CONCLUSIONS

Thus, on the basis of the above findings, it may be said that there is not only large scale inter-regional disparity and inter-temporal fluctuation in the existing agricultural growth rates, but also there is a likelihood of such disparity and fluctuation affecting the future growth adversely. If the existing trend is any guide, in the years 1990 and 2000, inter-regional disparities in agricultural productivity would reach a new dimension in which the positions of Assam, Gujarat, Haryana, Himachal Pradesh, Maharashtra, Orissa, Uttar Pradesh and West Bengal in relation to Punjab would worsen considerably. The emerging strong backwash effect, thus, would not possibly be neutralized by the spread effect of the developed agricultural regions and Myrdallian analysis of such a situation would only make us believe about the dark future of balanced agricultural growth in India. Further the study reveals that in States like Assam, Himachal Pradesh, Kerala, Orissa and Uttar Pradesh, the growth rates of agricultural output in the green revolution period were much lower as compared to the pre-green revolution period. Even in Punjab, Haryana, Bihar and Andhra Pradesh where the growth rates were high during the green revolution period, the growth rates in the seventies were found much lower than that of the late sixties. To a great extent both inter-regional disparities and inter-temporal fluctuations in growth could be explained by inter-regional and inter-temporal differences (both qualitative and quantitative) in fertilizer consumption, area under irrigation, HYVs, rainfall and credit.

To conclude, once the growth promoting and growth retarding roles of various factors are, thus, identified, there is need for a concentrated effort to regulate and plan them for a long-term balanced agricultural growth.

THE CONTRIBUTION OF LOCATION SPECIFIC RESEARCH TO AGRICULTURAL PRODUCTIVITY*

K. Kalirajan†

The problem of the lagging performance of paddy in the High-Yielding Varieties Programme (HYVP) is of fundamental importance in India’s quest for increasing food production. Compared to wheat, the performance of rice to date has been all the more disappointing in view of the considerable number of exotic modern varieties (EVs) of paddy bred by the International Rice Research Institute (IRRI) in the Philippines that had been imported and released in India, and of the large acreages reportedly planted with them.

* Data collection and analysis were done while the author was in the Department of Economics, Research School of Pacific Studies, The Australian National University, Canberra. The author acknowledges helpful comments of J. C. Flinn, L. E. Small, R. W. Herdt, Y. Hayami, J. A. Wicks and S. K. Jayasuriya.
† Department of Agricultural Economics, International Rice Research Institute, Los Banos, Philippines.
Experience showed that these varieties failed to approach their experimental yield potential under field conditions and frequently achieved yields below or barely matching those of the existing local or local improved varieties (LIs). This raises the basic question regarding cultivation: What are the factors that constraint farmers from achieving the yield potential of the modern rice varieties?

Answers to this question can be grouped mainly under two headings: (1) technological or biological constraints and (2) behavioural or socio-economic constraints. Technological or biological constraints deal with the problems created by, for example, variety, soil type, diseases, water management and weeds. Behavioural or socio-economic constraints relate to the problems associated with farmer behaviour: his knowledge, perception of risk, institutional factors, credit and input supply and distribution. The focus of the International Rice Agro-Economic Network (IRAEN) research was to measure the ‘yield gap’ between actual and potential yield in farmers’ fields, to identify the factors which caused this gap and to explain why the gap existed. In this network research, the physical environmental—soil, climate and water control, and the institutional factors—farm size, tenurial status which the farmer cannot as a rule control are considered as given. Thus, fertilizer and insect control were the most frequently used test factors in the constraints research to measure the yield gap in terms of each of these variable test factors. Though the network has been successful in achieving its basic objectives, it also brings out the important point that careful monitoring of site-related variables in the future analysis is necessary so that experimental sites reflect the existing variability in the most critical non-managed factors. As Crawford observed, “the technologies must be location specific in details in recognition of wide variations in climate, soil types and topography.” Location specific research should take careful account of seasonal duration, variation in timing and control of water supplies and biological variations by location in pest and disease types. It requires that the national research system should be characterized not only by ‘lead’ centres in specific crops, but also by a group of research centres concentrating on testing and applications of location specific research.

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5. Herdt, op. cit.
However, setting up the research stations in different locations is not the end. Surely the key is moving the adaptive research into farm (fields) environments so that the evaluation of alternative technologies is in an environment of sure relevance or predictive ability from the farmers' viewpoint. Evaluation of varieties over locations has immediate pay-off to researchers and farmers. It is in this context that the present study examines the benefits of the location specific research for paddy in Coimbatore district, Tamil Nadu in partially removing the technological constraints. Specifically, this paper compares the physical performance of two recently released location specific modern varieties (LSVs) ADT 31 and CO 37 developed for Coimbatore irrigated areas by the Aduthurai Research Station and the Tamil Nadu Agricultural University respectively with an exotic variety developed at IRRI. This variety, IR20 was exclusively used in the Coimbatore irrigated areas in the early seventies.

STUDY AREA

Gobichettipalayam block being the most progressive in terms of area grown to modern varieties and input use was chosen as the study site. To reflect the adaptation process with LSVs at the most advanced stage at the time of the survey (May-August 1977), the most 'progressive' village in Gobichettipalayam block was selected from a random sample of farmers growing LSVs (41) and EVs (41). Data collection was carried on all key aspects of the rice production cycle.

