until 1970, but now uses the World Food Model. Based on this model, the following predictions can be made in regard to wheat: by 2010, worldwide wheat production will reach 679 million tons; supply, 683 million tons; import, 129 million tons; and export, 128 million tons (Alexandrite 1995). By 2030, worldwide wheat production will reach 854.9 million tons, and the supply will reach 851.2 million tons (FAO 2003). The FAO has taken the stance that providing adequate food to developing countries is a duty of the developed world.

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The International Food Policy Research Institute (IFPRI 2001) developed the International Model for Policy Analysis of Agricultural Commodities and Trade (IFPRI 2002) and predicted that by 2020, the worldwide production and supply of wheat would be 760 million tons. In addition, other models have been developed by the United States Department of Agriculture (USDA 1999) and the Organization for Economic Cooperation and Development (OECD 1976). These agencies have studied the supply and demand of wheat on a global basis. However, little research has been done on the supply, demand, and maritime transportation of wheat in specific regions of the world.

### Objectives

In the 21st century, a steep increase in the global population is expected. This steep increase in global population will occur primarily in Asia and Africa. According to statistics from the FAO, the growing population can be maintained by increased cereal production. But an imbalance between supply and production still exists in the world. This research estimates the supply and import/export of wheat by continent. This method determines the volumes of wheat shortage and certain trade features of the import/export of the commodity.

### Research Method

This study obtained regional wheat production, supply, and trade statistics (FAO 2004) and analyzed population trends. United Nations population projections to 2030 (UN 2004) were used to elucidate factors causing changes in the production and supply of wheat. Regional wheat shortages were quantified in relation to production and supply (Figure 1).

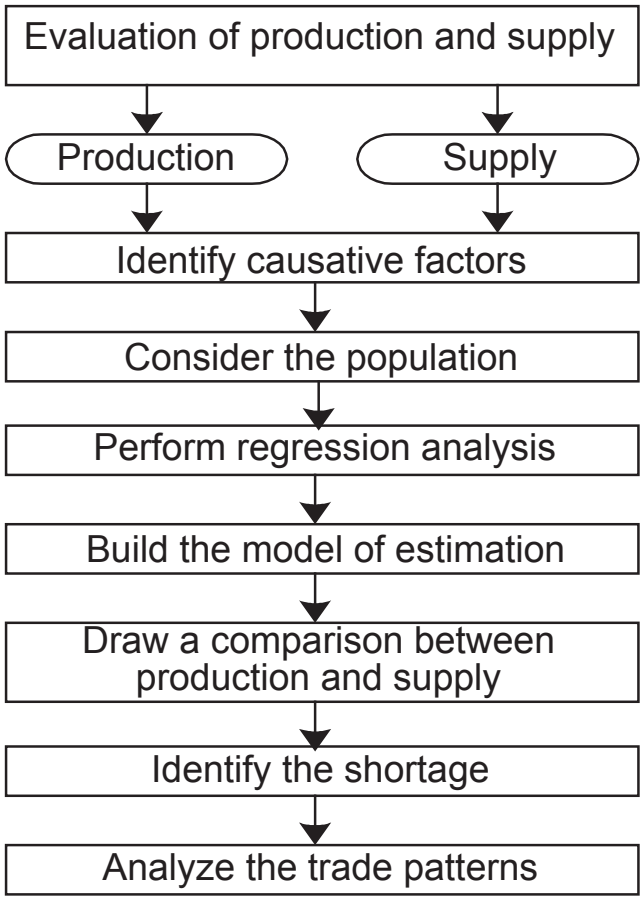


**Figure 1. Model Framework.**

## Factor Analysis of Population In Relation to Wheat Production and Supply

### *Regional Production and Supply*

As shown in Figure 2, the worldwide production of wheat has increased by more than 350 million tons since the late 1970s. The highest production recorded was 613.27 million tons, in 1997. Within about 25 years, global wheat production nearly doubled. Wheat production in developed nations increased from 90 million tons to 137 million tons during this period, and it more than doubled in developing countries.

Worldwide wheat supply for flour milling and for feed also has shown an increasing trend (Figure 3). With the prediction of depressed wheat production, the supply was expected to decrease slightly after 1997; however, it gradually increased again in 2000.

### *Population Predictions*

As shown in Figure 4, the world population doubled from 3,023.81 million in 1960 to 6,085.57 million in 2000. According to the U.N.'s "World Population Prospects" (2004), the world population will increase to 7,905.24 million by 2025 and to 9,075.9 million by 2050. These mid-range estimates show a 50 percent increase in 50 years, with the largest increases in Asia and Africa.

Five-year population estimations were examined for developed and developing countries. In developed countries, the population is projected to

