Ind. Jn. of Agri. Econ.
Vol. 58, No. 1, Jan.-March 2003

Changing Cropping System in Theory and Practice: An Economic Insight into the Agrarian West Bengal

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I

INTRODUCTION

The development of agriculture or crop economy of India is characterised by the process of crop diversification or changes in cropping pattern over time. The change has been associated with the increasing transformation of agriculture from subsistence to commercial farming.[1] The alarming population growth has led to a drastic fall in per capita availability of gross and net cultivable area (in spite of bringing some uncultivable land under cultivation and extension of multiple cropping) and the farmers are left with the opportunity of using land effectively and efficiently to raise revenue as much as possible from their limited holdings. With the expansion of irrigation potential, development of technology, market structure, and institutional mechanism, cropping pattern changes fulfils the increasing demands and matches the changing conditions. Sometimes a new cropping pattern is introduced to raise the expected farm income from the limited holding and to avoid risk and uncertainty. Changes in technology are also invited to make land suitable for the cultivation of more desired crops. Improvement of infrastructure also helps in accelerating the process of diversification that also varies across the regions for varied agro-climatic conditions and resource bases.

Several earlier studies have been devoted to analyse the role of different factors behind the changes in allocation of land resources towards different crops. Nerlove (1958) in his path-breaking analysis has considered actual and expected normal price for explaining the farmers' response to price variations. Expected normal price was found to play an important role in determining the long-run equilibrium acreage. Prices in his econometric approach were assumed to be independent data and farmers were the price takers and adjusted acreage distribution in response to the variation of prices and their future expectations (Nerlove, 1958). Narain (1965) in his pioneering work has observed that the shifts in cropping pattern are traceable to changes in the relative prices of crops, expansion of irrigation and changes in technology. He also

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The author is grateful to S.K. Datta, Department of Economics, University of Burdwan and S.K. Mishra, Department of Economics, North-Eastern Hill University, Shillong. He is also thankful to the anonymous referee of the Journal for his valuable suggestions. However, the author is solely responsible for all kinds of errors.

concluded that prices (market forces) of crops play a leading role in determining the acreage of commercial crops whereas rainfall, broadly weather plays a dominant role in the determination of area allocation among the food crops. Moreover, price relative to weather becomes the prime consideration of farmers when foodgrains as a whole compete with the cash crops (Narain, 1965).

The other studies available (Sarkar, 1988; Vyas, 1996; Gulati and Sharma, 1994; Narayanamoorthy, 1997; Sawant, 1997; Bhalla and Singh, 1997; Chand, 1996) also analyse the allocation of land (in terms of farmers' response to the variation in different factors) among the *competing crops* grown during the same season and found that either of the factors, relative price (market/administered), irrigation facility, soil condition, price policies of the government, yield of crops, technology, infrastructure, etc., are responsible for crop diversification in different places. They have hardly mentioned about the role of *inter-relationship among the crops grown in different seasons* (explained in detail later) on farmers' cropping decision. In fact *the choice of crops in the current season affects the choice of crops in the next season* by way of influencing the sowing time of the latter and hence affecting (favourably or adversely) productivity, profitability, chemical composition of soil etc. In practice farmers plan to earn as much as they can, throughout the year,[2] from their limited holdings and to maintain the same in the long run.[3]

Objective

The present paper tries to examine the basic reasons for crop diversification in the context of agricultural situation in West Bengal, one of the important agricultural states of India. During the post-Green Revolution period (particularly after 1970) cropping pattern in West Bengal has changed in favour of high remunerative crops and at the cost of the lower value crops (Bhalla and Singh, 1997; De, 1998; 2000). Area and production of *boro* rice, potato and oilseed (especially mustard) have experienced a relatively faster growth during 1970-71 to 1994-95 than that of other crops (De, 2000-01). The areas of those crops have increased not only due to the expansion of net area under cultivation but also due to the substitution of area under other crops (relatively low remunerative crops) (De, 1999 a).

Here the analysis is confined to the period 1970-71 to 1994-95, mainly because the Green Revolution though started in mid-1960s in the country, its wave came to West Bengal in the early seventies. Moreover, the complete data relating to the study were not available beyond 1994-95 so that the study could not be extended beyond the said period.

The plan of the paper is as follows. In section II we detail the specification of the regression model used for explaining the impact of different factors like irrigation, rainfall, price, etc. Section III presents the result of estimation of the stochastic functions. Then an analysis of the results obtained by regression method is done. Thereafter, an alternative method is explained in Section IV for studying the combination shift in terms of a cross-section analysis. The last section draws the conclusion and policy implication of the study.

For the purpose of analysis, the data on area under crops, yields of crops, rainfall, irrigation, consumption of fertiliser, etc., for the period 1970-71 to 1994-95 were collected from various issues of *Economic Review*, *Statistical Abstract of West Bengal.* Cost on different factors of cultivation and revenue, etc., for the year 1993-94, used in the second part of the analysis are collected from the field survey by the author.

II

MODEL SPECIFICATION

The diversification in any particular geographical area is based on the changing social, economic, technological, geographical[4] and institutional structure of that region. Specificity of requirements of inputs in the case of different crops and their availability on time as well as the system of agriculture (subsistence or commercial) are the key factors in determining acreage allocation. The major underlying factors, conceived to be of great importance in determining the allocation of land resources among the competing crops[5] are prices[6] and yields of different crops, level of irrigation, availability and variation of other agricultural inputs (pattern of agro-implements, varieties of seeds, synthetic fertiliser, etc.) and geographical characteristics of the respective region.[7] At first, regression method is followed to analyse the impact of different factors like irrigation, rainfall, chemical fertiliser, yields of crops and price, etc., on the acreage changes of those fast growing crops during 1970-71 to 1994-95. For the purpose of analysis, the following stochastic form of equation is considered:

$$Ln\ A_{it} = a_0 + a_1\ LnR_t + a_2\ LnI_t + a_3\ LnC_t + a_4\ LnY_{it} + a_5\ LnP_{i-1} + a_6\ LnY_{jt} + a_7\ Ln\ P_{j-1} + a_8D_t + U_{1t}$$

where A_{it} represents proportion of acreage of i-th crop to gross cropped area (GCA) in t-th year, R is the level of rainfall measured in millimetre,[8] I is the area under irrigation (only government canal is considered), C represents consumption of chemical fertiliser and Y, the yield of the particular crop. D is the dummy variable, where, D takes value 0 in a pre-land reform year and 1 in the post-land reform years beginning with 1979. Here the inception of land reform year is supposed to coincide with the time when the collection and distribution of vested land to the landless people started in West Bengal.[9] a_js are the elasticity of acreage growth with respect to j-th explanatory variable. Here P_{i-1} and P_{j-1} represent respectively the price of i-th crop and j-th crop lagged one year. Suffix j is used to denote the crop or crops that can be grown during the same season on the same field on which i-th crop is cultivated. U_i is the random disturbance term. a_6 and a_7 are the cross yields and price elasticities of area under i-th crop with respect to yield and price of j-th crop.

