RICE CROP PRODUCTION POLICIES AND FOOD SUPPLY IN BANGLADESH

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Abstract

This paper examines the roles of food producers, population and the government on the present availability of food in Bangladesh. The study employs a system dynamics model of the population-food-production system for its analysis. This model incorporates mechanisms of production and consumption of food, and population growth. Government policies are considered exogenously. The analysis suggests that, due to the presence of a feedback relationship between food availibility and population growth, any policy for improving food supply cannot be considered independently of time. In the long run, none of the policies tested alleviates the food shortage, although in the short and intermediate runs, agricultural development and population control policies may improve food consumption per capita. The paper thus seriously questions the rationale of agricultural development policies aimed at increasing food production. However, since many food surplus countries support small populations which are also growing at slow rates, points of entry for policies that effectively alleviate the food shortage should exist. Thus, food policy models for the developing countries should aim at identifying such entry points into the system instead of attempting to increase the food supply.

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1. INTRODUCTION

Food shortage is a chronic problem in Bangladesh in spite of its government's concerted efforts to boost domestic food production. Over the past 20 years the domestic food supply has nearly doubled, but, due to the accompanying growth in population, the country has to continue importing over 1.5 million tons of food grain every year which are needed for providing a bare minimum level of nutrition to the population. Even so, half the population has a deficient caloric intake and more than 80 percent are deficient in important nutrients (1).

Bangladesh has a land area of 143,998 square km and an estimated population of 83 million. Although most of the country's labor force is engaged in agriculture, the total cultivable area is only a little over 9 million hectares. Rice is the main crop as well as the staple food and 77 percent of the cultivable land is under rice crop (2,3). The main rice crop, called "Aman", is harvested between October and December and yields about 7 million tons of rice. Two minor rice crops called "Boro" and "Aus" are harvested between April and July and give an additional yield of 3 million tons each. Approximately 10 percent of the production goes to seeds and damages (4,5).

Bangladesh experienced a food deficit of about half a million tons in the mid 1950s. This deficit rose to 1.5 million tons by the late 1960's and to 2.5 million tons by the late seventies. The rising food deficits apparently occured because of a high population growth rate (over 2.6 percent per year) which far exceeded the growth in food production (2.1 percent per year) (6). The slow growth in food production is mainly attributed to the inability to expand the land area under rice cultivation, inadequate distribution of improved seed varieties, low levels of fertilizer and pesticide application, unsuitable mechanization programs, poor organization of irrigiation schemes, and vulnerability to droughts and floods (7,8). With the recent development of new high-yield varieties of rice and the establishment of two fertilizer factories, the government hopes to increase rice production substantially so as to achieve self-sufficiency in food which is defined by the government as 166 kg per year per person from domestic production (9). Indeed, as shown in Table 1, the emphasis on agriculture has appreciably increased in the five year plans formulated after 1975 (10,11).

Years	Expenditures for Agricultural development (million Taka)
1973 - 74	359
1977 - 78	1581
1978- 79	2033
1979 - 80	2339

Table 1: Agricultural Developement Expenditures in Bangladesh

The food shortages of Bangladesh have attracted world-wide attention over the past few years which has led to several aid programs aimed at increasing indigenous rice production as well

as at increasing the food supply through direct imports. The food shortages have, nevertheless, persisted.

This paper examines the efficacy of the food supply policies of Bangladesh which have been implemented in the past. A system Dynamics Model of the population-food-production system is used as the vehicle of analysis. Simulations with this model show that the effectiveness of a food production policy cannot be viewed independently of the time horizon of an analysis. In the presence of a positive causal relationship between food availibilty and population growth rate in animal and human populations, which is generally recognized in anthropology, any increase in food supply will, in the long run, be off set by a corresponding increase in population. Thus, serious doubts arise about the wisdom of implementing policies directly aimed at increasing the aggregate food supply for achieving self-sufficiency in food.