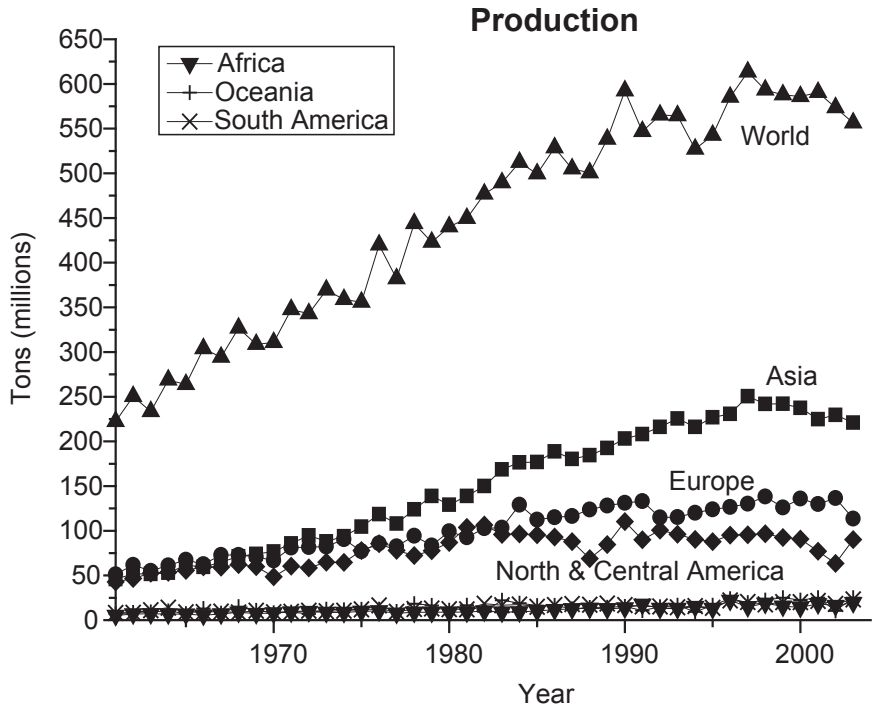


**Figure 2. Regional Changes in Wheat Production.**

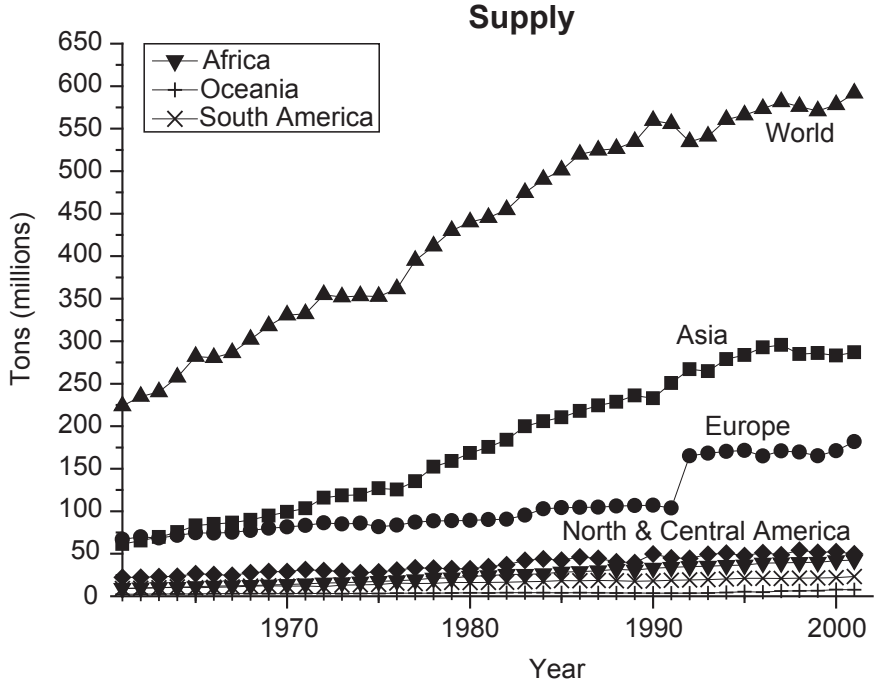


**Figure 3. Regional Changes in Wheat Supply.**

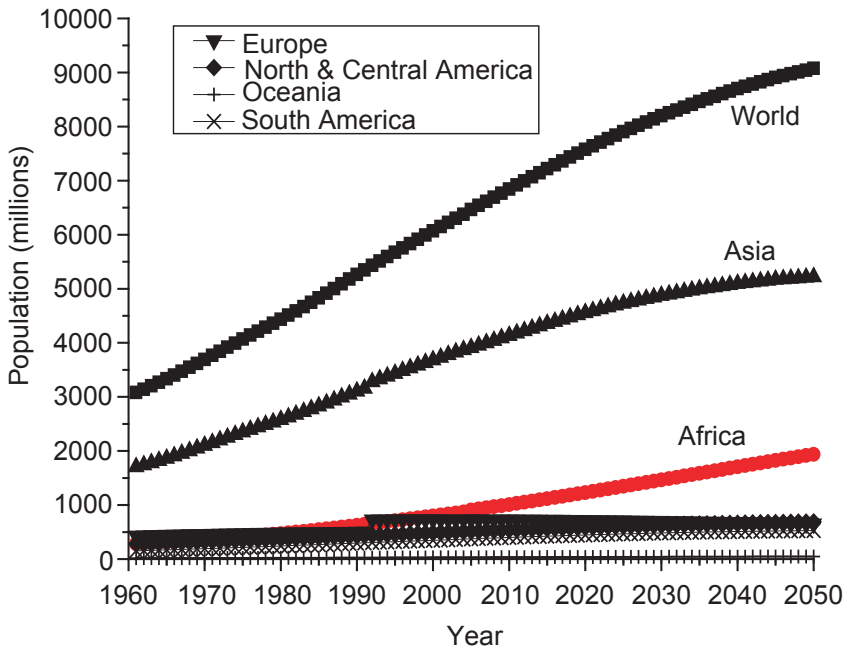


**Figure 4. Regional Populations.**

increase 2.3%, from 1,191.43 million in 2000 to 1,218.83 million in 2025. However, the population in these countries will decrease by 0.9% to 1,181.11 million by 2050. On the other hand, the population of developing countries will increase from 4,865.29 million in 2000 to 6,717.91 million in 2025. Moreover, it is estimated that the population in these countries will reach 8,141.14 million in 2050, for a 50-year increase of 67 percent.

The food shortage is aggravated by the rapid increase in the world's population. In some countries, the population growth rate is higher than the increase in food production. From 1985 to 1995, food production did not keep pace with the population growth rate in 64 of 105 developing countries. The worst situation was in Africa. In order to feed a projected population of 8 billion people in 2025, it will be necessary to double the present level of food production.

*Population Changes*

As shown in Figure 5, worldwide population growth declined briefly in the late 1980s. However, optimistically, even if the birthrate falls further, the population will continue to increase from now on, especially in developing countries. The growth rate in Asia leveled off along with that of the world in the late 1980s. Clearly Asia influences the world population. In Africa, the population is projected to increase annually until 2030 and to decrease after that. Presently, the population of Africa is growing faster than that of Asia.

*Wheat Production and Supply in Relation to Population*

A country-by-country analysis of wheat production and supply shows sharp differences, making it difficult to build a long-term forecasting model. Consequently, research institutions such as the FAO and IFPRI have come up with different predictions.

In this paper, we deal with the wheat problem on a continent-by-continent basis (Kubo 2004), which allows a smoother analysis of annual changes in production, supply, and import/export. The relationship between the production and supply of wheat can thereby be obtained and more-precise predictions can be made (Purevdorj 2005). According to the FAO, there are various ways of defining supply, and, in fact, various concepts are in use. The elements involved are production, imports, exports, and

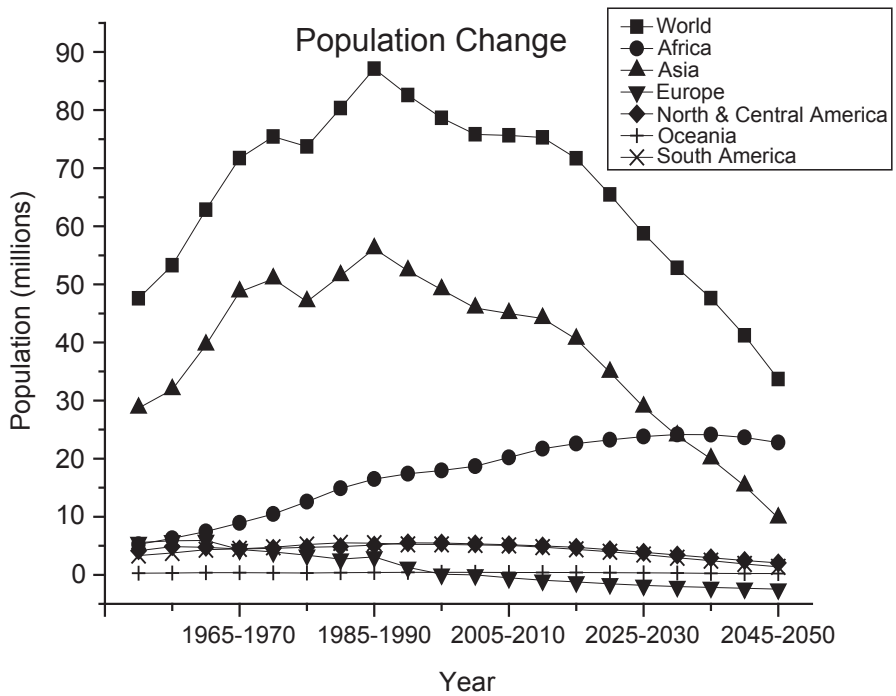


**Figure 5. Regional Population Changes.**

changes in stocks (increases or decreases). There is no doubt that production, imports and decreases in stocks are genuine supply elements. Exports and increases in stocks might, however, be considered as utilization elements. Accordingly, the following possible method of defining supply is used in this research:

Supply for domestic utilization = production + imports − exports + changes in stocks (decrease or increase).

For this study, we used the data of annual production reports by the UN and the FAO. The population of each country since 1961 and the various conditions for wheat production were examined. The areas investigated were Asia, Africa, Europe, North and Central America, South America, and Oceania, as well as the whole world. We especially directed our attention to areas where there are food shortages.

We investigated the variables that have influenced wheat production and supply. A regression model was used to analyze every area by making population an explaining variable. We presume Equation (1) and Equation (2):

$$(1)\quad P_z(t) = a_z POP_z(t) - b_z$$

$$(2)\quad S_z(t) = c_z POP_z(t) - d_z\ ,$$

where $P$ is production, $S$ is supply, $POP$ is population, $t$ is year, $z$ is region, and $a$, $b$, $c$, and $d$ are area coefficients.

As shown in Figures 6, 7, and 9, production, supply, and population correlate highly in areas with food shortages. Figures 8 and 10 show a high correlation and a close dependency between production and supply. It can be concluded that the close dependency is one feature of areas with food shortages.

