A Simulation Study of Domestic Rice Distribution Under New Japanese Food Law of 1994

MIKI Tatehiko, Professor, Dr.Eng.

Faculty of Management, Osaka Sangyo University

3-1-1 Nakagaito, Daitoh-shi, Osaka (Postal-code 574-8530)

TEL+81-72-875-3001 (ext4615) FAX +81-72-870-0664

Email miki@dis.osaka-sandai.ac.jp

URL http://www.dis.osaka-sandai.ac.jp/~miki

Abstract

The Japanese government has been developing policy in Japanese agriculture in a new international environment. A new Food Law, i.e., the Law Concerning the Stabilization of Supply, Demand and Price of Staple Food was passed in 1994. The old Food Control Law had been provided for all government control over the production, purchase and pricing of rice, but the new Law confines its role mainly to storage. On conditions that the government runs a projection for the supply and demand of rice to ensure the stabilization of supply and demand and to establish the price of rice and plan the smooth implementation of production adjustments and to coordinate a flexible stockpiling system to secure proper and smooth distribution, a simulation study was made to obtain a basic information about the operation of stockpiles and the amount of planned distribution of governmental purchases and imports. Assuming that rice is shipped through the voluntarily marketed rice channel or through government channels, a system dynamics model of the rice distribution was constructed. We reveal that our simulation greatly helps to understand and study that the voluntarily marketed distribution plan may be approved to maintain stockpiles and to withhold some rice from the market if necessary.

1. Introduction

In November 1995, the Law Concerning the Stabilization of Supply, Demand and Price of Staple Food (hereinafter referred to as the New Food Control Law) was enforced. As a result, the total control of rice by the government was relaxed to the

limited control, making the distribution of domestic rice easier. The characteristic in the control of rice distribution in Japan lies in the fact that the control is applied to not only the production of rice but also its stock, transport and sale because rice can be stored for a long time. First, let us describe the characteristics of rice distribution.

(1) In the distribution process of any commodity before it is handed over to its consumers, it is inevitable that the commodity is held in the process for a fixed period of time. Therefore, a distribution function in the broad sense always contains the storage function. Because the storage characteristic of rice is particularly strong, there exist the transport and storage functions as the means to adjust the temporal and spatial separations, indicating the importance of physical distribution function in rice distribution. That is, the main problem in modeling is what kind of main body, and at which points, will bear part of the roles of transport function and demand & supply adjustment. Special attention was paid in the modeling so that the following two points could be expressed:

(2) The characteristic of physical distribution function in the rice distribution of early date under the Old Food Control Law (1942) is the total control including the storage of domestic rice distributed throughout Japan by the government. The government also took charge of the transport of rice that was the scheduled transport based on the unified control. It imposed a big financial burden on the government and encouraged little competition among retailers as no serious competition in the transport of rice existed.

(3) In the rice distribution under the New Food Control Law, the change from the designation system to the registration system for an applicant who wanted to be a supplier of rice was made, more easily enabling such an applicant to become a supplier of rice.

Similarly, an applicant who wants to become a retailer of rice no longer needs to be approved by the government, in which the total number of retailers was limited, but onlyb required to register. In addition, respecting the self-initiative of rice producers, their supplying contract with more than one supplier was permitted, and the obligation for them to sell their rice to the government was abolished. That is, the minimum access system was introduced and the role of the government was confined to the storage of rice.

2. New Food Control Law and the distribution of rice

The simulation study of rice distribution in this paper is aimed at finding out

what kinds of changes will occur to the rice distribution or physical distribution before and after the introduction of the New Food Control Law. In the overall model structure, the storage characteristic of rice in the production sector is strong, which exists as the means to adjust the temporal and spatial separations as well as the transport function. Special attention was paid to the expression of the following two points in this modeling of rice distribution:

(1) The characteristic of rice distribution under the Old Food Control Law was the unified control of rice by the government that also bore the costs for the physical distribution of rice, resulting in little competition among retailers as no serious competition in the transport of rice existed.