Here prices of crops and that of competitors of the preceding year are included. Yields of substitute crops are also included along with the yield of the crop under consideration as they also have some influence on the allocative decision of the farmer. Considerable lag is usually observed between the changes in the prices of crops and acreage allocation. The price that motivates production decision should neither be the price at the beginning of the production process (just prior to the sowing time) nor should it be the price at the end. The former does not determine profits as it generally undergoes changes during the process. Even if the price variation that has occurred just before the sowing of any crop, the farmer's decision is assumed to remain unaltered. He can hardly take it into account, as there may not be sufficient time available for the preparation of land, which can be reallocated to other suitable (remunerative) crops or combination of crops. But it can affect the acreage allocation for that crop in the next crop rotation or the area of its substitute crop (in consumption) to be cultivated in the following season. Moreover, price at the end of the period is unknown when production is initiated. Nerlove has used a series of past prices with weights declining over time in his lag adjustment model from which the acreage variation is estimated. "In practice, however, the immediate previous results are believed usually to play a predominant role in forming expectations and farmers even in advanced countries are found to respond to actual prices" (Cassels, 1933). Nerlove's method though more scientific and consistent cannot be applied here primarily because the channels through which price information is disseminated are not so well developed in the countryside of a developing economy like West Bengal as in advanced countries (Raj *et al.*, 1988, p. 11). Moreover, Nerlove has explained acreage variation with an emphasis on the substitution between competing crops, which is more appropriate in a situation of pure commercial structure. In the present case, the area under any crop has been changing significantly due to substitution as well as expansion of total area under cultivation and there are several sorts of changes (cost of production, market structure, government policies), which ought to be taken into account for the adjustment of prices. However, it is very difficult to take care of all of them as they are subject to continuous change. In addition to that, farmers in most of the regions are mostly influenced by the pioneering role of a few innovators, who take the risk of introducing a new technology in the production of crops. Sometimes a few farmers are forced to withdraw their decisions of cultivating some crops because of non-matching decisions by their neighbours; otherwise it may create problems of harvest, transportation and marketing. Changes in prices also depend on other uncertain features, like government policies on export, import, support prices all of which may change during the gestation period and hence it is very difficult to form expectations.

The equation represents a modified Cobb-Douglas form of equation. Here a question may arise regarding the use of rainfall, irrigation, chemical fertiliser and yield simultaneously in the regression equation, which often seem to be closely related. Moreover, with the advancement of technology, yields of all these crops have been increasing over time and the prices are also increasing over time in spite of short-term fluctuations. True, there is a complementarity between the use of chemical fertiliser and the level of irrigation and the two along with rainfall can impact on the yield level. So there is a problem of multicollinearity; though the relationship is not a perfect one as yield also depends on some other factors like variety of seed, weather conditions, etc., (the multiple correlation coefficient of yield of each of potato, *boro* rice or mustard and rainfall, irrigation, chemical fertiliser is not one), which are not included here. The linear relationships between any two explanatory variables are shown in terms of two-way correlation in Appendix Tables 4 and 5. From the time-series data, it is observed that LnC is highly correlated with LnP_{b-1}, D (in Appendix Table 4) and LnC is found to have a strong correlation with LnP_{p-1}, LnY_p, LnP_{m-1}, LnY_m, LnP_{w-1} and D (Appendix Table 5). The specification of relationship among the explanatory variables is a very difficult one. Moreover, dropping any one of these variables may lead to specification bias. Hence two-stage least squares technique is applied for getting more appropriate result, since application of multi-equation model cannot improve the result as the ordinary least squares (OLS) residuals of different equations are tested and not found to be correlated with each other. Therefore, LnC is regressed on other variables with which it is highly correlated and the estimated values of LnC is computed and used in place of LnC and the second-stage regression is followed. Also regression was run on step-wise by inclusion and exclusion of explanatory variables (dropping variable technique) to notice the changes in coefficients and also explanation through R^2. The estimated equations fitted are presented below:

Regression Results

For *boro* rice[10]

At first taking only price lagged one year as explanatory variable,

$$\underset{}{Ln\ A_b} = \underset{(.82)}{-5.63^*} + \underset{(.147)}{.63\ LnP_{b-1}^*}\quad \underline{R^2 = .45.}\ (Adj.)\ \underline{R^2 = .43} \qquad ....(1)$$

Considering LnEC and LnI as explanatory variables,

$$Ln\ A_b = \underset{(3.019)}{25.66^*} + \underset{(.0706)}{.31\ LnEC^*} + \underset{(.5377)}{3.58\ LnI^*}\quad \underline{R^2 = .781.}\ (Adj.)\ \underline{R^2 = .76} \qquad ....(2)$$

$$\text{where } LnEC = \underset{(.773)}{5.43^*} + \underset{(.150)}{.853\ LnP_{b-1}^*} + \underset{(.1426)}{.571\ LnD^*}\quad \underline{R^2 = .903.}\ (Adj.)\ \underline{R^2 = .894} \qquad ....(3)$$

And considering all explanatory variables, we get

$$Ln\ A_b = \underset{(3.96)}{-24.64^*} + \underset{(.179)}{.0534\ LnR} + \underset{(.569)}{3.56\ LnI^*} \underset{(.351)}{-.17\ LnY_b} + \underset{(.077)}{.316\ LnEC^*} \qquad ....(4)$$

$\underline{R^2 = .784.}$ (Adj.) $\underline{R^2 = .74}$

In case of potato

Considering one explanatory variable first,

$$\text{Ln } A_p = -4.93^* + 0.387 \text{ LnP}_{p-1}{}^* \quad \underline{R^2 = .36.} \text{ (Adj.) } \underline{R^2 = .33} \qquad \ldots(5)$$
$$(.499) \quad (.11)$$