*Relation between Shortage and Population in Areas with Food Shortages*

If the difference between wheat production and supply is positive in a particular area, there will be a food surplus; if the difference is negative, there will be a food shortage, as is the case in Asia and

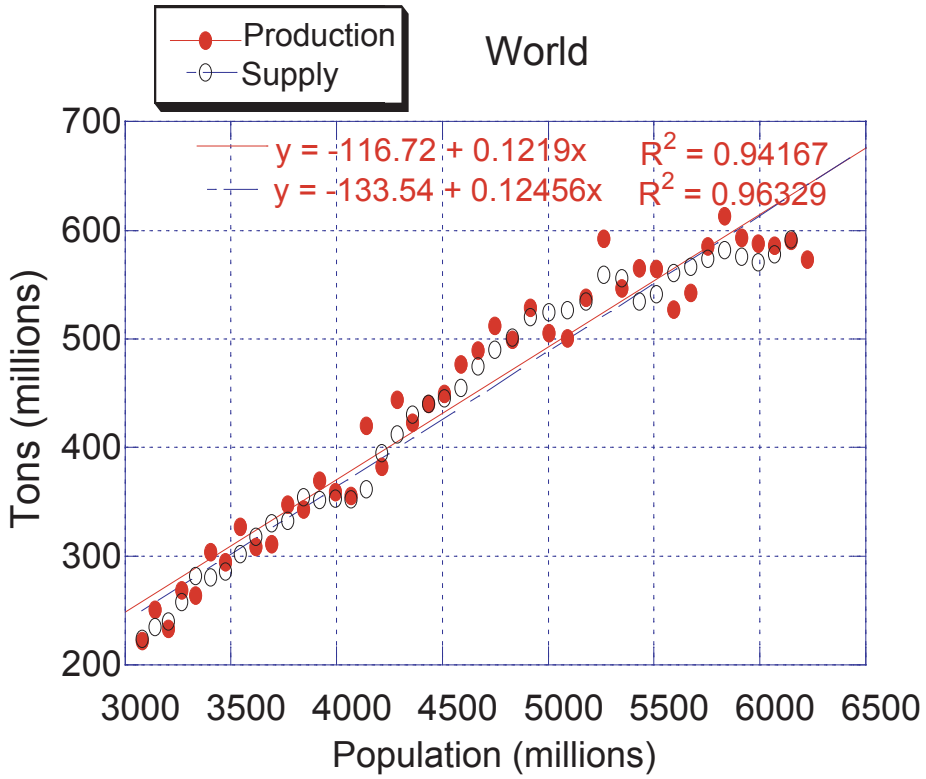


**Figure 6. Relationships among Worldwide Production, Supply, and Population.**

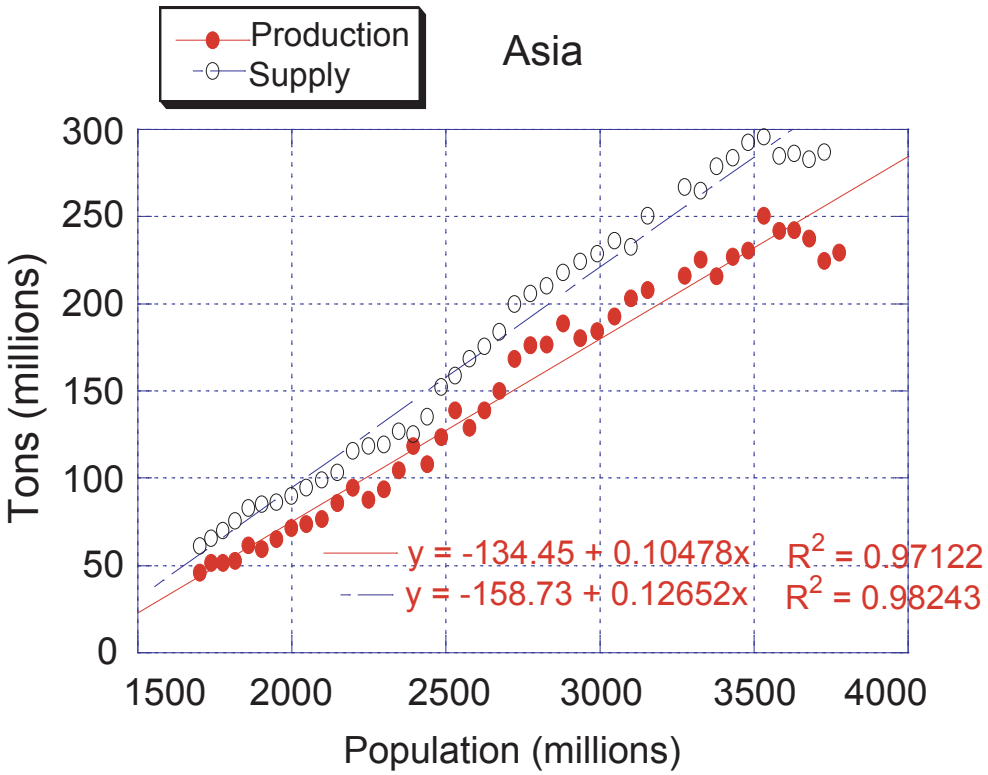


**Figure 7. Relationships among Production, Supply, and Population in Asia.**

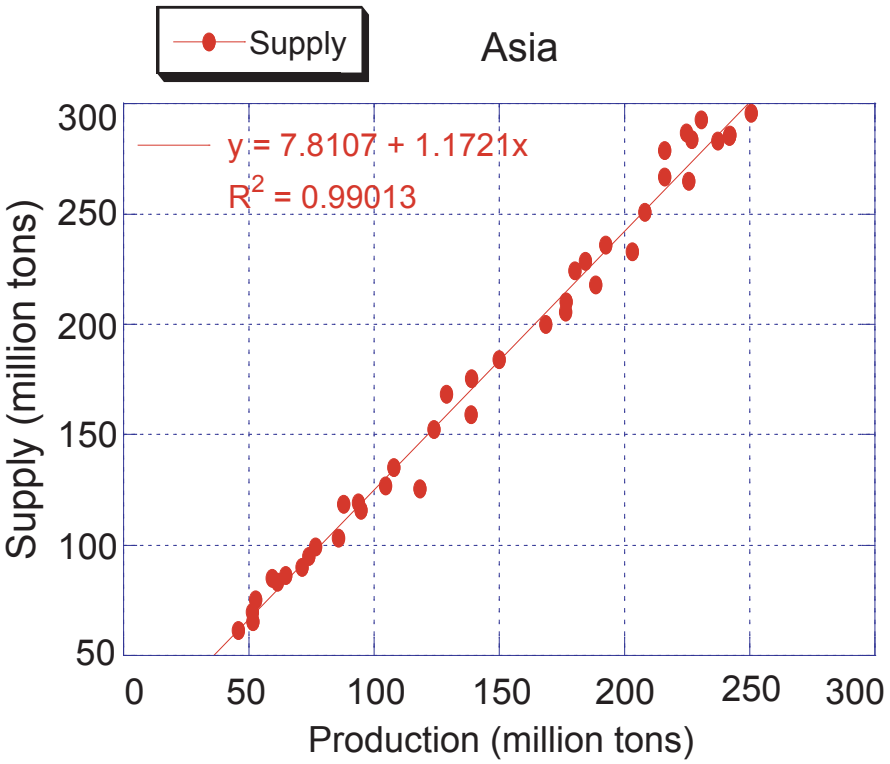


**Figure 8. Relation between Supply and Production in Asia.**

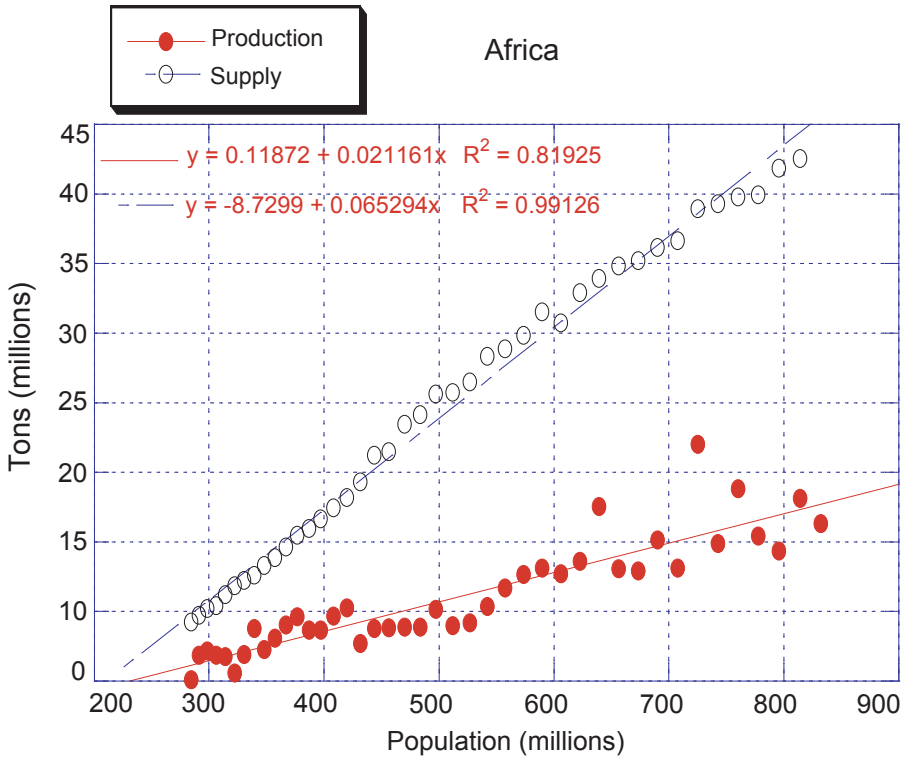


**Figure 9. Relationships among Production, Supply, and Population in Africa.**

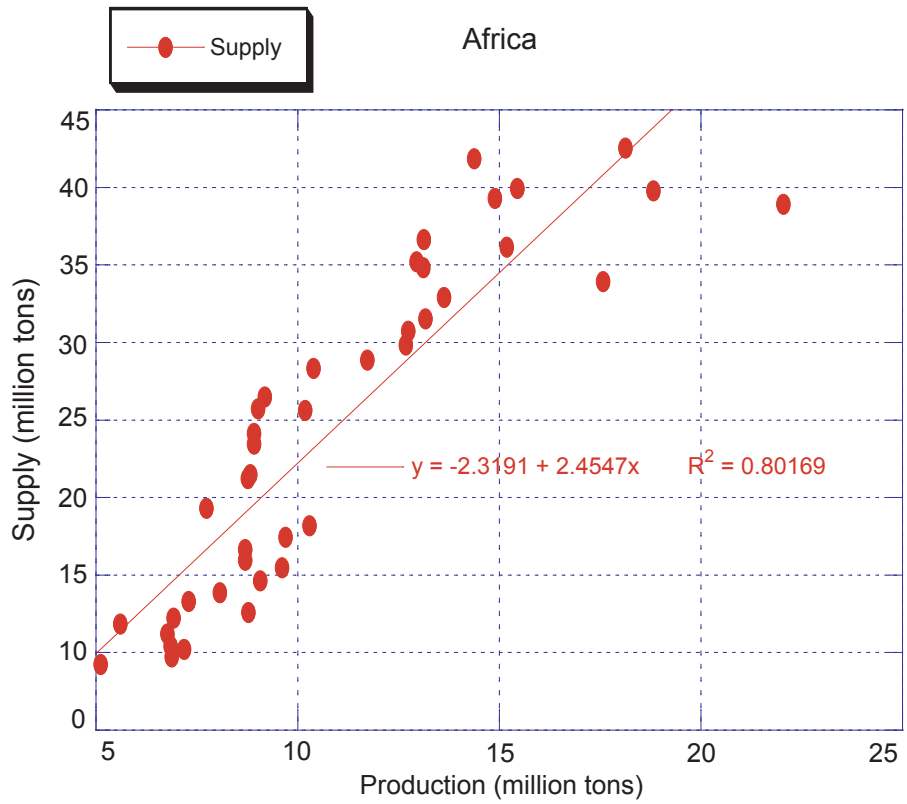


**Figure 10. Relation between Supply and Production in Africa.**

Africa. These areas, consequently, must import food from North and Central America, Oceania, and Europe, which have surpluses. The relation between a wheat shortage and population is shown in Figures 11 and 12. In areas with wheat shortages, a high determination coefficient is obtained. Thus we can use population to estimate wheat shortages in Asia and Africa.

## Relation between Shortages and Imports

The relation between shortages and imports in Asia and Africa is shown in Figures 13 and 14. It seems that imports greatly depend on shortages. In Figures 15 and 16, the regression line, E (y), and a 95% confidence limit of y are shown. More reliable estimates can be obtained for Africa than for Asia. From these two figures, shortage statistics can be used to estimate imports. Here, the volume of imports will be the volume of maritime transportation—because we analyze imports on a continental basis, maritime transportation volume closely approximates total import volume

## Trade Features of Areas with Sufficient and Insufficient Wheat

### *Exports from Areas with Wheat Surpluses to Areas with Wheat Shortages*

Exports of wheat to Asia, in descending order of volume, are from North and Central America, Oceania, and Europe. Exports of wheat to Africa, in descending order of volume, are from North and Central America, Europe, and Oceania. North and Central America and Oceania are especially important sources for both areas (Figures 17 and 18).

### *Share Analysis of the International Wheat Export Market*

The export shares to Asia from Oceania, North and Central America, and Europe are shown in Figure 19. Figure 20 shows export shares from North and Central America, Oceania, and Europe together. When a correlation coefficient was calculated for the annual market share of North and Central