(2) In the rice distribution under the New Food Control Law, the change from the designation system

to the registration system for an applicant who wanted to be a supplier of rice was made, and an applicant who wants to become a retailer of rice no longer needs to be approved by the government, but only required to register, increasing the number of distribution channels. To describe the changes in rice distribution that occur before and after the introduction of the New Food Control Law, the overall model structure is classified into three sectors - production, distribution and consumption sectors. The data used for this model are various kinds of statistical data regarding rice distribution collected for six years starting from 1989. The analytical method was the system dynamics (SD for short), which was a methodology to solve complex problems. Its basic concept is the analysis of dynamic characteristics of the cause-effect relationship loop. Only several decades have passed since the methodology of SD was introduced for the first time. Fundamentally, it is known that the method does not choose the type of computer language. In this study, F-BASIC and STELLA-II (Macintosh version) were used for the modeling. That is, in any of those phenomena, the law of causality like (1) cause => effect (principle) => result (phenomenon) can be observed. Conversely, it is also possible to examine the causality by tracking down the process like (2) observation data (result) => effect (principle) => cause. A problem that determines the output response for the input like (1) is the "forward problem." A problem set up from the viewpoint of (2) is the "inverse problem." To uantitatively analyze an inverse problem is known as the inverse analysis. This sort of idea is quite commonly utilized in many scientific methods.

Likewise, the fields where SD or one of the inverse analyses is applicable include

(1) problems that have systematic mutual relationships, (2) problems in which things in the past may affect things in the future, and (3) problems in which things that change with time draw attention. In the past, for example, there is a classic study (1922, [1]) regarding the impressive wave motion generated by the demand and supply as

in the circulation of pork between its supply and price. However, when the concept regarding the circulation of pork is attempted to apply for the circulation of rice, some problem arises in its modeling in respect to the following point. That is, it will be necessary to carefully examine the demand-supply characteristics (e.g. relationship between the dietary habit of Japanese and the flexibility of demand) and the supply characteristics (e.g. temporal gap in production adjustment).

Fig. 1 shows the SD model for rice distribution that was built in this study and used for analysis and part of the framework of SD simulation for a rice distribution model under the food control law. This figure was prepared by the authors based on the actual situation under the Old Food Control Law, which was comprised of the following sectors - the production of rice, change in population, distribution channel of rice and the stock. Among these sectors in the model, the sectors of the distribution channel of rice and the stock are the central cores. These are the main objectives to be examined in this study.

Rice distribution has been carried out according to the traditional distribution channel like:

producer => co-op => “Prefectural Economic Federation of Agricultural Cooperatives”(Keizairen) => “National Federation of Agricultural Co-operative Associations” (Zen-noh) => wholesaler => retailer => consumer.

Besides this channel, there are a number of different channels including the producer R consumer channel for unscheduled direct-deal rice. Those channels form today's rice distribution network. In this distribution network, there are five stock points - producers' stock, cargo collection dealers' stock, government's stock, wholesalers' stock and retailers' stock and the following eight main channels.

(1) Producer => cargo collection dealers' stock => government's stock =>
wholesalers' stock => retailers' stock => consumer

(2) Producer => cargo collection dealers' stock => wholesalers' stock => retailers' stock => consumer

(3) Producer => wholesalers' stock => retailers' stock => consumer

(4) Producer => retailers' stock => consumer

(5) Producer => consumer

(6) Producer => cargo collection dealers' stock => retailers' stock => consumer

(7) Producer => cargo collection dealers' stock => consumer

(8) Stock of imported rice => wholesalers' stock => retailers' stock => consumer

Because this study focused on the distribution channel and the stock, various other factors have been omitted. In other words, it was thought important that the expression using a relatively simple model was able to explain the actual changes to some extent. In this SD model, there exist several feedbacks of clear causal chains, inducing an extremely complex behavior. Among those feedbacks, the following three are the main feedback loops.