Considering all explanatory variables,

$$\text{Ln } A_p = -7.36^* - .0954 \text{ LnR} + .1723 \text{ LnI} + .393 \text{ LnEC}^* - .0353 \text{ LnY}_w \qquad \ldots(6)$$
$$(2.96) \quad (.1276) \quad (.399) \quad (.058) \quad (.2268)$$
$$\underline{R^2 = .767.} \text{ (Adj.) } \underline{R^2 = .718}$$

$$\text{where LnEC} = -.333 + .0685 \text{ LnP}_{p-1} + .361 \text{ LnY}_p + .218 \text{ LnP}_{m-1} + .40 \text{ LnY}_m{}^* \qquad \ldots(7)$$
$$(3.19) \quad (.188) \quad (.373) \quad (.2055) \quad (.2036)$$
$$+ .54 \text{ LnP}_{w-1} + .1146 \text{ D} \quad \underline{R^2 = .937.} \text{ (Adj.) } R^2 = .915$$
$$(.292) \quad (.211)$$

In case of mustard,

Considering one explanatory variable,

$$\text{Ln } A_m = -15.8^* + 2.0 \text{ Ln P}_{m-1}{}^* \quad \underline{R^2 = .60.} \text{ (Adj.) } \underline{R^2 = .59} \qquad \ldots..(8)$$
$$(2.06) \quad (.345)$$

Considering all explanatory variables,

$$\text{Ln } A_m = -21.54 + 1.107 \text{ LnR}^{**} - 2.534 \text{ LnI} + 1.95 \text{ LnEC}^* + .465 \text{ LnY}_w \qquad \ldots(9)$$
$$(14.27) \quad (.614) \quad (1.92) \quad (.2816) \quad (1.09)$$
$$\underline{R^2 = .795.} \text{ (Adj.) } \underline{R^2 = .75}$$

Here LnEC is same as represented by estimated equation 7.

Figures in parentheses represent standard errors of the corresponding coefficients. *, and ** represent respectively that the coefficient is significant at 5 and 10 per cent level of significance by two-tailed test.

Analysis of Regression Results

From the above estimated equations 2, 3 and 4, it has been observed that irrigation and chemical fertiliser have substantial positive impact on the relative acreage growth of *boro* rice. Chemical fertiliser and yield growth have led to increase in the acreage of potato and mustard (from equations 6 and 9 and since LnC is positively related to LnY_p and LnY_m as is evident from equation 7). In the case of *boro* rice, yield is found to have insignificant impact but dummy variable shows positive influence on acreage allocation.[11] Irrigation is the leading determinant (input) in the case of *boro* rice because it is grown during summer and regular water supply is essential for rice cultivation. Here the growth of irrigation infrastructure is thus associated with a shift in the composition of dry season crops, particularly with a rising share of area under *boro* rice.

But the effect of irrigation is not found much stronger in the case of potato, and even negative in the case of mustard. The actual situation is however not like so. The reason is that, potato and mustard are winter crops and during winter one cannot depend on rainfall. Thus irrigation is essential. In the present analysis, actually the area under canal irrigation (provided by government canals) has been considered from which still now, hardly a few places in Burdwan get irrigation during winter. A major part of the areas in winter and summer have been under minor irrigation dominated by shallow tubewell, deep tubewell, submersible pumps, tanks, etc., owned mainly by private people along with a few under government ownership (De, 1999 b). With the expansion of sphere of these sources, cultivation of potato and mustard has increased. But continuous data on these sources are not available and so they are not included in the list of explanatory variables in the present discussion.

The coefficient of dummy variable is found to be insignificant in the case of both potato and mustard (comparing equations 7, 6 and 9).[12] There is much doubt about the contribution of the beneficiaries to the process of undergoing diversification. Most of the evaluation studies are conducted on the basis of the performance of the beneficiaries of the programmes. The diversification is actually associated with the spread of new technology and adoption of new technology by the beneficiaries is mainly dependent upon their resource strength.[13] But the government support measures are not adequate (Raychaudhuri and Sen, 1996) and the channels through which the government aids are distributed are not so reliable. Moreover, the beneficiaries may have benefited in different ways from substantial development of technology (especially irrigation) and inputs' market, which could push them forward to cultivate those crops. So, just by looking at the performances of the beneficiaries, one cannot assure the impact of land reforms, since the improvement in this respect may be due to the advancement of other things. A comparison may be made between the cropping pattern changes of the beneficiary farms and that of the same category (small and marginal) of non-beneficiaries to ascertain the efficiency of land reform measures.

In neither case rainfall shows significant effect on the variation of acreage except mustard. This may be due to the fact that the data used here relate to rainfall of the whole year, which is not evenly distributed over throughout the year. For the sowing of any crop the quantity of rainfall in the pre-sowing period is most important.

It is evident from the above estimated equations that the farmers are highly influenced by last year's price of the crop which is to be chosen for cultivation. It is also realised that irrigation and chemical fertiliser are the leading inputs for potato and simultaneously the price and yield, both are found to have an attractive influence on the farmers' choice. However, the cross (indirect) effects of price and yield are found to result in ambiguity when equations 7, 6 and 9 are compared. The cross effect of yield of mustard on potato is significantly positive (from equations 6 and 7), which seems to be inconsistent with the rational economic behaviour. An increase in yield of mustard brings about an expansion of area under it, with area remaining the same; acreage of potato cannot increase.[14]

An explanation may be given for the above seemingly contradictory results. In the early years of development much of the land was not available for cultivation during winter and summer seasons (because of unavailability of irrigation facility). With the expansion of capacity of irrigation it became easier to bring those plots under cultivation during *rabi* season and also during summer. During 1970s, when changes came, wheat observed an impressive growth relative to the others. This was due to the government's special programme on food production, high-yielding varieties of wheat came and entered the erstwhile rice regime of West Bengal.[15] Gradually the food crisis in the region was over and agriculture of West Bengal faced a commercial movement. The cultivation of potato and mustard became increasingly profitable with rising prices and yields due to the arrival of high-yielding seeds, development of irrigation and technical implements. There started a shift of land from relatively less profitable crops like wheat, *rabi*-pulses to potato and mustard. Simultaneously, most of the new plots brought under assured irrigation responded accordingly. The farmers tried to allocate their increased area under cultivation between potato and mustard meticulously, on the merit of their comparative profitability, cost and risk (which are relatively higher for potato though its profit is also higher) and their managerial ability that has however been increased with the development of technology.[16] Thus increased land has been devoted for the cultivation of both crops in a way to balance between management and profit and at the manageable risk. In the case of mustard we also observe almost the same result from equations 7 and 9.