Seemingly the solution to the food shortage problem lies neither in increasing food producion and imports, nor in limiting population growth rate. In the long run, both these policies would fail to alleviate the food shortage because of the dominance of the system pressures which strive to achieve complementarity between population and food supply. However, since many developed countries supporting small populations which are growing at slow rates have a food surplus, points of entry into the social organization of the food deficit countries should exist for policies that may cause a lasting change in food availability. Thus, serious rethinking is needed for designing food policies for food-short countries like Bangladesh.

2. A SYSTEM DYNAMICS MODEL OF POPULATION-FOOD-PRODUCTION SYSTEM

The model of the population-food-production system is developed in two parts. The first part incorporates the major feed-back loops which affect the behavior of the system. In the second part, policies for irrigation, and for the application of fertilizer and pesticides are translated into potential production which drives the production rate in the first part. The second part of the model is not necessary for arriving at the qualitative conclusions of the paper, although, it is useful for interacting with an audience who might be concerned with a realistic translation of the various policy options into variables of the model (12). Technical details of the model and a machine readable listing are available from the authors on request.

Figure 1 shows the causal structure of the population-food-production system. In the absence of any effort towards agricultural development, food production will rise whenever food prices are increased. An increasing food production builds up a food stock which, in turn, depresses prices. Food production also rises when more labor is available per hectare of land. Assuming that the agricultural labor force is a constant fraction of the population, an increase in population will cause an increase in the agricultural labor force. The population rises

when the birth rate rises or when the death rate declines. The birth rate is increased when per capita consumption rises. This can occur when food prices fall. However, the birth rate wil be depressed when more cash is available to a household for spending on education and health-care. Such expenditures would also increase life expectancy and thus depress the death rate. The cash earnings of a family rise as a higher price is offered for the crop but are depressed when more of the crop is consumed by the household instead of being sold in the market.

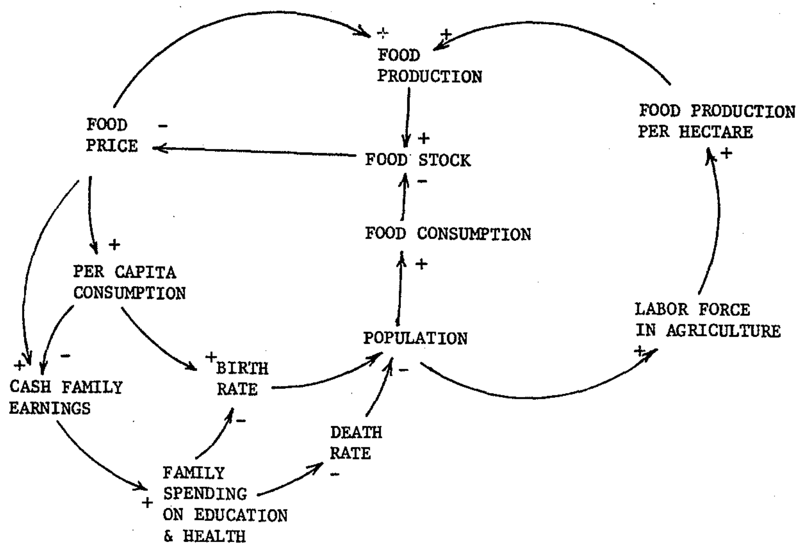

Figure 1: Simplified Causal Structure of the Population-Food-Production System

The causal relationships illustrated in figure 1 create 6 major negative feed-back loops shown in figure 2. These feed-back loops should tend to resist any changes in the food supply position. It is interesting to note that only two of these feed-back loops, labeled A and B, function independently of the population. These incorporate the relatively simple responses of the producers and the consumers to prices. However, in the pressence of a relatively inelastic consumption pattern and finite food production resources, the major changes in food stock occur because of changes in food consumption, which depend largely on population -- a key variable in the remaining negative and positive feed-back loops. Thus policies based on short term price adjustment models may be expected to be ineffective in the long run over which the latter set of feedback loops exercise dominant roles.