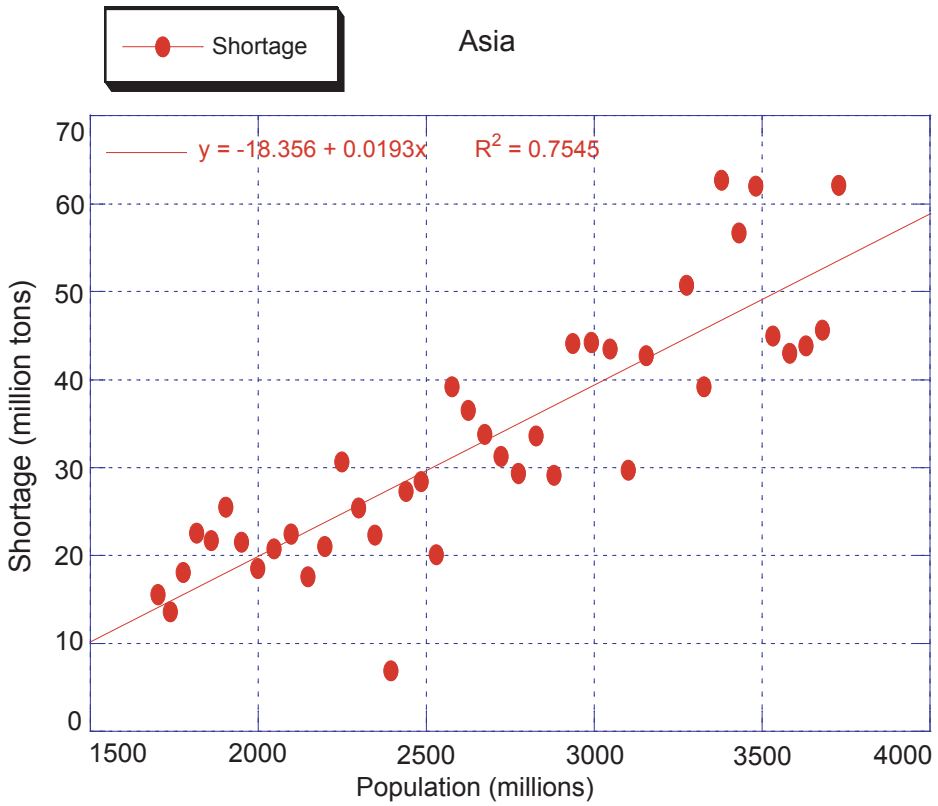


**Figure 11. Relation between Wheat Shortage and Population in Asia.**

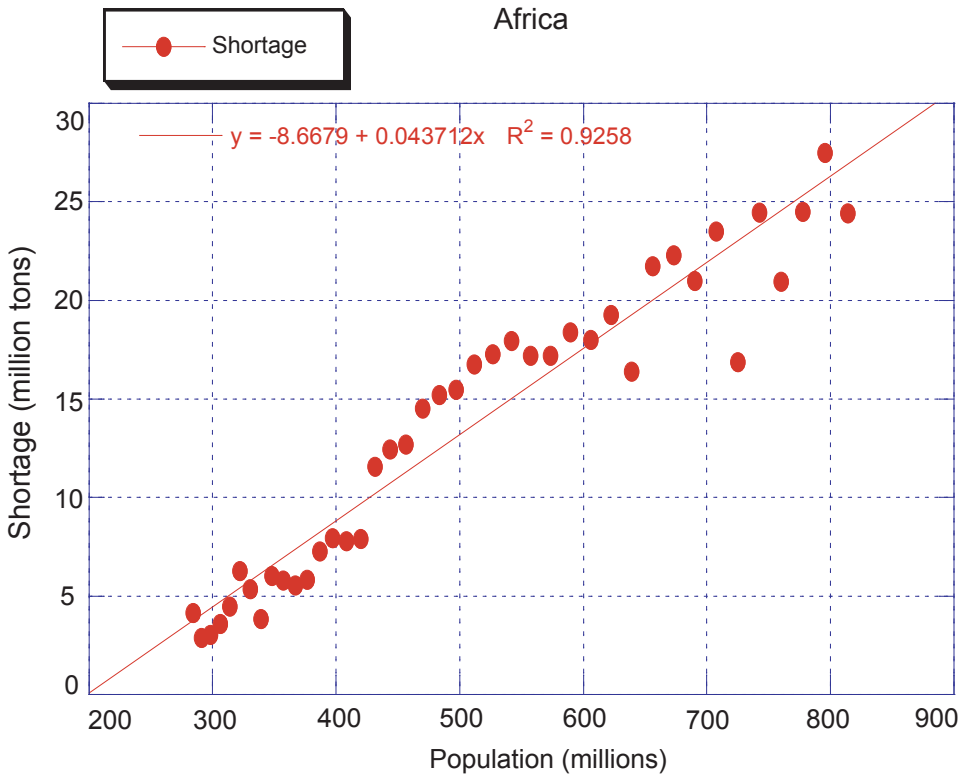


**Figure 12. Relation between Wheat Shortage and Population in Africa.**

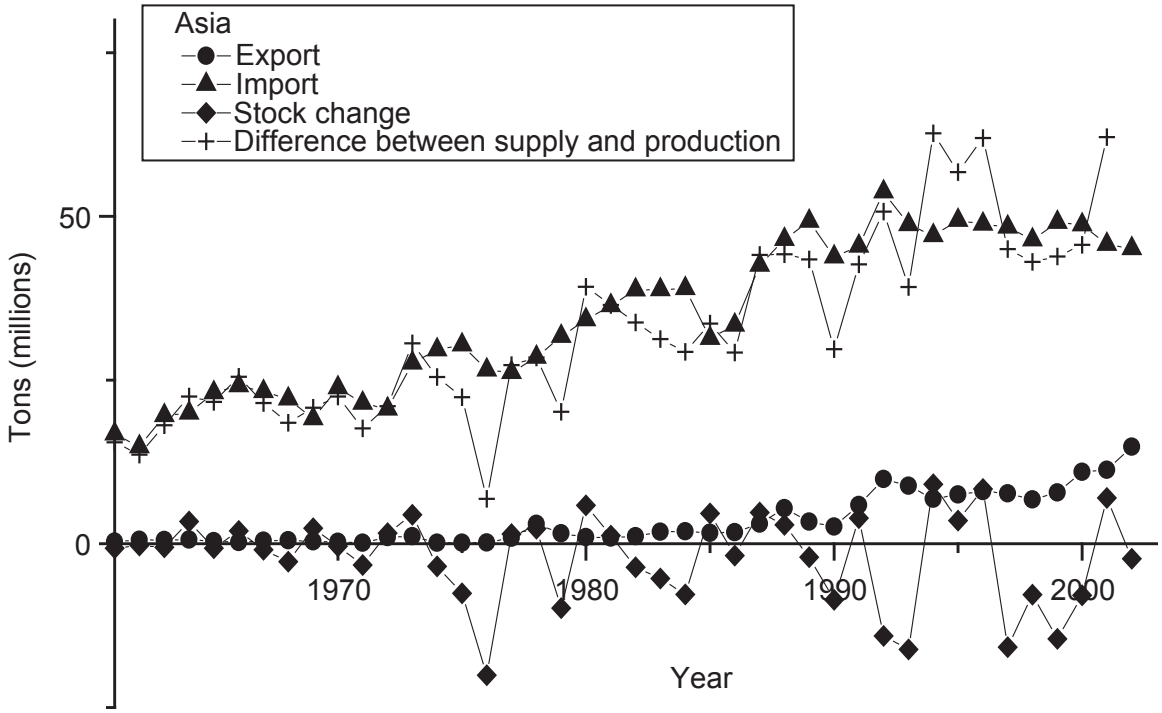


**Figure 13. Relation between Import and Deficit in Asia.**

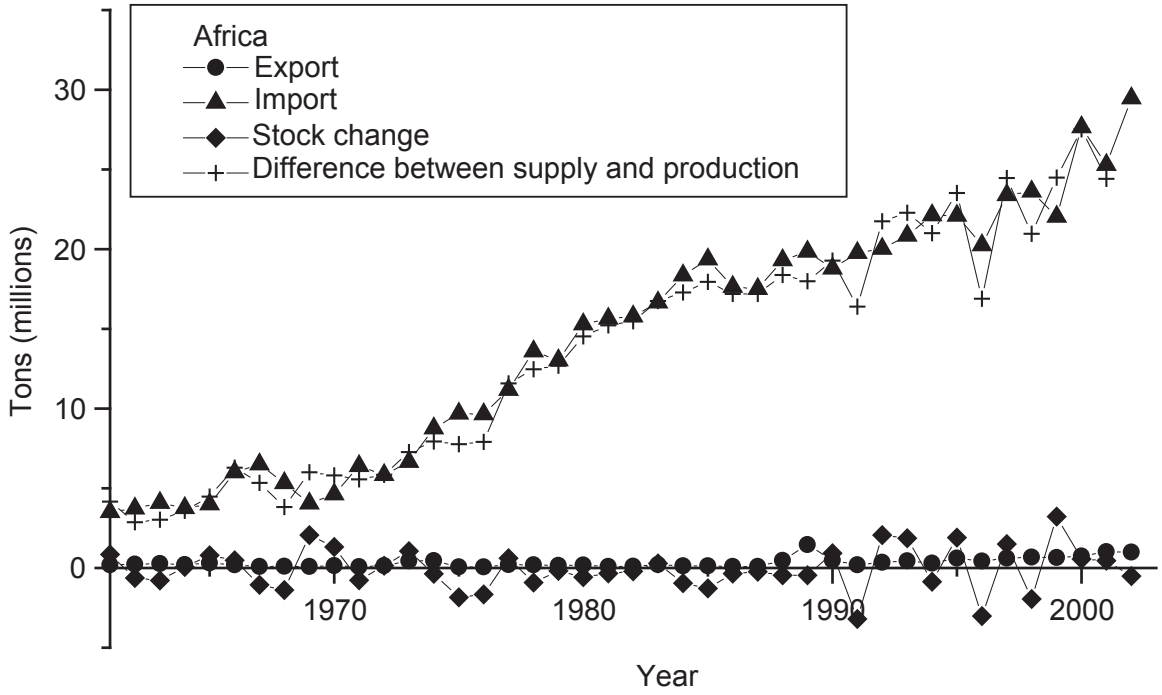


**Figure 14. Relation between Import and Deficit in Africa.**

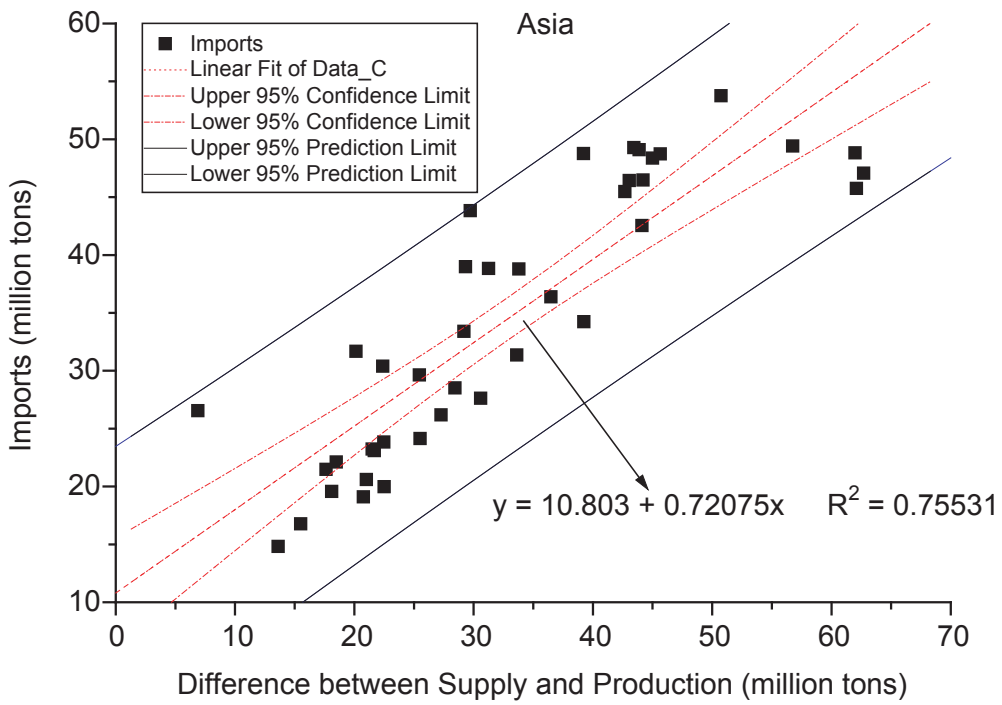


**Figure 15. Relation between Import and Wheat Shortage in Asia.**

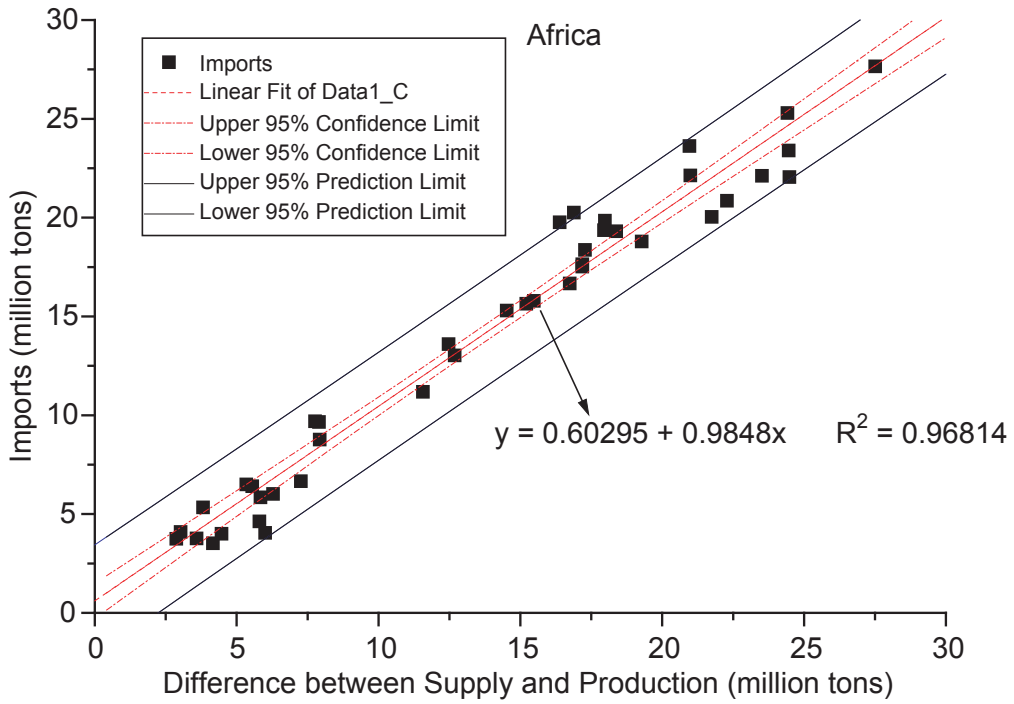


**Figure 16. Relation between Import and Wheat Shortage in Africa.**

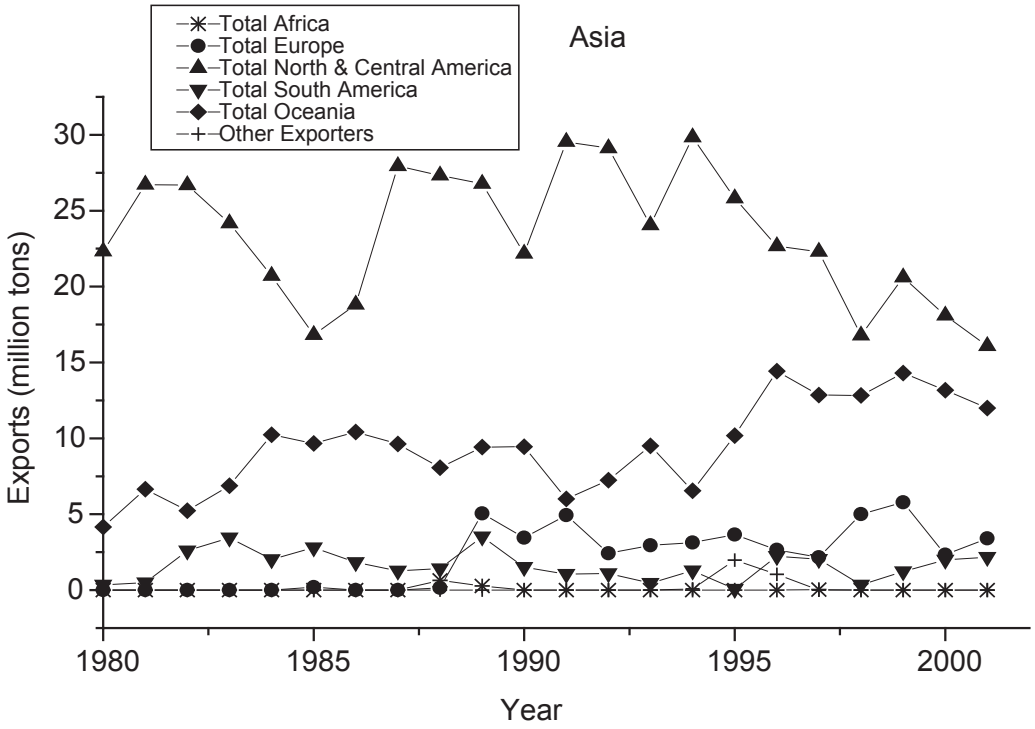


**Figure 17. Changes in Imports to Asia.**

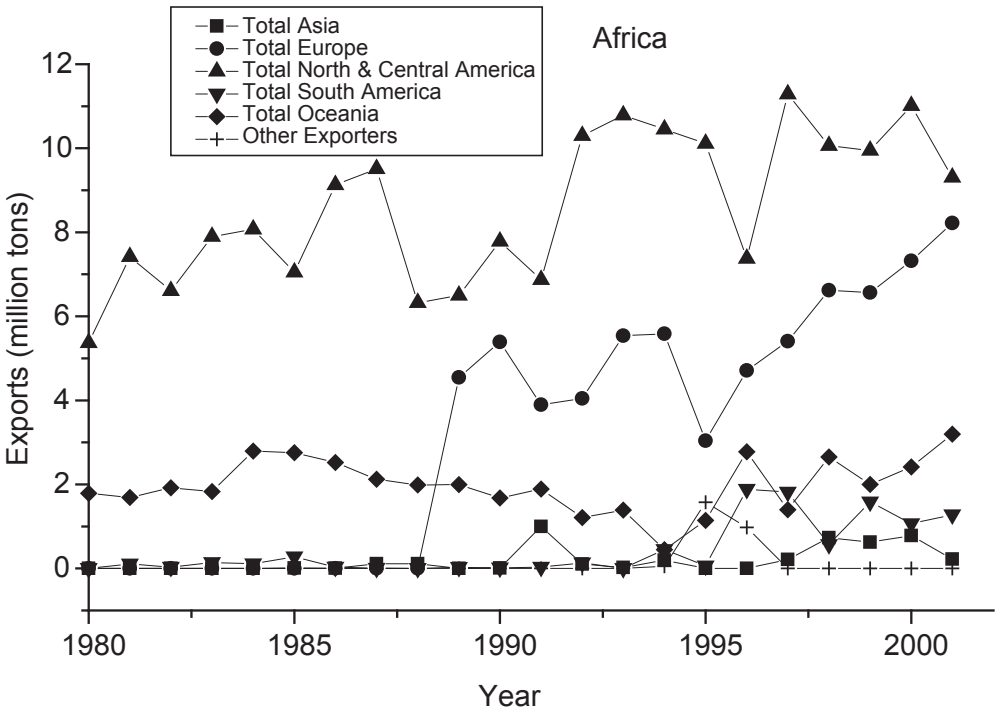


**Figure 18. Changes in Imports to Africa.**

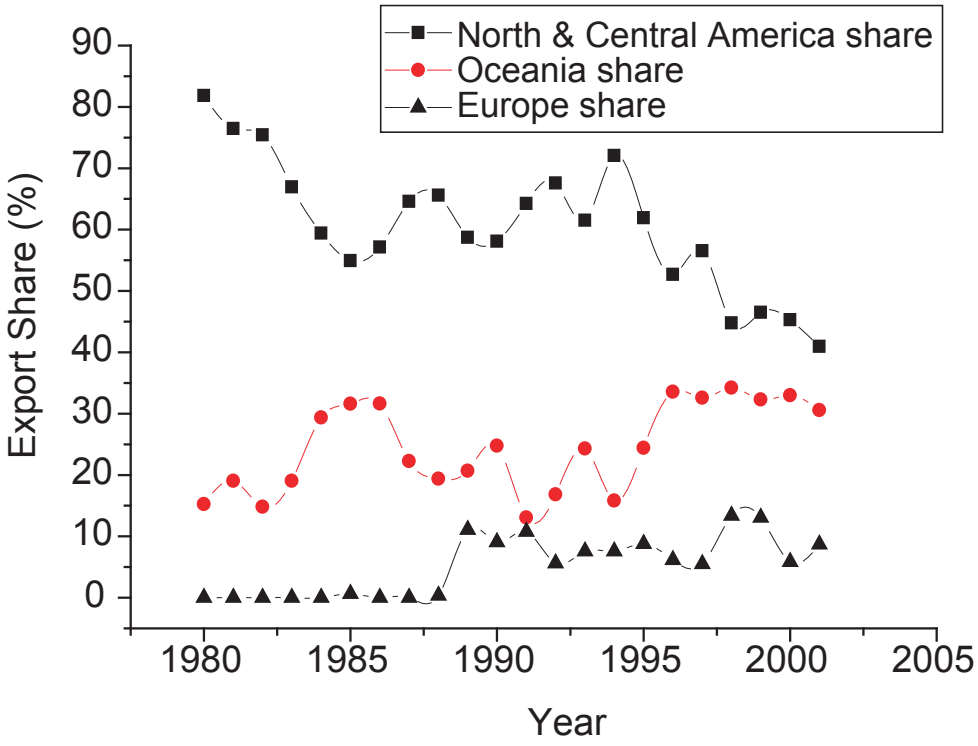


**Figure 19. Export Shares to Asia from Three Areas.**

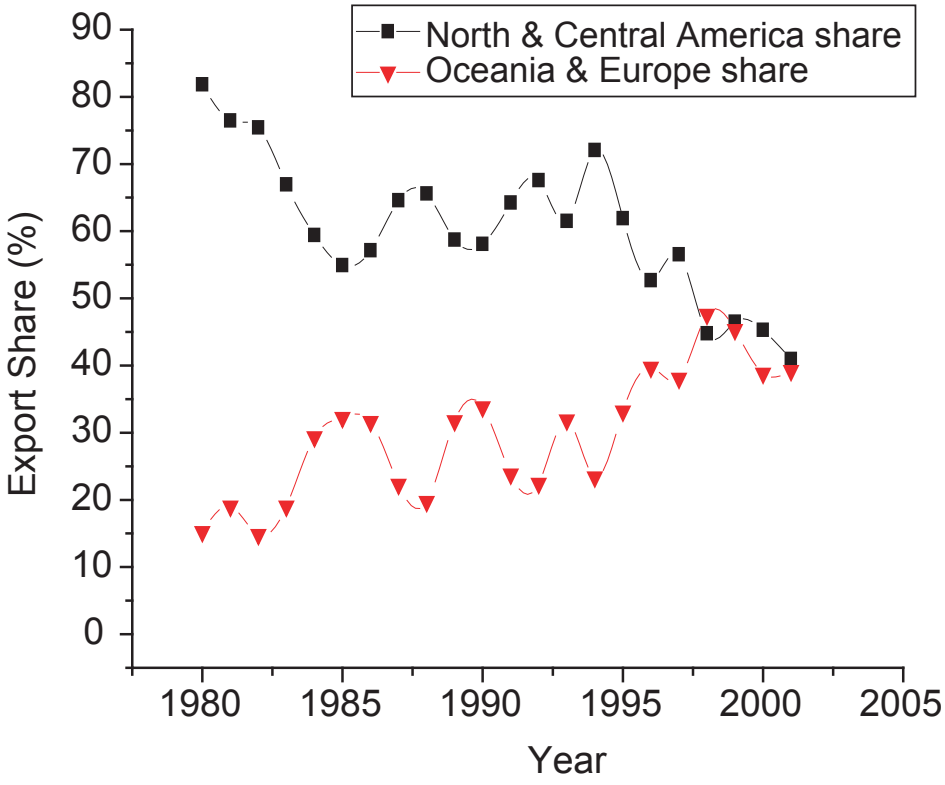