(1) Retailers' stock => total stock => excessive stock => farm price => farmer decreasing rate => number of farmers => area under cultivation => producers' stock increasing rate => producers' stock => cargo collection dealers' stock => wholesalers' stock R retailers' stock (negative feedback loop, refer to Fig. 1).

(2) Retailers' stock => total stock => excessive stock => price of foreign rice being distributed => retail price => retailers' stock decreasing rate => retailers' stock (negative feedback loop)

(3) Retailers' stock => total stock => excessive stock => farm price => farm price & cultivation area increasing rate multiplier => farmer increasing rate => number of farmers => area under cultivation => producers' stock increasing rate => producers' stock & changing rate in the stock of rice directly from farm => retailers' stock decreasing rate => retailers' stock (positive feedback loop)

3. SD simulation analysis and the discussion

In this chapter, noticing the changes in rice distribution before and after the enforcement of the New

Food Control Law, the SD simulation analysis and the discussion about the result will be carried out. In the section below, the system before and after the enforcement of the New Food Control Law will be called "Old Institution" and "New Institution", respectively, for the sake of convenience. Assuming that the New Food Control Law would be enforced in the 10th year after the start of the simulation, the system was set up so that five new channels corresponding to the new bases for rice distribution and the diversification of marketing outlet would be included. As a result, with the enforcement of the New Food Control Law a distinct change in the distribution amount of rice due to the diversification in the channel of rice distribution took place. The following figures show the changes over the past 20 years. That is, Fig. 2 shows the change in the stock of rice under the New and Old Institutions while Figs. 3 and 4 show the changes in the distribution amount of rice through the distribution channels under the New and Old Institutions.

In short, with the enforcement of the New Food Control Law, the market mechanism was introduced into the existing rice distribution system, with which the control of rice was shifted from the unified control by the government to the multidimensional control by the government and merchants. This contributed to the stable supply of rice and the production and supply of rice capable of meeting the needs of consumers. Because this study focused on the distribution channel of rice and its stock, various other factors have been omitted. However, the model shown here can explain the actual changes to some extent. As shown in Fig. 1, the existence of feedback loops that pass through the entire system is considered to be clearly indicating that the comprehensive control of rice including the import of rice is essential under the New Food Control Law. In addition, it was found that the analytical results in the simulation of rice distribution systems under the New and Old Food Control Laws could prove the content described in Chapter 2 to some extent and express the main characteristics of physical distribution function technically.

1) Change in the stock of rice under the New and Old Institutions (Fig. 2: producers' stock, etc.) In the role of the government's stock, emphasis is placed on the stockpile of rice. Considering that 1.50 million tons of rice per year are the standard stockpile, the combined amount of the governmental and nongovernmental stockpiles is stored. As shown in Fig. 2, it is considered under the New Food Control Law that a yearly stock of about 1.50 million tons of rice or the combined amount of JA's and the government's stocks will be able to fulfill the governmental target.

2) Change in the distribution amount of rice (Figs. 3 and 4) With the enforcement of the New Food Control Law, some change began to occur in terms of not only the channel of rice distribution but also the distribution amount of rice in the individual channel. As is apparent from Figs. 3 and 4 that show the distribution amount of rice in the producer R wholesaler channel, etc. and in the cargo

