CHANGES IN CONSUMPTION AND INVESTMENT UNDER THE OLD AND NEW FOOD GRAINS TECHNOLOGY IN INDIA--A CONCEPTUAL FRAMEWORK

by

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I. Analytical Background

There is a set of literature in development economics which reveals a consensus on the role of agriculture in economic development (5, 8, 9, 17, 20). The consensus seems to have grown deeper due to recent breakthroughs in food grains technology in many developing countries. This can be reflected from the revival of dualistic models of economic development (10, 11), as well as from the concerns of policy makers to the immediate widening of income disparities in rural areas. The recently increased skewness in income distribution has sparked both pessimism and optimism about the future growth. The pessimists argue that such disparities would eventually lead to the concentration of economic opportunities in the hands of those who own the basic resources and also to the indulgence in conspicuous consumption by the privileged class. The optimists see the immediate widening of income disparities as a boon in disguise, although not as a natural force that is not to be interfered by the public policy. They base their judgment by analyzing the implications of such distribution and of the increases in production and incomes to (12, 14, 15) the --

(i) increases in marketed surplus of food grains so crucially needed to support a higher rate of growth of employment;

(ii) new demand patterns for those manufactured and other goods which are produced in small-scale and low capital-labor ratio industries; and

(iii) increases in saving and investment (direct as well as indirect) by agriculturists in industry.

Analytically the economic effects of the new food grains technology can be classified into primary, secondary and tertiary. Primary effects are defined as changes in production and incomes in the food grains sector. Secondary effects are defined as changes in consumption and investment expenditures in this sector as a result of the primary effects. And the tertiary effects are defined as the changes in employment, incomes and production in both the food grains and nonfood grain sectors. The potential linkages between the primary and tertiary effects come through the secondary effects. It is these linkages which would enable agriculture to become an "engine" of growth.

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The magnitude and pattern of secondary effects is a function not only of the size of primary effects but also of how these effects i.e. increased incomes, are distributed among various classes in agriculture. The size and distribution of primary effects would vary from one technology to the other. Thus, the nature and magnitude of the other two types of effects would also vary from one technology to the other. This brings us to the question of different technologies in agriculture.

II. Classification of Agricultural Technologies

A review of the past as well as more recent experiences of agricultural development in various parts of the world indicates that agricultural technologies can be classified into three distinct categories.[1] These are:

Technology I is characterized by land reclamation, land consolidation, soil conservation, better husbandry and farm management practices coupled with some use of irrigation and inorganic fertilizers. This technology emphasizes the development of land and labor-intensive methods of production.

Technology II is embodied in high yielding seed varieties, fertilizers, irrigation including better water management, insecticides and pesticides, and also the selective mechanization that facilitates multiple cropping. This technology envisages the substitution of certain forms of capital and labor for land.

Technology III is characterized by highly mechanized methods of production coupled with the increased use of new biological inputs. This technology emphasizes the substitution of capital for land as well as labor.

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[1] Hayami and Ruttan have classified these three technical conditions into two viz., land-saving or biological (technology I and II in our terminology) and labor-saving or mechanical (technology III). (5, pp. 43-53) We distinguish two techniques under the land-saving classification because the sources of growth in output under technology I are relatively less responsive to production and also to augmenting the use of land and labor than those under technology II. This has direct implication to the size of increase in production and incomes and also to how the increased incomes get distributed under two technologies. More detailed justification of our distinctions will become clear as we proceed.

III. Identifying Three Variables Influencing Consumption and Investment

The basic contention of this paper is that the level and pattern of marginal propensities to consume and invest would vary from one agricultural technology to the other. This relationship between the marginal rates of consumption and investment and level of technology materializes through three key variables viz., income level, income distribution and rate of return on investment. Each of these variables would vary with the level of technology. We shall now explain how these variables change under the afore-mentioned three technologies. We shall then proceed to examine the short and long run implications of changes in these variables to changes in consumption and investment.