From the above analysis it is possible to throw some light on the impact of individual factors on the acreage growth of crops under study. But it is not possible to draw any particular conclusion regarding the cross-effect of price, yield or returns per hectare of competitive crops on absolute acreage from the multivariate regression analysis. It is thus very difficult to build up any irrefutable hypothesis regarding the cross-effects from those equations. Moreover, in the above regression analysis the effects of individual factors like expenditure on irrigation, chemical fertiliser, etc. on the proportion of acreage allocation is considered, which simultaneously affects both cost of cultivation and returns from the cultivation of any crop. But here the effect of changes in the total cost of production that is also related with the changes in revenue through the changes in yield, price, etc. was not considered and if total cost is not covered by revenue, inspite of rising price and yield it may lead to stopping of cultivation of any crop as the farmers will find the cultivation of that crop to be non-interesting.

IV

AN ALTERNATIVE APPROACH: COMBINATION SHIFT

Most of the earlier studies have concentrated on the substitution of area among the crops that can be grown during the same season on the same plot of land. They have hardly paid any attention to the consequence or the external effects (favourable or adverse) of the cultivation of any crop on the cultivation and profitability of crops that can be grown on the same field during the following season. With the expansion of irrigation facility and extension of multiple cropping, the farmers have been facing the problem of cropping choice over all the seasons of the year. A simple argument can be made from the accepted pattern of relationship among different crops that can be grown on a particular piece of land in a crop year (one complete crop cycle). The relationship among the crops in production is exposed through the overlapping sowing and harvesting seasons, which is manifested in the changing yield and output of crops.

A rational farmer always tries to maintain the ideal time of sowing and harvesting of crops. But in multiple cropping system some bottlenecks arise due to the overlapping timing of harvesting of a crop and that of sowing of its subsequent crop/crops, where crops within a cycle are cultivated in succession. The cycle repeats itself year after year and the combination of crops grown may change over the years depending upon the nature of effect that the cultivation of one crop has on its next crop(s). Harvesting of any crop must be completed within a certain time to leave adequate time for the preparation of land to cultivate the next crop. The preparation time and harvesting period has been reduced to a great extent with the development of mechanical devices like tractors, power tillers, etc. In addition to that, crops with short period maturity and high-yielding varieties are increasingly grown. Still the relationship is observed, because in many cases, ideal/natural timing of sowing and maturity has not changed significantly and is unlikely till a new variety has emerged.[17] If any crop is cultivated at its usual time and inputs are used in an optimum proportion, it will mature at an ideal time (if no natural disturbances occur) and give optimum gross and net profit. The natural harvesting time of any crop may coincide with the natural sowing time of its immediate successors. So, if the latter is cultivated after the harvest of the former on the same piece of land, then the performance of the latter will be delayed and productivity or profitability will be adversely affected. The same effect may be transmitted to the following crops due to the identical relationship. Sometimes premature crops are harvested to leave room for the next one. It is done only if there is a possibility to compensate the loss incurred due to premature harvest by the production of the next crop.

The case is not similar where on the same plot of land, the cultivation of potato is preceded by *aus* and followed by *boro* rice to that one in which *aus* or high-yielding *aman*, mustard or wheat and *boro* rice come in succession. In the two cases the yield of *boro* rice and also cost of *boro* cultivation would be different. This is due to the differences in the combination of crops in which it is grown. Empirically, it is found that the cultivation of *boro* rice preceded by the harvest of wheat in February-March from the same plot of land is a late running performance and its productivity would be much lower even with usual application of other factors than that if it had been sown earlier. However, if wheat is followed by jute or potato is followed by jute, then the yield of jute is not affected due to this problem of matching of time.[18] In the earlier case the farmers are supposed not to choose this combination if the yield and profitability of wheat are not so high that it can overcompensate the expected loss of profit of *boro* rice due to its late sowing and harvesting. On the other hand, if *boro* rice follows potato it also becomes too late and the yield of *boro* rice is likely to be adversely affected. The cost of potato cultivation is much higher than that of the other crops but at the time of harvest it leaves much of fertiliser used (the residual) and thus virtually very little amount of chemical fertiliser is needed for the following crop like *boro* rice, til, etc. The pesticides' cost however increases because the invasion of pests is comparatively higher in the case of late running crops.[19] Still the farmers may choose this combination if the productivity and net profit of potato are so high that it can over-compensate the expected loss of profit of the latter. The farmers are supposed to choose a combination in such a way (to grow on the same field in a particular year) that they can disperse the risk and maximise expected profit. The choice of combination is also important from the point of view of maintaining a sustainable income over a long period of time, though in many cases the farmers are also guided by their short-term goals. The cultivation of some crops like potato, jute, etc., leads to an increase in land productivity through preserving surplus fertiliser in the case of potato and raising nitrogen content of land in the case of jute. This rising land productivity is utilised in the production of next alternative crop. The imputed value of rising land productivity due to the above reasons however cannot be calculated directly by an economist but the task can be left to a biochemist or soil scientist. What an economist can do is to compare the average yield of any crop (like *boro* rice) of different plots within same environment (having similar land character, water resources, etc.) but grown after or in combination with different crops (such as potato or mustard or local *aman,* etc.). However, due to changes in the crop cultivated on a particular plot in the previous season, cost and revenue of the crop cultivated on the same plot in the following season (because of variation in sowing and harvesting time as well as requirement of different inputs and yield of the latter crop) changes, which is not very difficult to calculate.

Thus relative cost-benefit of alternative possible combinations of crops that can be grown on a single plot within a crop year (which may be assumed to start with the cultivation of *aus* or *aman* and ends up with the harvest of *boro* rice, til or jute), may be used as one more reasonable explanation than that used earlier. Here the explanation is made assuming the land as a scarce factor and each plot is under optimum useable multiple the cropping system (i.e., cropping intensity is almost 300 per cent). Even if irrigation is not available throughout the year and thus the cropping intensity is less than the optimum, a similar explanation can be made under the existing condition.

Here a cross-section study of a particular year is adopted. Most of the combinations noticed in the present days were absent in the early part of the 1970s. So it is not possible to compare the relative profit of the present dominant combinations with the relative profit of the same in the early years of the 1970s after deflating by index of prices. However, any combination can be compared with the contemporary competitive combinations in terms of their profitability.