collection dealer R retailer channel, etc., respectively, the distribution amount of rice from the cargo collection dealers' stock to the government's stock has markedly decreased under the New Institution. This is indicating the following changes. Namely, the rice distribution route as shown in Fig. 1 changed to some new routes such as those for voluntarily marketed rice and the rice directly from farm under the New Institution. At the same time, under the New Food Control Law the control of the distribution of rice was transferred to the private sector from the government as a result of deregulation so that more traders that were private could take charge of rice distribution business. The change in the demand and supply of rice during this period is shown in Fig. 5 (Change and the forecast in the demand and supply of rice in 1970 - 20102)) In this SD model, on the assumption that the New Food Control Law would be enforced in the 10th year after the start of the simulation (November 1995), some new rice distribution bases were added to the model. Additionally, the system of the model was set up so that five new channels corresponding to the diversification of marketing outlet were included. As a result, in the 10th year and later after the start of the simulation, a drastic change in the distribution amount of rice as well as in the government's and wholesalers' stock (Graphs 3 and 4 in Fig. 2) has occurred. That is, it is possible to read the beginning of the import of foreign rice (Graph 3 in Fig. 3), its inflow into the government's stock (Graph 4 in Fig. 4), and the flow from the cargo collection dealers' stock to the retailers' stock (Graph 1 in Fig. 4). Besides these, it is also possible to read some other drastic changes. As shown in Fig. 3, the wholesalers' and retailers' stocks have increased under the New Institution compared with those under the Old Food Control Law. This is explaining that the stock of rice was totally controlled by the government under the Old Food Control Law but the pattern of rice storage was diversified under the New Institution. That is, there are many different kinds of stock points including the stock in commercial warehouses, stock of rice dealers and the stock of transporters as the main stock points. In the future, the commercial capital of wholesalers and retailers will control the stock of rice. FAO (Food and Agriculture Organization of UN) has set up a rough standard of inventory ratio (between the amount of stock and the total amount of consumption). As the safe stock level, it gives an inventory ratio of 17 - 18 percent and 14 – 15 percent to all cereals and the rice, respectively. According to the material released by the Department of Agriculture of the United States, meanwhile, the stock level of all cereals in 1994 and 1995 was 16.6 percent.

3) Minimum access

Under the Agreement on Agriculture of Uruguay Round (December 15, 1993), the tariff on the rice is suspended for six years by special provision. Meanwhile, the amount of rice equivalent to 4 - 8 percent of the domestic consumption (a gradual increase from about 80,000 to 800,000 tons) will be imported as the minimum access. This model describes the above-mentioned situation. However, it is important to carefully watch how far the imported rice will take the domestic market in the future.

In short, with the enforcement of the New Food Control Law the market mechanism is introduced into the existing rice distribution system, with which the control of rice is shifted from the unified control by the government to the multidimensional control by the government and merchants. This contributes to the stable supply of rice and the production and supply of rice capable of meeting the needs of consumers. Thus, it will be realized again that the comprehensive control of rice including the import of rice is essential under the New Food Control Law. That is, under the New Food Control Law the stocking pattern of rice changes to the merchant-type stock from the government-oriented stock, making the transport of rice more complicated. For example, the introduction of the two-stage, three-stage and inverse transport systems will improve the economic aspect of rice distribution in their own way. On the other hand, the competition among the retailers of rice becomes fiercer, further promoting the diversification of rice distribution route.

Here, it is necessary to reexamine the physical distribution function of rice from the viewpoint of the efficiency improvement of distribution system. It was found that to understand this point was very important for not only retailers but also the government.

4. Conclusion

In this paper, the distribution of rice under the New Food Control Law and the physical distribution were studied by simulation from the viewpoint of the physical distribution that has received the changes of distribution system by the Food Control Law of Japan. Especially regarding the control of rice, it was necessary to deal with the stock, transport and sale of rice as well as its production as the important elements due to the particularity of rice.

The general conclusions thus obtained are as follows:

1) With the proposed SD model, several feedback loops were found in the causal chains. That is, they were the following two negative feedback loops and one positive feedback loop.

Retailers' stock => total stock => excessive stock => (omission of the intermediate stocks) => retailers' stock (negative);

Retailers' stock => total stock => (omission of the intermediate stocks) => retailers' stock decreasing rate => retailers' stock (positive).

2) In rice distribution under the New Food Control Law, the change from the designation system to the registration system for an applicant who wanted to be a supplier of rice was made, the minimum access was introduced and the main role to be played by the government changed to the stockpiling of rice. It became possible to describe the general trend of these situations by simulation.