IV. Behavior of the Three Variables, and Consumption and Investment Patterns

Visualize a group of labor and farm households in a homogeneous region witnessing the three technical conditions in food grains farming over a period of time. The effects of each of these technologies on the following aspects of the economy of these households are conceptualized.

(1) Size of increase in production and incomes,

(2) Shares of factors of production in increased production and incomes,

(3) Link between factor shares in food grains income and other sources of income,

(4) Size of aggregate marginal propensity to consume and invest and their relative importance,

(5) Pattern of marginal propensity to consume,

(6) Pattern of marginal propensity to invest.

Aspect (1) corresponds to the income variable, whereas aspects (2) and (3) correspond to the income distribution variable. The behavior of the third variable viz., rate of return on investment under three technologies will be discussed while analyzing the above aspects.

(1) Size of increase in production and incomes:

The size of increase in production under each technology can be expressed as a function of (a) movement along, and (b) the upward shift in the production function. Both these effects would be progressively stronger as we move from technology I to III. This is because (i) under technology I, irrigation is the prime and only

shifter,[2] whereas, in the other two technologies, in addition to irrigation, new seeds, fertilizers, pesticides and insecticides also cause the shift in production function; and (ii) under technology I, unlike the other two technologies, the increase in the use of land is soon arrested due to the physical limits to extensive farming, a rapid decline in marginal productivity of resources and also small size of marginal returns on investment.

The size of increase in gross food grains incomes of farm households is a function of changes in (a) physical quantum of production, and (b) prices. Given the demand conditions, under the free play of market forces, one would expect factors (a) and (b) to move in opposite directions. This, in turn, may negatively affect subsequent increases in food grains production. However, such a result would be prevented at least in the short run because of (i) greater strength of production response due to nature of technologies, and (ii) high short-run income elasticity of demand for food grains. In the long run, when food grains prices decline, we would expect a change in production patterns from food grains to, say, commercial crops like cotton, sugarcane etc. Thus, we hypothesize that the size of increase in incomes of farm households would rise as we move from one technology to the other.

So far we have analyzed the effects on the average farmer's income. But the size of increase in production and incomes of farms of different sizes would vary because of differential rates of adoption of new technologies, and also the new cropping patterns. The differential rates of adoption are primarily caused by differences in access to new inputs, and also in the ability of various farms to bear risk and uncertainty associated with the new techniques and the new high-value crops such as sugarcane and cotton (21). Because of these factors, the increases in marginal productivity of land, capital, and labor on small farms would be smaller compared to that on large farms, as we move along the three technologies.

The size of increase in (absolute) incomes of (hired) labor households depends on increase in farm employment, and farm wage rate. As we pass from technology I to II, the farm employment will increase. This would be caused by increased harvests in a season, multiple cropping, use of such inputs as fertilizers, irrigation etc., and substitution of hired labor for family labor. Against this, the farm wage rate (in monetary units) would also rise as we move from technology I through III, because of such factors as the rise in (absolute) marginal productivity of labor, relatively high food grains prices on account of high income elasticity of demand for them

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[2] Fertilizer is not a strong shifter under technology I because of the extremely limited responsiveness of the traditional varieties. This is also to an extent true for irrigation.

in the short run, and inelasticity of labor supply in seasonal peaks under technology II. Thus, the size of increase in (absolute money) (farm) incomes of labor households would also rise as we move along the three technologies.

(2) Shares of factors of production in increased production and incomes:

Although the absolute size of increase in incomes of both the labor and farm households would rise as we move along the three technologies, the relative size of increase in incomes of the labor households would decline.[3] The empirical evidence of this inherent bias[4] of the technical change is given by Parthasarathy and Prasad (18), and Mellor and Lele (15). And it can be explained using the neo-classical theory of production and distribution (1, 16).