The frequently observed combinations in West Bengal, particularly in Burdwan are: (i) high-yielding *aus*, potato and *boro* rice, (ii) high-yielding *aus*, potato and jute, (iii) high-yielding *aus*, mustard and *boro* rice, (iv) high-yielding *aus*, mustard and til, (v) high-yielding *aus*, potato and til, (vi) high-yielding *aman*, *boro* rice, (vii) high-yielding *aman*, potato and *boro* rice, (viii) high-yielding *aman*, mustard and til, (ix) high-yielding *aman*, wheat and til, (x) high-yielding *aman*, wheat and jute, (xi) high-yielding *aman*, potato and til, (xii) high-yielding *aman*, mustard and *boro* rice, (xiii) local *aman* and *boro* rice and (xiv) high-yielding *aman*, potato and jute.[20]

Data on separate plots on which either of these combinations were present have been collected from 60 sample farms, 20 chosen from each of three villages in Madhabdihi block of southern Burdwan district of West Bengal in 1993-94. The block is well developed in agricultural sphere and the three contiguous villages are chosen purposively as those villages were known for several years where agricultural development had taken place at rapid strides. Most of the plots of those villages are now within the purview of multiple cropping. There are good irrigation facilities mostly under private irrigation system and a few under government canals, river lift irrigation as well as government provided deep tubewell. The canals provide irrigation mainly in the monsoon season whereas the shallow tubewells, deep tubewells and submersible pumps can function throughout the whole year. Now many of the shallow tube-wells and submersibles are electrified and a few are running with diesel engines. The development of marketing facilities, co-operative and banking system, and diffusion as well as innovation of technology have led to the diversification of crop in those villages. The farmers cultivate crops for their own use as well as for marketing. Production is operated with the help of own as well as hired labour. Even the small peasants hire labour for their cultivation work and sometimes they hire out their own labour when they are free.

The farms were selected by simple random sampling without replacement. Most of the chosen farms are found to be marginal (below one hectare), small (more than one hectare but less than two hectares) and medium (above two hectares and up to four hectares) category. From each selected farm various data relating to the availability of irrigation facilities, topology of plots, price about the inventory and livestock with its value and the repair, if any, etc., are collected. Information like utilisation of family and hired labour, quantity and value of seeds, fertilisers, manure used, share of landowner (if leased-in), cost of machinery (pumpset, power tiller, etc.) incurred for each crop (hired or own) are collected. Data on quantity of land allocated to each crop in a particular season corresponding to the portion of its area used for different crops in the preceding and subsequent seasons have been collected. Also yield of crops and inputs used in such separate plots are collected in the same way.

All the relevant information relating to expenditure and revenue have been collected for each crop separately corresponding to different preceding crops. The gross revenue, cost and profitability of each crop corresponding to different preceding crops have been calculated. Thereafter, a flow chart was prepared that showed the flow of land in aggregate of all the 60 farms together throughout the year. Cost, gross return and profitability of major combinations have been calculated (and are presented in Tables 1, 2 and 3 respectively) and compared to observe whether there is any relationship between the profitability of different combinations and flow of land allocation towards the production of crops involved in different combinations.

Observations

The flow of land allocation over the seasons revealed that out of total area (242 acres) cultivated in the *kharif* season by all the farms during 1993-94, 166.5 acres were used for high-yielding *aman*, 52.5 acres for local/traditional *aman* and 23 acres for high-yielding *aus*. At that point of time, local *aus* varieties were not in the fields of those farmers. In the *rabi*/winter season land used for the cultivation of potato, mustard, wheat was 58.2, 54.5 and 4.6 acres respectively, while the other crops were grown on 18.8 acres of land. Here others include onion, lentil and other *rabi*-pulses.[21] Some other winter crops such as vegetables, although grown in good amount, have not been considered in the present survey as they do not constitute a very large portion of total land and also not the main crop of the region. During the next season 11.5, 26.6 and 115.5 acres of land were used respectively for jute, til and *boro* rice. Here it is noticed that in the *kharif* season high-yielding *aman*, in the winter season potato and in the summer season *boro* rice occupied the largest proportion of land cultivated respectively. The flow of land over the seasons is the highest for the combination of high-yielding *aman*, potato and *boro* rice (row 7 in Table 1). It is followed by the combination of local *aman*, *boro* rice (i.e., combination 13) and combination of high yielding *aman*, mustard, *boro* rice (i.e., combination 12).

Cost and gross returns per acre for different combinations (average, maximum, minimum and standard deviation across different sample farms) in 1993-94 of the selected sample are presented in Tables 1 and 2 respectively. Here *total cost* includes cost of seed, expenditure on labour (butllock, human and machine like tractor or

TABLE 1. AVERAGE COST AND VARIATION OF COST FOR CULTIVATING DIFFERENT COMBINATIONS OF CROPS PER ACRE DURING THE WHOLE CROP YEAR IN THE SELECTED SAMPLE FARMS - 1993-94

Combination of crops	Area (acre)	Cost per acre in a crop year (Rs.)			
		Average	Maximum	Minimum	σ_n
(1)	(2)	(3)	(4)	(5)	(6)
1. Aus (HYV), potato, boro rice	4.0	26,562.80	30,653	24,291	212.66
2. Aus (HYV), potato, jute	1.0	23,434.61	26,982	21,401	226.35
3. Aus (HYV), mustard, boro rice	6.0	18,443.16	20,056	16,738	186.87
4. Aus (HYV), mustard, til	1.0	12,884.26	13,295	12,346	173.28
5. Aus (HYV), potato, til	1.8	21,796.99	24,902	20,167	220.17
6. Aman (HYV), boro rice	8.0	14,701.71	15,996	13,427	57.94
7. Aman (HYV), potato, boro rice	34.4	26,447.11	30,396	24,464	132.78
8. Aman (HYV), mustard, til	3.5	12,768.57	13,037	12,519	51.67
9. Aman (HYV), wheat, til	1.4	13,343.31	13,680	12,911	50.25
10. Aman (HYV), wheat, jute	0.5	15,027.81	15,780	14,219	50.54
11. Aman (HYV), potato, til	10.7	21,681.30	24,645	20,340	129.84
12. Aman (HYV), mustard, boro rice	24.5	18,327.47	19,798	16,911	84.42
13. Aman (Local), boro rice	31.4	13,642.40	15,156	12,234	288.99
14. Aman (HYV), potato, jute	5.0	23,318.92	26,725	21,574	133.53

TABLE 2. AVERAGE RETURNS AND VARIATION IN RETURNS FROM DIFFERENT COMBINATIONS OF CROPS PER ACRE DURING THE WHOLE CROP YEAR IN THE SELECTED SAMPLE FARMS - 1993-94