3) From the analysis of rice distribution by simulation, it was realized again that the comprehensive control of rice including the import of rice is essential under the New Food Control Law due to the change in the amount of stock under the New and Old Food Control Laws. That is, under the New Food Control Law the stocking pattern of rice changes to the merchant-type stock from the

government-oriented stock, making the transport of rice more complicated. For example, the introduction of the two-stage, three-stage and inverse transport systems will contribute to the economic rationality of rice distribution in their own way. As a result, the competition among the retailers of rice becomes fiercer, further promoting the diversification of rice distribution route.

For this reason, it became possible to prepare a useful SD model capable of making it possible to re-realize the physical distribution function of rice from the viewpoint of the efficiency improvement of distribution system.

4) This dynamic analysis of domestic rice distribution problem through a model of a production-distribution system that shows oscillatory behavior. Production scheduling and farmer force management policies generate the 3-5 year business cycle. Economic cycles are caused by capital investment policies that fail to account for delays in acquiring long-lead time plant as rice. Some of the model validity was improved through partial model testing.

The problem to be solved in the future is to determine the appropriate stocking level of rice. This is also important to keep the level of imported rice at a low level.

Though the amount of imported rice is relatively small, it closely links to the global demand-supply relationship of food. Therefore, the distribution of rice should be considered as part of the global food production. The change in population dynamics on earth will significantly affect the agricultural policy for rice.

Reference

[1] Hanau: Die Prognose der Schweinepreise, Vierteljahresheft zur Konjunkturforshung, sonderheft 2. in p.92 of “Tinbergen & Polak: Dynamics of Business Cycles, 1922”.

[2] T. Arata et al: Plan for Food Reserve Base in a Cold Region Port, Cold Region Port and Harbor Engineering Research Center,
http://lib1.nippon-foundation.or.jp/1996/0646/contents/445.htm

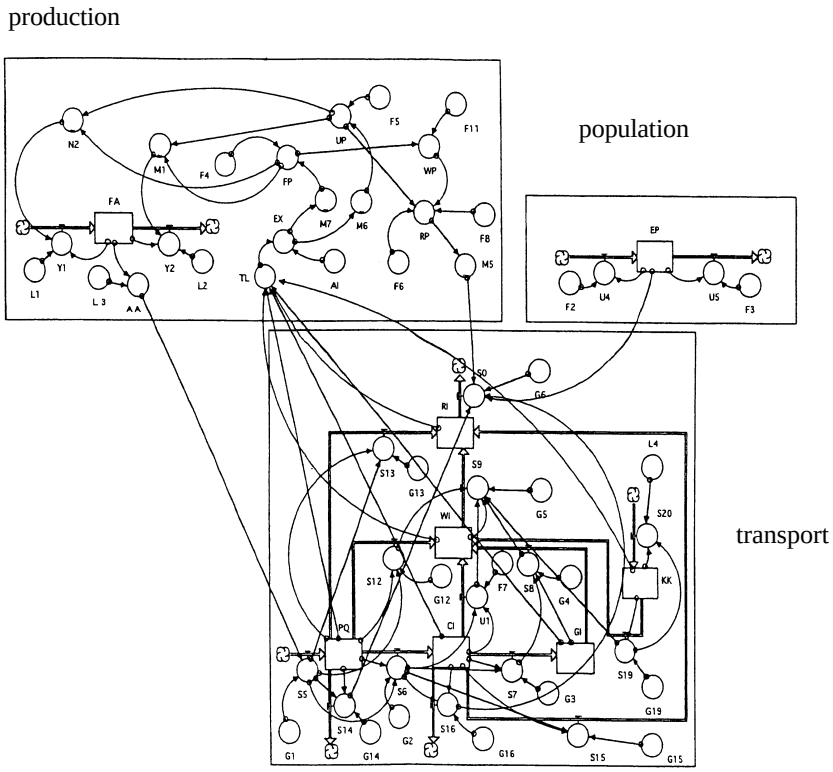


Fig1. A system dynamics model for rice distribution (in Stella)