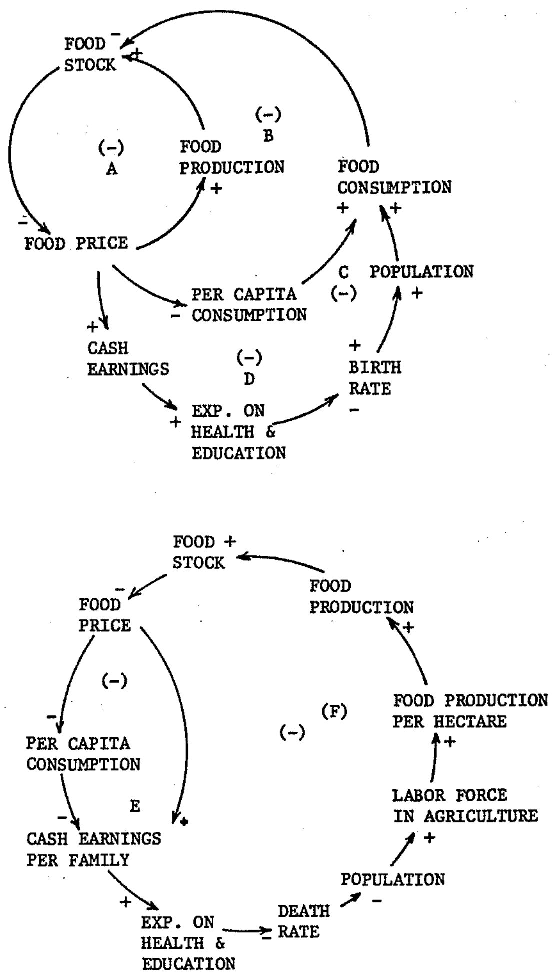

Figure 2: Control Mechanisms in the Population-Food-Production System

The major positive feedback loops in the system are shown in figure 3. These loops indicate that any growth in food stock will be concomitant with a growth in population while the ultimate limits to growth are imposed by the land resources available for agriculture.

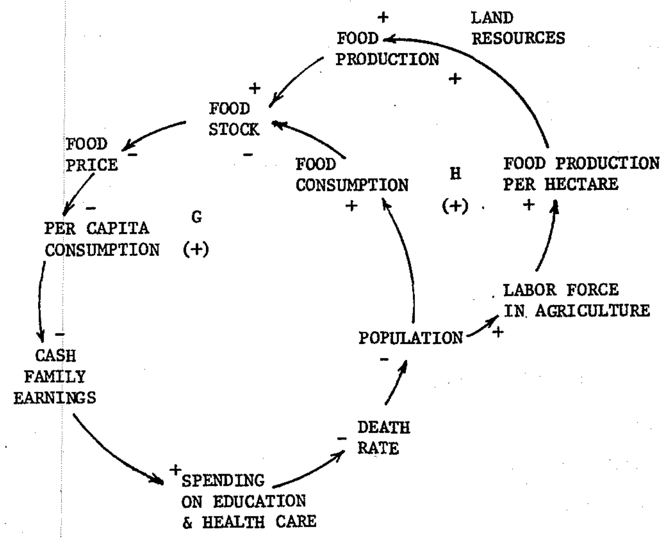

Figure 3: Growth Mechanisms in the Population-Food-Production System

There are no significant feedbacks in the second part of the model which translates the various food production policies into their effect on potential production. The structure of this part of the model introduces realism into the policies tested. Since many types of agricultural land are available, when the coverage of a policy expands, its application will be extended to relatively less productive land tracts. Thus, increases in potential production caused by a policy may vary over time. An irrigation expansion program may at first yield large increases in production as a high quality fertilized area is irrigated, but the incremental changes in yield may decline as marginal lands are brought under irrigation. Similarly, fertlizer application may lead to substantial gains in production at first when fertilizer is applied to high quality irrigated land, and to relatively lower gains when, having exhausted high quality land, the application is extended to low quality land.

The irrigation policy enters the model as additional hectares of irrigated land. Similarly the fertilizer application policy enters the model as additional hectares of land to which fertilizer is applied. The latter policy, however, assumes that an optimum fertilizer mix is used as recommended by Bangladesh Rice Research Institute (13). The yield response of fertilizer application for the various land types is based on data published by the Bangladesh Bureau of Statistics (14,15), and is calculated using stepwise multiple linear regression.