Within the framework of this theory and assuming a linear homogeneous production function, a relative decline in labor's share in increased production and incomes can be explained as follows:

As we move along the three technologies, the marginal product of land and capital relative to that of labor would increase.[5] Given a factor-price ratio, this would cause substitution of land and capital for labor. This in turn, would increase the capital-labor ratio as we move from technology I to II. It must, however, be borne in mind that under technology II, land is being substituted by certain industrial inputs like fertilizers, pesticides and irrigation (equipment). Thus, under this technology, although the substitution of labor by these inputs would rise, this substitution being imperfect would be quite low relative to that under technology III. Hence, (i) the increase in capital-labor

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[3] The skewness in the direct distribution of increased incomes from technological change between farms of various size was explained earlier in terms of inequality in increases in marginal productivity of land, labor and capital on these farms on account of differential rates of adoption.

[4] Hicks defines the bias of technological change in terms of proportional change in the ratio of marginal products of the two factors of production (6).

[5] Land is distinguished from capital because under technology I and II the form of capital is very different from that under technology III. Further, to the extent to which such capital is financed by the farmer himself a larger proportion of increased returns on investment accrues to him. This is yet another explanation of the increase in skewness in the direct distribution of increased incomes among farms of varied sizes.

ratio under technology II would be quite modest, and (ii) the relative decline in the increase in labor's marginal productivity will be smaller than that under technology III, but it would be greater than that under technology I.

From the above, we may therefore hypothesize that the functional distribution of increased food grains incomes may worsen for both the labor and small farm households as we move from one technology to the other.

(3) Link between factor shares in food grains income and other sources of income:

Thus far the analysis is confined to income shares that flow out of participation in the food grains production process only. Since consumption and investment decisions are governed by total income (i.e. income from all sources) and its distribution among households, it is necessary to determine the income from all sources.

The other important sources of income in rural areas are nonfood grain crop farming, dairying and rural industries. The shares of income from these sources also flow out of participation in the production process. And hence they are largely determined by the nature of technology used in their production process. Further, there are secondary income shares like capital gains, transfers, remittances, etc. These shares primarily arise from the ownership of human as well as material capital.[6]

The size of increase in incomes from the nonfood grains economic activities as well as from the secondary shares like capital gains, etc. would be influenced as we move from technology I through III. We anticipate that as the economy proceeds along the three technologies the size of increase in income from these sources would rise. This can be explained by such factors as (a) increase in demand for products of the nonfood grain industries as a result of technological change in food grains production, (b) increase in employment in these industries due to the release of wages goods constraint, (c) the possibility of substituting nonfood grains farming for food grains farming on account of both the decline in food grains prices in the long run and the increased availability of such inputs as land, fertilizers, and irrigation needed for commercial crops, (d) the possibility of appreciation in farm assets like land due to technical change in food grains production.

As before, the income shares of the increased incomes from nonfood grain economic activities between various households will

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[6] One of the criticisms levelled against the neo-classical theory of income distribution is that it ignores these secondary income shares (19).

be determined by the nature of technology in these activities. Assuming that the present technology in these activities continues, we formulate two hypotheses:

(a) That the distribution of increased incomes from nonfood grain irrigated crop farming like cotton, tobacco, sugar cane, banana, etc., may worsen for small farms and labor households.[7]

(b) That the distribution of increased incomes from dairying and certain rural-based industries that have low capital-labor ratios may improve for labor and small farm households seeking employment.

We also hypothesize --

(c) That the distribution of increased incomes from capital gains, transfers, remittances may worsen for small farms and labor households who are disadvantaged groups in respect of ownership of both human and material capital.

Thus, at a given point in time, the final result on income shares among various farm and labor households would depend on the relative importance of these three broad sources of income.

Whether or not the income distribution for low income households become favorable in the future will depend on changes in inequality in (i) factor (including sophisticated human capital) ownership, (ii) rate of returns on the factors owned and/or that may be acquired, and (iii) saving propensities. Given the inherited inequality in factor ownership, we hypothesize that the future income distribution may not be favorable to small farm and labor households. This is because these households may have lower saving propensities. Also, because they require a much higher rate of return due to their inability to bear risk and also due to high opportunity cost for them to postpone consumption and/or to borrow for undertaking investment. Thus, unless policy measures are taken to influence the above three factors, the future income distribution may not improve for low-income households.