**Figure 20. Export Shares to Asia from Two Areas.**

America, Europe, and Oceania from 1980 to 2001, the result showed a strong negative correlation of –0.92 (Figure 21). A negative correlation also was seen for Africa (Figures 22–24). The export volume from Europe and Oceania increased when the export volume of North and Central America decreased. In other words, for the 20 years indicated above, while the market share of Europe and Oceania was increasing, the market share of North and Central America was decreasing. Although the world wheat market is influenced by all three areas, it is thought that the above statistics are directly related to the agricultural policies of North and Central America.

## Improvement of the Wheat Distribution System

The worldwide gross production of cereal grains increased by 2.3 times between 1961 and 2000, from about 900 million tons to 2,100 million tons, according to FAO statistics. This increase helped support the growing population. From 1961 to 2000, the average annual rate of increase for cereal production was about 2.1%, exceeding the population growth rate. Cereal production in the world increased faster than the marked increase in population during this period, so the per-capita amount of cereal production increased slightly as a result. The above statistics seem to imply that the growing population can be maintained by increased cereal production (Gilland 2002). However, according to FAO estimates, about 800 million people worldwide suffer from malnutrition. Maritime transportation to every continent must be increased in the future; meanwhile, wheat distribution must be improved.

## Conclusion

Wheat is the principal food for about half of the world's population. The supply of wheat is increasing with the increase in population. Through the above analysis, the results are summarized as follows:

1. Until now, although country-by-country predictions have been researched often, they are hard to estimate. This study deals with the wheat problem