Productions sector(upper left),Consumption sector (upper right),distribution sector(lower)

EP: population

U4: population increasing rate

U5: population decreasing rate

F2: population increasing rate multiplier

F3: population decreasing rate multiplier

FA: number of farmers

Y1: farmers increasing rate multiplier

Y2: farmers decreasing rate multiplier

L1: farmers increasing rate

L2: farmers decreasing rate

AA: area under cultivation

AI: desirable amount of stock

EX: excessive stock

rate multiplier

L3:average are aunder cultivation

F4: desired farm price

F5: average rice price distributed

TL: total stock

FP: farm price

WP: wholesaler price

UP: price of foreign rice being distributed

RP: retail price

M1: farm price & cultivation area decreasing rate

multiplier

N2: retail price & consumption rate multiplier

M5: farm price & cultivation area decreasing rate

multiplier

N6: excessive stock price & farm price rate

multiplier

M7: excessive stock price & farm price

S14: producer's stock & retailer's stock transfer

rate

S15: dealer's stock & retailers stock transfer

rate

F6: fraction of retail price
F8: fraction of rice price distributed
F11:average retail rice price
PQ: producer's stock
CI: cargo collection dealer's stock
GI: government's stock
WI: wholesalers' stock
RI: retailer's stock
KK: stock of import rice
S5: producer's stock increasing rate
S6: producer's stock & dealer's stock transfer rate
S7: dealer's stock & govern transfer rate
S0: retailer's stock decreasing rate
S12: producer's stock & wholesaler's stock transfer rate
S13: producer's stock & retailer's stock transfer rate
S16: dealer's stock & retailers stock transfer rate
S19: importer's stock & wholesaler's stock transfer rate
S20: foreign trader's stock & importer's stock transfer rate
G1: annual yield per hectare
G2: G13: G19
G3: G14: F7:
G4: G15:
G16:inventory transfer rate multiplier
G6: annual consumption per capita
L4:increasing rate of imported rice

rate multiplier
L3:average are aunder cultivation
F4: desired farm price
F5: average rice price distributed
F6: fraction of retail price
F8: fraction of rice price distributed
F11:average retail rice price
PQ: producer's stock
CI: cargo collection dealer's stock
GI: government's stock
WI: wholesalers' stock
RI: retailer's stock
KK: stock of import rice
S5: producer's stock increasing rate
S6: producer's stock & dealer's stock transfer rate
S7: dealer's stock & govern transfer rate
S0: retailer's stock decreasing rate
S12: producer's stock & wholesaler's stock transfer rate
S13: producer's stock & retailer's stock transfer rate
S14: producer's stock & retailer's stock transfer rate
S15: dealer's stock & retailers stock transfer rate
S16: dealer's stock & retailers stock transfer rate
S19: importer's stock & wholesaler's stock transfer rate
S20: foreign trader's stock & importer's stock transfer rate
G1: annual yield per hectare
G2: G13: G19
G3: G14: F7:
G4: G15:
G16:inventory transfer rate multiplier
G6: annual consumption per capita
L4:increasing rate of imported rice