(4) Size of aggregate marginal propensity to consume and invest and their relative importance:

An obvious hypothesis that would follow from the preceding discussion is that as we pass from one technology to the other the

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[7] The existing technology in Indian farming of commercial crops, particularly irrigated ones, is quite similar to the technology II under study. The only, but an important difference, is that the seeds of these crops are not as high-yielding, although a small beginning in this direction is already underway for crops like cotton and sugar cane. Against this, the present technology in dairying and in some rural-based industries is relatively labor-intensive.

marginal propensity to consume (MPC) would decline and the marginal propensity to invest (MPI) would increase.[8] This is because (i) the absolute levels of total income of different size farms and labor households would increase, (ii) the direct distribution of incomes from food grains and nonfood grain irrigated crop farming is more favorable to upper income groups, although the distribution of incomes from dairying and certain rural industries may be more favorable to small farm and landless labor households, and (iii) rate of return on investment rises as we move along the three technologies.

We further hypothesize that under technology II and III, there may exist short periods when MPI is even greater than MPC. To explain this, we conceptualize the consumption and investment behavior of farmers as follows:

The main feature of the farm households is the integration of two decision units into one, viz., a family acts both as an entrepreneur and as a consumer. This results in an interdependence of consumption and investment decisions. Consumption and investment decisions are interdependent because the former, through savings and marketed surplus, influence cash flows and determine the latter. And investment, through the expected rate of return, would influence the expected size of incomes and determine the consumption.

The MPC would be smaller than MPI under the simultaneous operation of the following four conditions: (i) the expected rate of return on investment is high, (ii) this rate of return is very certain and not risky, (iii) the gestation period of investment is short, and (iv) the amount of investment is large.

Finally, the shorter the phase during which MPC < MPI the earlier the growth linkages[9] of consumption expenditure would start operating. And the linkages of consumption expenditure differ from those of investment expenditure. Indeed, the linkages differ for each of the

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[8] Consumption in this study is defined to include expenditure on nondurable consumer goods, durable consumer goods and consumer services. This definition is different from the one advocated by the modern consumption function theories (3). These theories consider, besides the expenditure on nondurable consumer goods and services, that expenditure on durable goods that is required to use them as consumption. Investment in this study is defined as that expenditure (including on variable inputs) which postpones present consumption to the future.

[9] In development literature linkage effects are usually defined from the viewpoint of supply of output and demand for inputs by a sector (7). Such a definition completely ignores the linkage effects that may arise from the increase in demand for consumption goods. Agricultural sector has an important role to play as a source of markets for consumption, besides investment, goods (8, 13).

three broad types of expenditures viz., those on consumption goods, nondurable and durable investment goods, as well as for individual items within each of these three types of expenditures. They differ in three broad respects (15). First, the extent of stimulus each can provide to the domestic economy. Second, the magnitude of employment and capital use each can induce in various sectors. Third, the type of industries, whether small or large, regionally dispersed or concentrated, each encourages. This brings us to the question of patterns of expenditure on consumption and investment goods.

(5) Pattern of marginal propensity to consume:

We hypothesize the behavior of marginal propensity to expend (MPE) on four major consumption expenditure groups[10], viz., (i) food grains, (ii) nonfood grains agricultural, (iii) semidurable nonagricultural, and (iv) durable nonagricultural and consumer services. We expect that as we move from technology I to III the MPE with respect to income for food grains to be positive but declining. Against this, the corresponding MPE on the remaining three groups to be positive and increasing. This is because the absolute levels of incomes are rising and also because the distribution of income is skewed further as we move along the three technologies.