The policy translation mechanisms of the model first ascertain the quantity of each type of land affected by an agricultural promotion program and then calculate the net effect on crop production of the accumulative effort made to date. Figure 4 illustrates the selection process for the irrigation and fertilizer application programs. Pest control and drought control programs are assumed to affect yield uniformly irrespective of the land type.

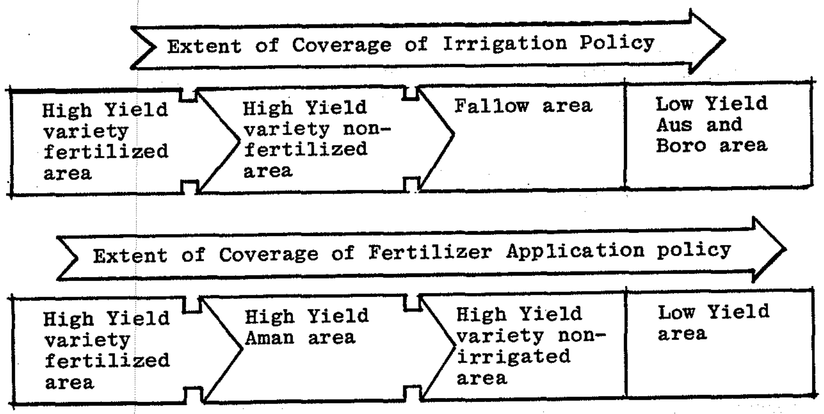

Figure 4: Crop land affected by expansion in irrigation and fertilizer application

3. MODEL BEHAVIOR AND IMPLICATIONS FOR THE RICE CROP PRODUCTION POLICIES OF BANGLADESH

The model is initialized with 1960 conditions. It also contains agricultural development policies implemented between

1960 and 1980. In 1960, fertilizer application covered only half a million acres, high yield variety seed was practically unknown, and no special effort was being made to control pests and droughts. Also, irrigation programs extended irrigation water to only 10,000 additional hectares per year which barely replaced the deteriorating irrigation facilities. The irrigation programs were intensified in 1965 when high-yield varieties of rice, which demand a constant water supply, were introduced. The number of additional hectares irrigated thus increased to 40,000. Fertilizer use was also extended to an additional 700,000 hectares in 1972 making the total area under fertilizer application equal to 1.2 million hectares. No major policy changes occured thereafter. These measures considerably increased rice production over the 1970s although food deficits, which led to food imports, continued.

The base simulation run of the model contains the policies stated above which are continued thereafter. Food imports are not allowed after 1980 in this run. Subsequent simulation runs introduce additional policies after 1980. Figure 5 shows the base simulation run. The equilibrium sought by the system incorporates a low per capita consumption and a high level of population, as was anticipated in section 2. Because of the concomitant growth of food supply and population, the short-term market-clearing mechanism relating price to production does not lead to a sustained increase in food availability.