Fig.2 rice inventory of old & new stages

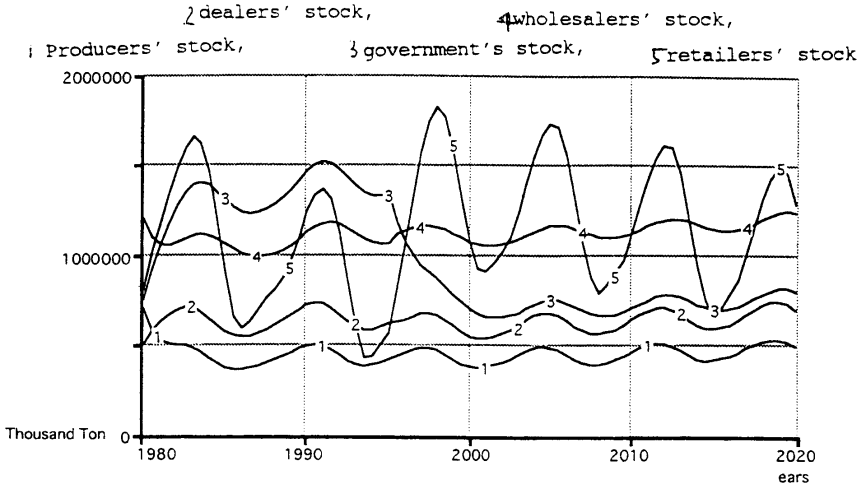


Fig.3(a) rice distribution in major channel in old & new stage

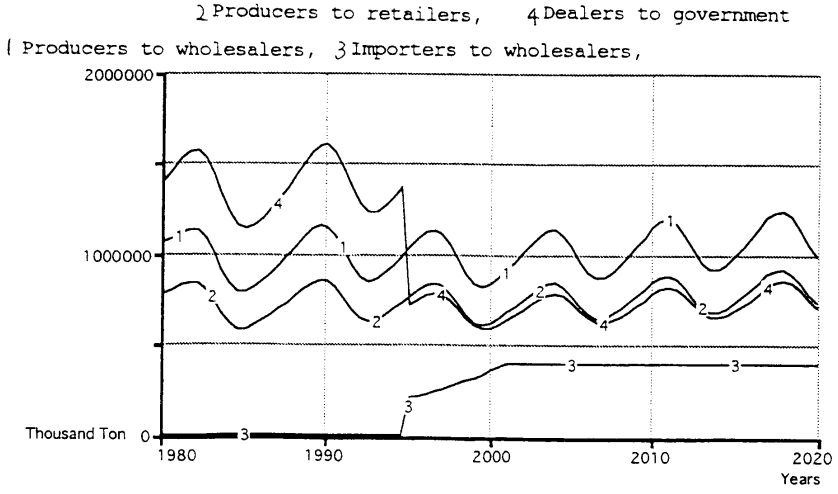
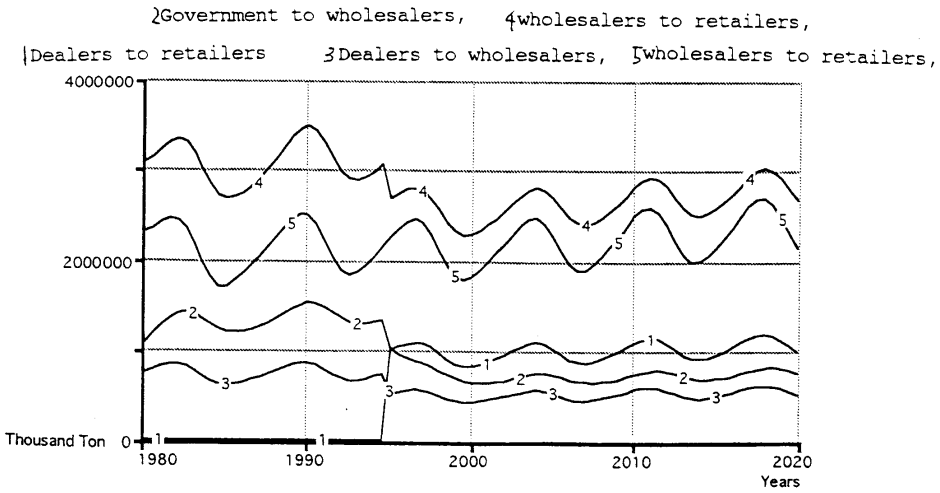


Fig.3(b) rice distribution in major channel
in old & new stage



Back to the Top