While the above result holds on an average, the more important results would follow from the study of MPE on the four expenditure groups in various income classes. We hypothesize that the lower income classes (landless laborers and marginal farmers) would support a movement from one technology to the other through their high MPE on food grains. We further hypothesize that the beneficiaries of new technology particularly II, are those whose MPE on such items as dairy products, vegetables and fruits, edible oil, processed foods, transistors, radios, etc. is high.

So far the changes in demand for a good with respect to changes in income are discussed. The demand for a good also depends on its price and prices of related goods. The demand theory divides the price effects into income and substitution effects. The MPE with respect to own-prices would be negative for each of the four expenditure groups. The important qualification to this being that the income effects do not overwhelm pure substitution effects. The

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[10] (i) Food grains include cereals and pulses, (ii) Nonfood grains agricultural include milk, milk-products, meat, eggs, fish, tobacco, edible oil, sugar, gur, dehydrogenated edible oil, vegetables and fruits, spices, beverages and other processed foods like jam, etc., (iii) semi-durable nonagricultural include footwear, cotton, woolen, and synthetic textiles, (iv) durable nonagricultural and consumer services include consumer durables like furniture, radio, transistor, etc., conveyance charges, and consumer services like domestic servant, barbers, drycleaners, etc. The MPE for each group can be estimated by adding MPE on each commodity that comprise an expenditure group. The MPE on each commodity can be estimated from the consumption function for each commodity.

MPE with respect to the prices of related goods for each expenditure group would be either positive or negative, depending on the elasticity of substitution of different commodities that comprise an expenditure group.[11] It is also not possible to assess a priori, whether or not the two marginal propensities would increase or decrease as we pass from one technology to the other. This is because the changes in the levels of own-price and the prices of related goods depends on a complex set of factors. For example, the change in the prices of related goods would depend also on the supply conditions of these goods. And the supply may be constrained by shortage of capital, institutional and other factors.

Thus far we have used the classical theory of household behavior. To adapt this theory to analyze the behavior of rural households, some modifications are necessary. The most important one being the introduction of parity price index instead of retail price index (22). This modification is required because the rural households act as both producer and consumer. The parity price index indicates the resource flows between various sectors in which the different commodities are produced. Since prices received by a household directly affect its real income and since these prices refer to those commodities that the household consumes, this variable represents three effects, viz., income effect, own-price-gross-substitution effect and the effect of prices of substitutes and complements. Determining a priori, the direction of change in the level of expenditure on the four groups as a result of a change in parity price index is not possible for the same reasons discussed earlier in connection with income and substitution effects of a price change.

(6) Pattern of marginal propensity to invest:

We hypothesize the behavior of marginal propensity to invest in farm working capital and durable capital inputs. Determining the investment function for these inputs involves finding out the demand functions for different investment goods.[12] This demand function is primarily governed by the nature of technology. And the nature of technology under study varies according to the rate of return and also the (relevant) factor-factor price ratios. In addition, the demand for investment goods would depend on the farmer's financial condition (2).

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[11] The cross-elasticity of each expenditure group as a whole would be very low, and therefore MPE with respect to prices of related goods (for the group as a whole) may not present an interesting case of analysis.

[12] Since the demand for durable capital unlike that for a nondurable input, is a demand for stock, the investment function for such capital must be derived from the demand for the stock (4).

Assuming that the past savings of a household represents its financial condition, we can write the demand function for investment goods as a function of rates and size of returns (R), (relevant) factor-factor price ratios (P), and past savings (S).

Using these variables we may hypothesize that as we move along the three technologies the MPI in such yield-increasing inputs as seeds, fertilizers, and water would increase. Similarly, the MPI in irrigation equipment and other farm implements would also increase. This is because the returns on the use of these inputs would not only be higher, but also the price ratio between land and land-substituting inputs would be favorable to these industrial inputs. We finally hypothesize that under technology II the MPI in such capital goods as tractors and threshers would increase rapidly, particularly on large farms. This is because of improved returns on mechanization and/or favorable capital (tractor) - labor price ratio on account of the possibility of inelastic labor supply at seasonal peaks.

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