Combination of crops	Area (acre)	Returns per acre in a crop year (Rs.)			
		Average	Maximum	Minimum	σ_n
(1)	(2)	(3)	(4)	(5)	(6)
1. *Aus* (HYV), potato, *boro* rice	4.0	32,691.02	39,768	28,516	381.05
2. *Aus* (HYV), potato, jute	1.0	29,391.02	35,611	25,619	414.71
3. *Aus* (HYV), mustard, *boro* rice	6.0	24,448.13	28,034	23,200	353.05
4. *Aus* (HYV), mustard, til	1.0	16,244.90	17,991	15,160	404.96
5. *Aus* (HYV), potato, til	1.8	27,901.02	34,441	28,304	404.86
6. *Aman* (HYV), *boro* rice	8.0	21,656.23	24,368	20,828	561.05
7. *Aman* (HYV), potato, *boro* rice	34.4	33,519.02	40,668	29,291	415.53
8. *Aman* (HYV), mustard, til	3.5	17,072.90	18,891	15,935	478.29
9. *Aman* (HYV), wheat, til	1.4	16,807.21	17,951	15,674	575.22
10. *Aman* (HYV), wheat, jute	0.5	18,522.21	19,546	17,452	578.28
11. *Aman* (HYV), potato, til	10.7	28,729.02	35,341	29,079	464.77
12. *Aman* (HYV), mustard, *boro* rice	24.5	25,276.13	28,934	23,975	430.64
13. *Aman* (local), *boro* rice	31.4	18,528.23	21,435	17,864	328.13
14. *Aman* (HYV), potato, jute	5.0	30,219.02	36,511	26,394	466.00

power tiller) if hired and for owned bullock, tractors, etc., and family labour which is calculated at the going market rate as they could earn if hired out, irrigation charges (even if the farm owns irrigation set-up then its running cost, depreciation of machinery, electric bill if electrified are considered), organic or synthetic fertiliser, pesticides as well as the rent of leased in land (in the case of owner cultivator how much he/she could get if leased out), transportation and marketing cost.[22] *Returns* include value of main and by-product only. However, cost and gross returns from crop on a plot with different combinations vary mainly because the requirement of fertiliser, pesticides for growing a particular crop and its yield changes for differences in crop grown in the preceding season on the same plot, as explained earlier. All these data are collected for each crop corresponding to different preceding crop from each farm separately. Then the corresponding cost and returns are calculated taking the data of all combinations of all the sample farms together. Thereafter, net returns over total cost per acre of each combination are calculated by subtracting total cost from total gross returns of the corresponding combination.

Table 3 reveals that the profitability (net returns) per acre of high-yielding *aman* (calculated at Rs. 3,691.19) is greater than that of high-yielding *aus* (Rs. 2,747.50) and local *aman* (Rs. 1,622.50). During monsoon season the farmers have no other option but to choose the highest profitable among different varieties of *aus* and *aman* which have less adverse effect on the following cultivable crop. High-yielding *aman* appeared to be the most profitable among them *without having any adverse effect on the sowing time of next crops* (as after the harvest of it in October-November, one can easily cultivate any winter crop). Thus during monsoon season, high-yielding *aman* became the most popular variety to the farmers. Generally potato is not cultivated after local *aman* rice on the same plot because in that case, normal sowing time of potato is greatly disturbed. Local *aman* rice is harvested during the month of December. If potato is cultivated after that, then its productivity will be much lower than that of the earlier one sown and so would be the profitability. Normal level of yield of potato remains unaffected if it is grown after *aus* or high-yielding *aman* rice, since the ideal sowing time of potato is not affected in this case. If there is no distortion of ideal time of sowing during winter season, potato is found to be the most profitable crop among all the *rabi* crops. If *boro* rice is cultivated after potato,

TABLE 3. ALLOCATION OF LAND TOWARDS DIFFERENT COMBINATIONS AND NET BENEFIT PER ACRE OVER TOTAL COST IN THE SELECTED AREA - 1993-94

Combination of crops (1)	Area (acre) (2)	Total profit over total cost per acre in a crop year (Rs.) (3)
1. *Aus* (HYV), potato, *boro* rice	4.0	2,747.50 + 2,559.41 + 821.31 = 6,128.22 (6)
2. *Aus* (HYV), potato, jute	1.0	2,747.50 + 2,559.41 + 649.5 = 5,956.41 (9)
3. *Aus* (HYV), mustard, *boro* rice	6.0	2,747.50 + (-5.86) + 3,263.33 = 6,004.97 (8)
4. *Aus* (HYV), mustard, til	1.0	2;747.50 + (-5.86) + 619.00 = 3,360.64 (14)
5. *Aus* (HYV), potato, til	1.8	2,747.50 + 2,559.41 + 797.12 = 6,104.03 (7)
6. *Aman* (HYV), *boro* rice	8.0	3,691.19 + 3,263.33 = 6,954.52 (3)
7. *Aman* (HYV), potato, *boro* rice	34.4	3,691.19 + 2,559.41 + 821.31 = 7,071.91 (1)
8. *Aman* (HYV), mustard, til	3.5	3,691.19 + (-5.86) + 619.00 = 4,304.33 (11)
9. *Aman* (HYV), wheat, til	1.4	3,691.19 + (-846.29) + 619.00 = 3,463.90 (13)
10. *Aman* (HYV), wheat, jute	0.5	3,691.19 + (-846.29) + 649.50 = 3,494.40 (12)
11. *Aman* (HYV), potato, til	10.7	3,691.19 + 2,559.41 + 797.12 = 7,047.72 (2)
12. *Aman* (HYV), mustard, *boro* rice	24.5	3,691.19 + (-5.86) + 3,263.33 = 6,948.66 (4)
13. *Aman* (local), *boro* rice	31.4	1,622.50 + 3,263.33 = 4,885.83 (10)
14. *Aman* (HYV), potato, jute	5.0	3,691.19 + 2,559.41 + 649.50 = 6,900.10 (5)

Note: (i) Figures in the parentheses represent ranks. (ii) The column of area (acre) follows from flowchart.

the profitability (Rs. 821.31) is found more than the profit of jute (Rs. 649.50) and of average profit of til (Rs. 797.12). That is however far less than the profit earned when *boro* rice is cultivated after local *aman* or mustard, which is calculated at Rs. 3,263.33. The average profit of *boro* rice remains more or less the same if it is grown after local *aman* or mustard. Yet, combination 7 (high-yielding *aman* rice, potato, *boro* rice) remains the most profitable combination yielding a net profit of Rs. 7,071.9 during 1993-94. Thus combination of high-yielding *aman* rice, potato and *boro* rice in successive seasons has been increasingly preferred by the cultivators to others. Accordingly, the cultivation of potato and *boro* rice has been accelerated over the years. This does not indicate that this combination gives the highest profit in all the years. In future, any other variety of crop/crops may be generated and thus a new crop combination may be developed that will yield higher possible net return than that of any other combination. Then the farmers may tend to switch over to that combination if other conditions necessary for the cultivation of those crops are available.