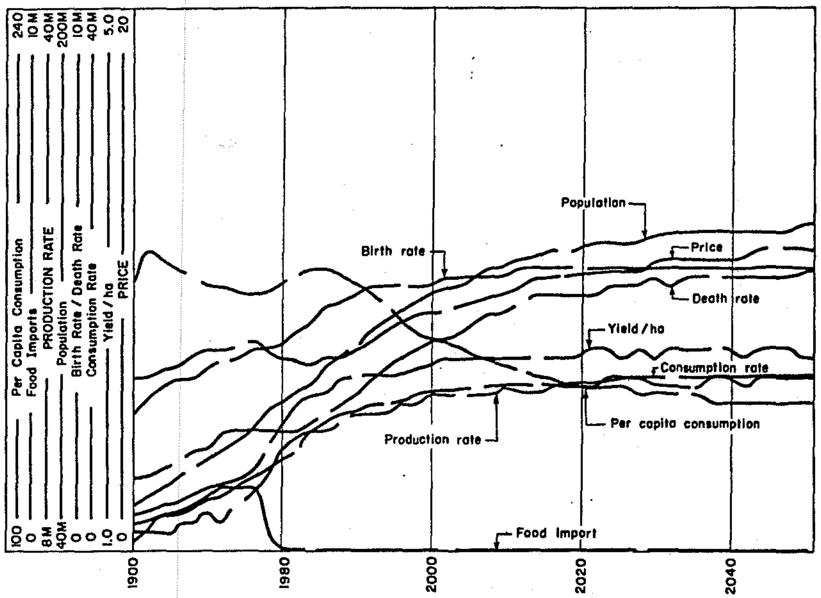

Figure 5 Base simulation run

The behavior of the model in the long run appears to be dominated by the positive feed-back loops of figure 3, which cause complementary growth in population and food stock, with the long term negative feed-backs relating food stock and population causing some restraint in growth. The growth is ultimately limited by the food production capacity.

In such a system, even very aggressive food production policies may only temporarily improve per capita consumption as indicated in the simulation of figure 6. This simulation incorporates the expansion of the high-yield variety area, as well as expansion in fertilizer application, pest and drought control, and irrigation. As in the previous simulation, food imports after 1980 are not allowed.

The system seeks an equilibrium at a higher level of population than before, which is again determined by production capacity. However, this equilibrium also incorporates a low per capita consumption and perpetuation of the food shortage.

The allowing of food imports increases food availibility slightly as shown in the simulation of Figure 7, although the equilibrium level now sought by the population is higher than in figure 6. This would ultimately lower food consumption per capita, as food production rate does not rise to a higher level than before. Thus, a substantial amount of food has to be imported to support the additional population towards the ends of the simulation.

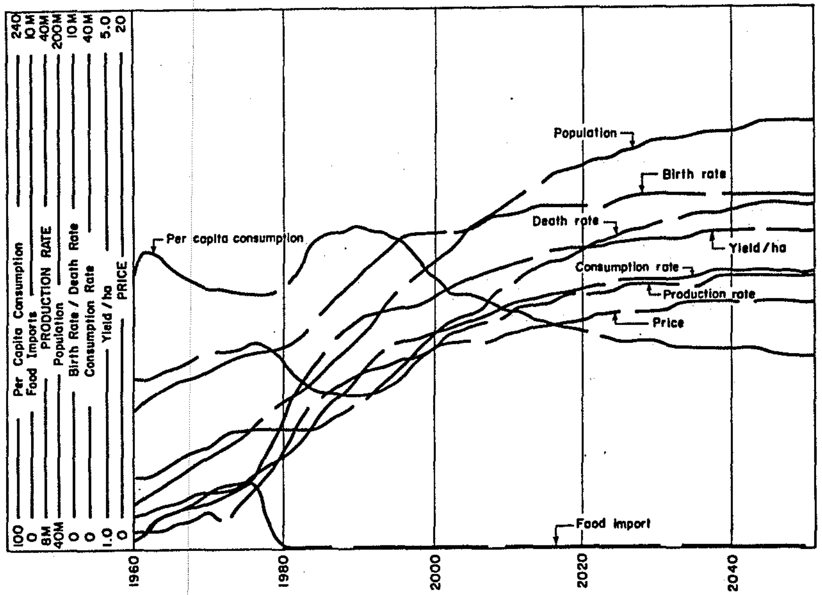

Figure 6 Simulation with large scale Agricultural development after 1980, no food imports