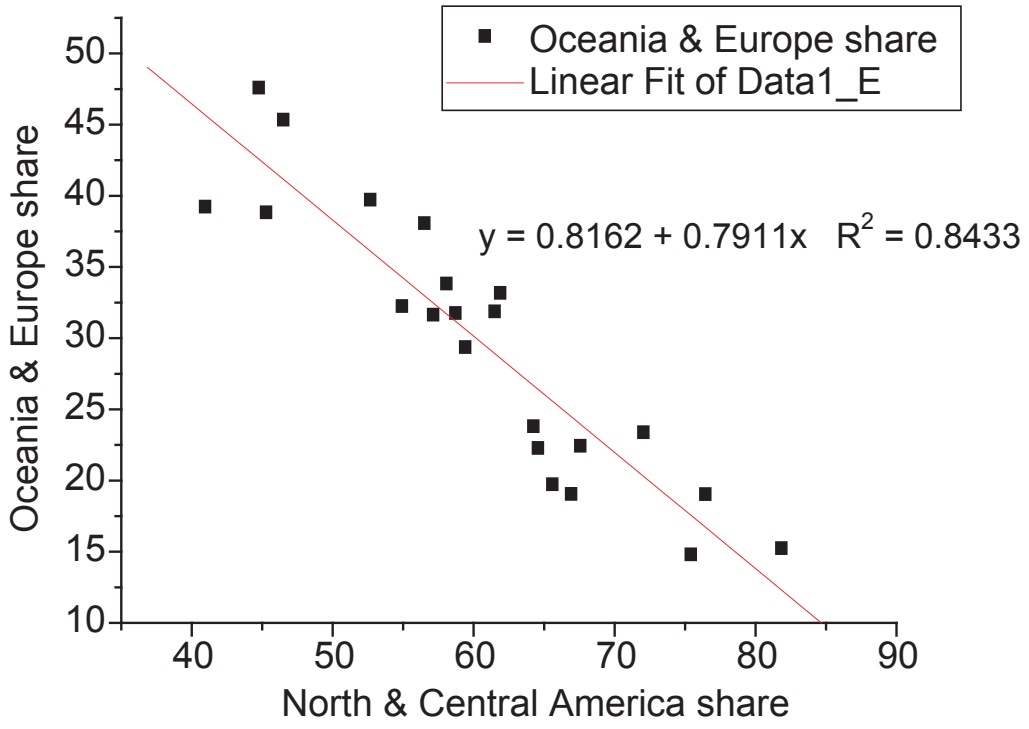


**Figure 21. Relation to Export Share in Asia.**

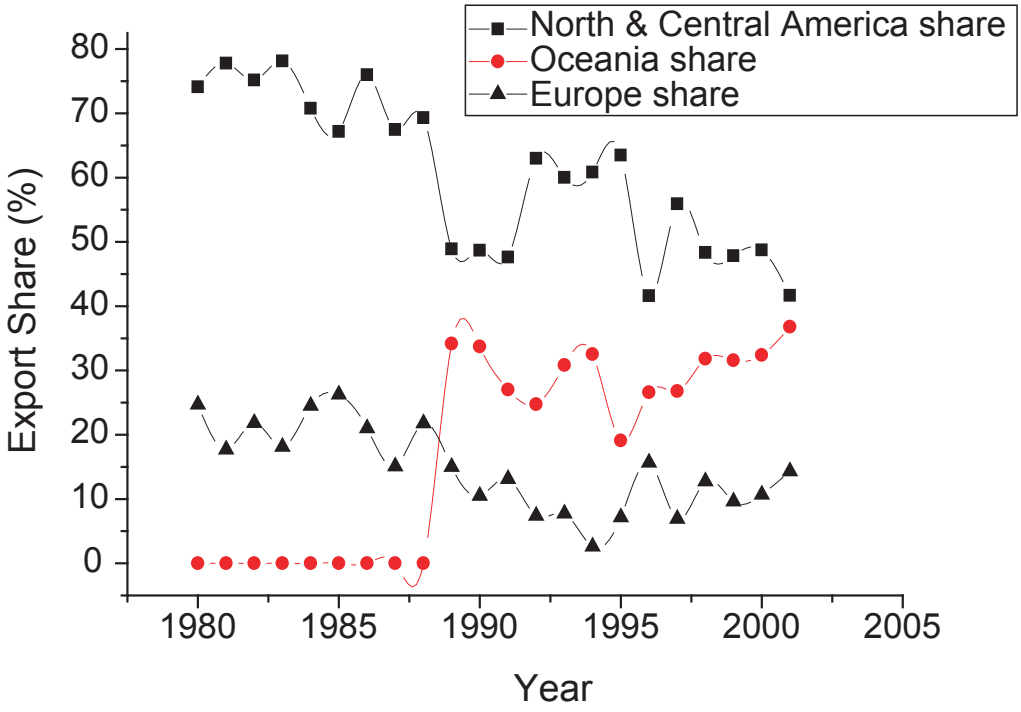


**Figure 22. Export Shares from Three Areas in Africa.**

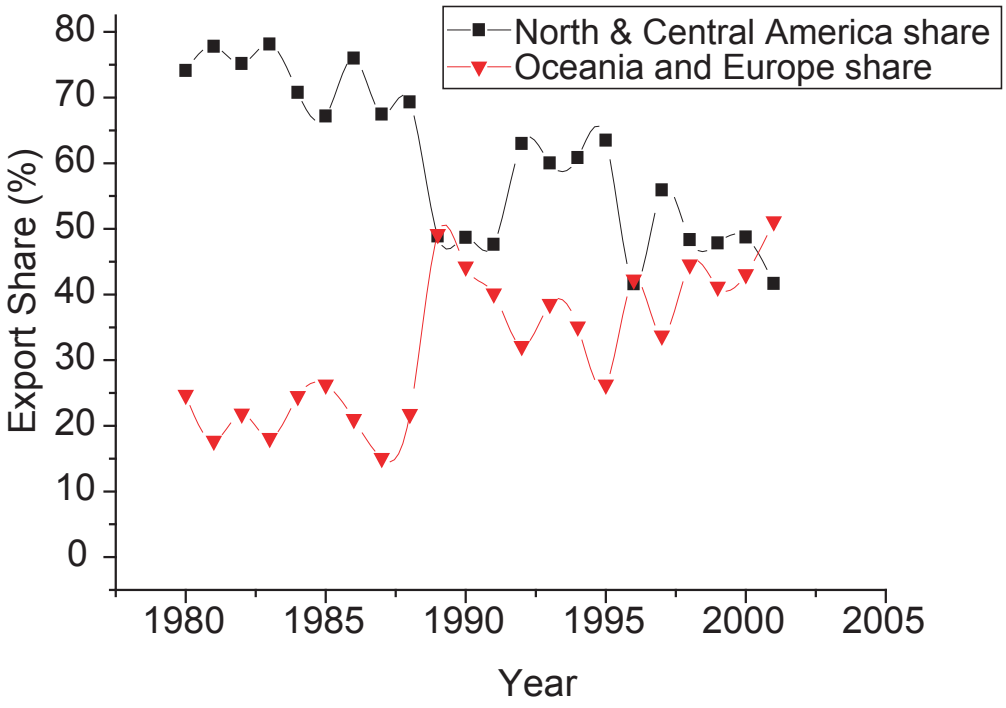


**Figure 23. Export Shares from Two Areas in Africa.**

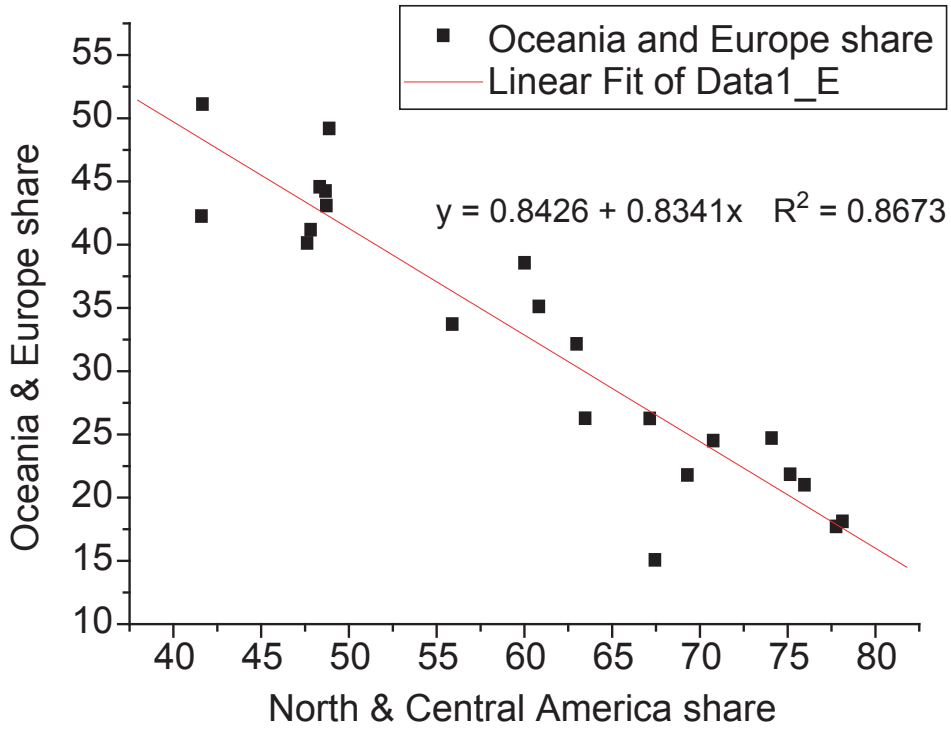


**Figure 24. Relative Shares of Exports to Africa.**

on a continent-by-continent basis, and good results were obtained. The accuracy of the model and the reliability of the results were high.

2. Using populations as a variable, we were able to estimate wheat production and supply. There was a high correlation between the difference in production and supply and the import volume (amount of wheat transported by sea).

3. A continental model of wheat production and supply with food shortages was built.

4. A negative correlation between surplus areas was obtained for the market share of wheat.

The wheat shortages in Asia and Africa are especially dependent on production in North and Central America, Oceania, and Europe. In order to solve the worldwide wheat-shortage problem, it is necessary for the UN to improve its food plan and to establish a new maritime grain-distribution system.

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