The flow of acreage towards the combination of local *aman* and *boro* rice is also very high despite much lower net profit (returns) (Table 3). One reason may be that nowadays local *aman* rice is generally grown on the fields, far away from the residential places of the farmers, where despite adequate irrigation facility *rabi* crops are not cultivated on a large scale because of the problems of transportation, management and protection. For early harvesting and the resulting transportation problem, short period crops are generally not grown on far interior fields and so are the *rabi* crops like mustard, potato. Only *boro* rice is cultivated after local *aman,* in the span of January-April, that is found to be more profitable than any other crop grown in that season. Moreover, in those areas many farmers grow *boro* rice on their own land and thus enjoy in addition to the net profit over total cost (as shown in Table 3) the amount of rent that is usually paid by a sharecropper to the landowner. Table 2 also reveals less variability of returns from combination 13, i.e., less risk is involved in its cultivation. Though mustard yields net negative profit over total cost including rent, it is preferred mainly by those who engage family labour for cultivation (as mentioned earlier that many of the farmers in the region are small and medium, who cultivate land themselves) and those who grow on their own land (as gross returns and returns over paid-out cost of mustard are moderate though not very attractive as is observed from Appendix Table 6).[23] This is also clear from the fact that those farmers do not give much weight on the value of self-labour and rent of self-owned land in their profit approximation. Moreover, in spite of high profitability of potato, during *rabi* season the cultivators (especially the small cultivators) do not always remain in a position to cultivate potato to the extent they desire. This is because of the highest cost per unit of land and the risk involved in the cultivation of potato (Appendix Table 6). Demand-supply mechanism and storage facility also matter much in this case. This would provide another reason behind the expansion of mustard (with the development of irrigation facility) despite much lower profit than potato. The profitability consideration also provides the reason why the growth of cultivation of mustard during the nineties decelerated irrespective of a high growth in the eighties (De, 1999 a). The flow of area towards combination 10, 4 and 2, which yield much lower total profit compared to that of others is very limited and production on a low scale is maintained only for domestic purpose (like jute) or to avoid risk, financial problem, infrastructure, etc.

CONCLUSION AND POLICY IMPLICATION

The whole analysis reveals that development of irrigation and technology in other fields are the main factors behind the relatively rapid expansion of cultivation of *boro* rice, potato and mustard in West Bengal. Growth of chemical fertiliser also plays an important role in accelerating the growth of those crops. Though availability of inputs, location of plots and technology of cultivation of crops play some important role, the relative profitability expected by the farmers from different combinations of crops ultimately becomes instrumental in the planning of allocation of limited land holdings of the cultivators. The farmers prefer that combination of crops from which they can derive maximum possible net revenue at least possible risk, if there is no dearth of essential factors of cultivation of those crops. Sustainability of income that can be obtained from their limited plots is also considered by the rational farmers. However, the choice of crops to be grown though a matter of cost-benefit in a commercial system, it is bound to come to a limit unless it is supported by those supporting factors like irrigation facility, availability of chemical fertiliser, improved implements and technical knowledge. A further technological break-through would bring new cost-benefit relatives and thus a new cropping pattern may emerge accordingly.

In a situation where the scope of bringing more land under cultivation and extension of multiple cropping is very limited, proper choice of cropping pattern can help in raising revenue from their limited plots. It is also possible to use land optimally and affecting productivity of soil less so as to sustain the farm income in the long run. The objective at the state level should be to give emphasis continuously on the research and development programme in order to develop short period, high-yielding and more resistant crops to properly utilise resources and to cope with the changing situation and needs of the people. Continuous breakthrough of technology is also required to generate alternative resources for the sustainability of the developmental process.

Received March 2001. *Revision accepted January 2003.*

APPENDIX

TWO-WAY CORRELATION TABLE 4

Variable (1)	LnR (2)	LnI (3)	LnC (4)	LnP_b (5)	LnY_b (6)	D (7)
LnR	1	0.198	0.324	0.133	0.198	0.368
LnI		1	0.267	0.296	-0.219	-0.043
LnC			1	0.91	-0.072	0.869
LnP_b				1	-0.087	0.770
LnY_b					1	0.320

Note: Value in the ij-th cell represents correlation between I-th and j-th variable.

TWO-WAY CORRELATION TABLE 5

Variable (1)	LnR (2)	LnI (3)	LnC (4)	LnPp (5)	LnYp (6)	LnPm (7)	LnYm (8)	LnPw (9)	LnYw (10)	D (11)
LnR	1	.198	.3246	.348	.1696	.2538	.3489	.2178	.1121	.384
LnI		1	.2671	.3477	.013	.2411	.1098	.259	-.127	.124
LnC			1	.744	.8095	.91	.8124	.823	-.420	0.88
LnPp				1	.4218	.784	.5855	.7403	-.357	0.63
LnYp					1	.735	.6615	.736	-.246	.716
LnPm						1	.685	.877	-.367	.745
LnYm							1	.538	-.374	.910
LnPw								1	-.289	.612
LnYw									1	-.415

Note: Same as correlation in Table 4.

TABLE 6. PER ACRE COST AND RETURN OF DIFFERENT CROPS IN THE SELECTED AREA (1993-94)

(Rs.)

	Cost				
Crop (1)	Paid-out cost (2)	Average total cost (3)	Maximum (4)	Minimum (5)	σ_n (average total cost) (6)
Aus (HYV)	3,777.50	5,952.50	6,138	5,604	254.51
Aman (HYV)	3,454.81	5,836.81	5,881	5,777	51.37
Aman (local)	3,177.50	4,777.50	5,041	4,584	225.65
Wheat	2,317.25	4,200.50	4,445	3,876	69.36
Mustard	2,676.05	3,625.76	3,803	3,484	158.35
Potato	10,791.61	12,491.61	15,390	11,231	552.96
Boro (after *aus*/local *aman*/mustard)	6,764.55	8,864.90	10,115	7,650	673.73
Boro (after potato)	6,618.34	8,188.69	9,125	7,456	451.63
Jute	3,173.00	4,990.50	5,454	4,566	443.78
Til (after *aus*/local *aman*/mustard)	2,356.00	3306.00	3,354	3,258	48.65
Til (after potato)	2,103.00	3,352.88	3,374	3,332	20.75

(Contd.)