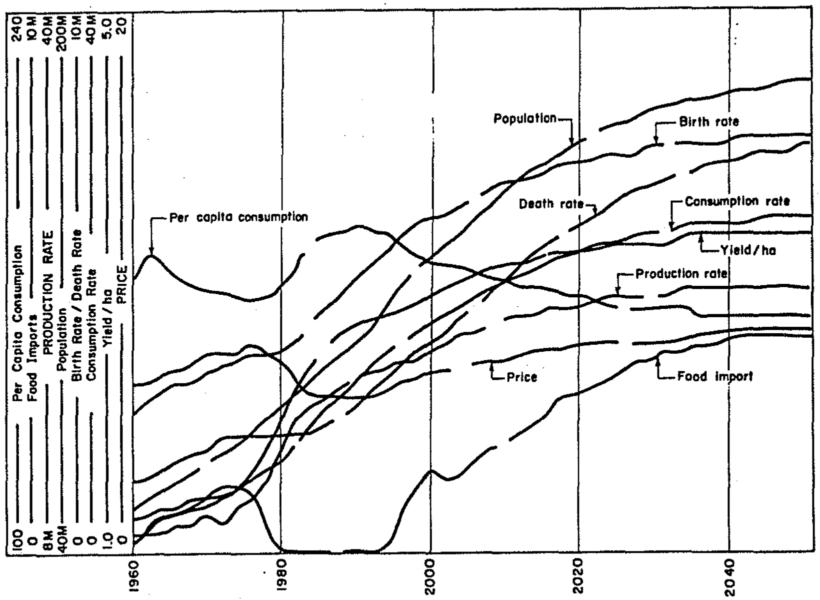

Figure 7 Simulation with large scale Agricultural development after 1980, with food imports

Population control policies implemented simultaneously with food production policies may not be expected to cause any change in the internal tendency of the system. A birth control policy can be simulated by reducing the birth rate normal. The birth rate, however, soon rises again when food availability rises. Thus, population with birth control may rise almost as fast as without birth control. This can be established by implementing a birth control policy in the simulations made so far and comparing them with the simulations without birth control. Table 2 compares the end condition of the key variables in the two sets of simulations. The birth control policies are introduced in 1990. Although food consumption per capita is higher and population is lower with birth control than without, the end conditions shown are farther away from equilibrium in the former. Thus, birth control policies may only temporarily improve food availibility.

Simulation	2050 condition with Birth control policy			2050 condition without Birth control policy		
	POP	PROD	PCC	POP	PROD	PCC
Base case (figure 5)	122.02	17.391	147.81	134.66	18.033	137.31
Aggresive food production/ no Imports (figure 6)	153.08	23.613	159.33	178.00	23.54	132.5
Aggresive food production/ with import (figure 7)	159.85	23.390	165.68	165.34	23.992	149.89

POP: Population (millions); PROD: Production (million metric tons/year); PCC: Per capita consumption (Kg/person/year)

Table 2 : Comparison of End conditions of Simulation with and without Birth Control

4. CONCLUSION

The analysis of this paper does not identify any policies which should effectively alleviate the food shortage in Bangladesh in the foreseeable future. The paper, however, raises several practical and ethical issues about the design of agricultural development policies and about humanitarian concerns leading to aid in the development of food resources of a food deficit country (16). It may be argued that the characteristic behavior of the model of this paper arises from the critical assumption about the relationship between food availibility and population growth rate. This argument is indeed a valid one, but to ignore the possibility of such a relationship in the light of almost overwhelming historical and anthropological evidence is to be naive. A debate about the validity of the various relationships of the model may vindicate professional biases, although it will not provide a solution to the food shortage problem. The solution to this problem, however, should exist as is indicated by the presence of many food surplus countries where population does not seem to grow when food availability rises.

At the outset, it is suggested that food policies based on the short-term price adjustment models of economics, which attempt to maximize food supply at a single point, or at multiple points, in time over the near future, and which treat population growth rate exogenously are quite irrelevant for achieving adequacy in food (17). When the relationship between population growth and food supply is recognized, all policies striving to increase the food supply and control population appear to have a relatively short term perspective. Even though these policies may alleviate the food shortage for a short time, food deficits will reappear in the long run as the population rises to complement the increased food supply.

The solution to the food shortage problem probably lies in identifying appropriate points of entry into the social organization of a food- deficit society and changing the criteria of the decisions taken by its members. Such a solution may differ radically from the currently practiced phenomenological policies of increasing food production or introducing birth

control (18).

Further work is needed for identifying policies for effectively alleviating food shortages in Bangladesh but it should be recognized that these policies may not appear to be directed towards the food shortage problem per se but to the pressure points in the system which have a potential to change the system behavior. It should also be recognized that short run implications of the policies which are effective in the long run may not be politically appealing. Nonetheless, the usefulness of the policies which attempt to increase food supply in the short run without considering the long run implications of the relationship between food supply and population growth is seriously in question.

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