TABLE 6 *(Concld.)*

Crop	Return					
	Average return	Maximum	Minimum	σ_n (average return)	Net return over paid-out cost	Net return over total cost
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Aus (HYV)	8,700.00	9,300	8,238	518.23	4,922.50	2,747.50
Aman (HYV)	9,528.00	10,200	9,013	588.00	6,073.19	3,691.19
Aman (local)	6,400.00	7,267	6,049	555.93	3,222.50	1,622.50
Wheat	3,354.21	3,626	2,886	83.59	1,036.96	-846.29
Mustard	3,619.90	4,566	3,147	688.99	943.85	-5.86
Potato	15,051.02	20,591	11,828	675.15	4,259.41	2,559.41
Boro (after *aus*/local *aman*/mustard)	12,128.23	14,168	11,815	35.64	5,363.68	3,263.33
Boro (after potato)	8,940.00	9,877	8,450	413.38	2,321.66	821.31
Jute	5,640.00	5,720	5,553	83.57	2,467.00	649.50
Til (after *aus*/local *aman*/mustard)	3,925.00	4,125	3,775	175.53	1,569.00	619.00
Til (after potato)	4,150.00	4,550	3,750	404.12	2,047.00	797.12

NOTES

1. If the society is a self-sufficient village economy, then need-based choice of cropping pattern is given much priority, the price or profit cannot exercise much power to impress the farmer; while in a modern capitalist society the decision of the farmers is guided by the profit motive. Production is organised mainly for market and thus price or profitability will be the major cause of variation in cropping choice, while the factors like soil structure, rainfall, irrigation, etc., are of much importance in all these situations. Untimely appearance of rainfall or lack of irrigation may throw some crop out of cultivation even though production is organised for making money. Prices of crops, which the farmers will not be able to cultivate due to any of the constraints, would not enter in decision-making.

2. Here the crop year is like a simple during which at present maximum three crops can be grown if sufficient irrigation is available. The year is supposed to start with the cultivation of *aus/aman* rice and ends up with the harvest of *boro* rice/til/ jute. It may be identified as one crop rotation or one crop cycle. Broadly the duration of *three seasons are: kharif (*June-July to November-December), winter or *rabi* (October-November to February-March) and summer (January-February to May-June). But within each season different crops may require different duration of time periods for maturity and duration of some crops overlaps between two seasons.

3. In a system of capitalist farming, farmers have no compulsion of producing any particular crop as was in subsistence farming. Here it is possible to collect the means of requirement from the market in exchange of money that had earlier been obtained in exchange of goods produced by the individual farmers.

4. Geographical structure includes the location of the place, elevation and slopes of agricultural land and other agro-climatic conditions.

5. Competing crops are defined as crops among which area shifts can occur. In other words, those are potential rivals who compete for any plot in a particular place. Different places may face different crops to compete for attracting land areas.

6. If price of any crop, especially the expected price increases relative to that of others, it is generally supposed to tempt the farmers to increasingly allocate land if possible to the production of that crop and vice versa. See Nerlove (1958); Narain (1965).

7. Due to lack of availability of data all the factors are not taken into account in the regression analysis.

8. Here rainfall of the year is considered though rainfall during the particular season when the crop is grown especially during pre-sowing time is important for the determination of acreage sown. It is because the data were not available in such way.

9. There is the likelihood of the presence of a time lag after which the effect (it has) would be realised.

10. The major competitor of *boro* rice in Burdwan is til. But the data on price and yield of til are not available for a major part of the period. Though price could be substituted by the price of its substitutes in use (consumption), say mustard, the method can hardly be applied for yield. Hence it is kept out of consideration.

11. Yield of *boro* rice has not increased significantly during the period under discussion. In Burdwan the exponential growth rate of yield of *boro* rice during the 1970-71 to 1993-94 period was only 0.102 per cent per annum. In the first half the trend rate growth was negative due to uncertain irrigation and during the second half the rate was significantly positive.

12. The question has been raised in several studies regarding the developmental impact of rigorous land reform measures (mainly collection and distribution of vested land and Operation Barga) undertaken by the Government of West Bengal. Some former evaluators have argued that in the self-evaluation made by the Government, the results have been manipulated in order to inflate the success of the programmes. Mallick, 1992, Harriss, 1993, Lieten, 1990, Rao, 1992 and Vaidyanathan, 1987 have acknowledged the turnaround of agricultural performance in West Bengal was due to significant growth of irrigation, especially, groundwater irrigation.

13. Cultivation of potato and *boro* rice is much costly affair. So only distribution of small plots to the landless people does not ensure the cultivation of crops on commercially unless financial and technical supports are extended to them.

14. Here it is presumed that during *rabi* season, there is a maximum manageable area supported by irrigation on which any kind of *rabi* crop can be grown (though different *rabi* crops require different quantity of irrigation). So in any year with unchanged irrigation, if cultivation of any crop is to expand, the area under any other must have to contract.

15. At that time India had to import much food to meet her domestic consumption needs. A large part of food imports during the 1950s came in the form of United States PL-480 aid, with generous repayment conditions. See Government of India (1959), and Rath and Patvardhan (1967).

16. This is because potato is more perishable than mustard and good storage facility is essential for its preservation if not sold immediately after the harvest. Thus the market of potato is relatively more unstable than that of mustard.

17. Sometimes a little early maturity may however be observed for crops due to disproportionate application of inputs but not without affecting yield rates.

18. The case would be different in a different agro-climatic region.

19. The late running crops are usually more vulnerable to pests and different bacteria.

20. High yielding *aman* is the newly generated varieties of paddy that are now increasingly cultivated in the place of traditional *aman*. The new one is generally planted in the month of July and harvested in October-November after which it is thus possible to grow mustard or potato. On the other hand the old varieties are planted normally in July-August and harvested in the month of December-January, after which cultivation of potato or mustard will become too late and the performance will not be good enough. However, wheat can easily be cultivated as usual. *Aman* (HYV), potato and jute can also form another combination like *aus* (HYV), potato and jute; but the same is not popular because of uncertainty in the jute market.

21. Two types of onion are generally grown. One in the purely *rabi* season and the other is normally cultivated in January-February and harvested in March-April.

22. One may also consider the interest on capital invested (loan or owned) for the cultivation of each crop but it will raise complicacy of calculation. The quantity of available capital also affects the cultivation of crops and that too differs for different size of farms. Here some farm takes loan from bank in a season but uses it for different purposes, inputs like fertiliser, pesticides are purchased on terms of payment after harvest at some higher prices. Not only that the farmer spends throughout the whole cropping season (from sowing to harvest and marketing) and it is not included to avoid complicacies in computation.

23. It is also clear from the farm management study (Vol. 36, 1993-94) conducted by the Evaluation Wing of the Directorate of Agriculture, Government of West Bengal, which presents data on cost, revenue and net benefit for different crops in different districts of West Bengal.

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