MEAN INPUT LEVELS AND YIELDS

The differences between the per acre means of input use, yields and size of holdings for the sampled farmers are listed in Table I. It was found that

<table>
<thead>
<tr>
<th>Inputs and farm characteristics</th>
<th>Exotic modern varieties (EVs)</th>
<th>Location specific modern varieties (LSVs)</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size (acre)</td>
<td>2.40</td>
<td>3.65</td>
<td>2.04**</td>
</tr>
<tr>
<td>Hired labour (man-days)</td>
<td>209.49</td>
<td>186.02</td>
<td>1.63</td>
</tr>
<tr>
<td>Nitrogen (kg.)</td>
<td>45.71</td>
<td>46.09</td>
<td>0.58</td>
</tr>
<tr>
<td>Phosphorus (kg.)</td>
<td>23.07</td>
<td>21.06</td>
<td>1.27</td>
</tr>
<tr>
<td>Potassium (kg.)</td>
<td>20.73</td>
<td>21.46</td>
<td>0.44</td>
</tr>
<tr>
<td>Pesticides expenditure (Rs.)</td>
<td>118.90</td>
<td>110.60</td>
<td>0.59</td>
</tr>
<tr>
<td>Seed expenditure (Rs.)</td>
<td>52.70</td>
<td>53.60</td>
<td>1.01</td>
</tr>
<tr>
<td>Expenditure on other inputs (Rs.)</td>
<td>263.60</td>
<td>268.07</td>
<td>0.96</td>
</tr>
<tr>
<td>Yield (ton/acre)</td>
<td>1.77</td>
<td>2.68</td>
<td>3.29***</td>
</tr>
<tr>
<td>Sample size</td>
<td>41</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

Notes:— ** Significant at 1 per cent level.
*** Significant at 5 per cent level.

both the groups of farmers used similar levels of inputs, yet the mean yields of the LSVs were significantly higher than the EV. This suggests that there is scope for increasing paddy production substantially through LSVs without changes in infrastructure.

Thus, assuming the same cultural practices and application levels of all inputs for both the varieties, it is possible to find approximately the benefits from LSVs by measuring how much total production of paddy could be increased among sample participants by replacing EV with LSV seed. If the average yield increase of 0.90 ton per acre is multiplied by the total area under EVs (98.39 acres) in kharif (May-August), the total production of paddy could be increased to almost 89 tons in the study area. This suggests that there is scope for increasing paddy production substantially by switching from EVs to LSVs without changes in infrastructure. Thus, the data strongly implies the superiority of LSVs in increasing paddy production, but show that reaping the full benefits from LSVs will require all farmers to switch to them. The factors responsible for this superiority of the LSVs over the EVs is examined in the following section using yield function analysis.

**YIELD FUNCTION**

A Cobb-Douglas type of yield function was used as the analytical tool to measure the gain of the location specific research in Coimbatore district. Specifically, the study attempts to measure the differences in the shape and as well location of the yield curve using LSVs and the yield curve using EVs.

Assuming that the yield curve of LSVs differ both in the shape and location from that of EVs the intercept and slope dummies\(^{11}\) were introduced into the yield function, thus:

\[
\ln y = \ln D_1 + \ln D_2 + \ln D_{12} + \sum_{i=1}^{4} (\beta_i + \beta_iD_i) \ln X_i + u \quad \ldots (1)
\]

The variables included in the above function (1) are as follows:

- \(y\) represents yield per acre of paddy cultivated;
- \(x_1\) is labour input per acre in man-days;
- \(x_2\) is per acre expenditure on fertilizer application which includes expenditure on fertilizer and total wages paid to labourers applying fertilizer;
- \(x_3\) denotes per acre capital flow which is the sum of depreciation, maintenance and opportunity costs of capital stock such as agricultural implements including animal and machine plants;
- \(x_4\) is per acre expenditure on other inputs which is composed of expenditure on seeds, and cost of hiring of bullocks, tractors and sprayers.

The incidence of brown plant-hopper (BPH) attack on both LSVs and EVs was reported during the survey. In fact, BPH attack had been reported

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10. Hence one needs to know why some farmers lag in the adoption process. In the study area, in fact, only 11 per cent of the total area was under EVs in kharif 1977 thus showing IR20 was fast losing its popularity.

ever since the *kharif* season of 1973 in the study site. This necessitated the sample farmers to take preventive measures against BPH. Even then, they could not eliminate BPH as the pests learn how to cope with the pesticides through selective breeding. Since all sample participants had applied pesticides, almost as recommended by the extension officials, representation of plant protection in equation (1) either in monetary or physical terms could not explain yield differences significantly. In this analysis, therefore, a dummy variable \( D_3 \) was included to take account of this fact, utilizing data from personal field observations and from questionnaires. The value of unity was given to instances where the attack was not severe, and zero was given otherwise. The dummy variable in depicting the severity of the attack thereby reflects too the susceptibility of the varieties and the effectiveness of protective measures taken by farmers. It enters the production function as a shift variable, implying that the absolute difference in yield between fields severely attacked and those pest free or mildly attacked is independent of the quantities of inputs included in equation (1).

A varietal dummy \( (D_1) \) was also introduced into the production function by assigning values of unity to LSVs and zero to EVs. The coefficients of the dummy variables together with the constant term provide an estimate of the shifts in the value of yield, the dependent variable \( (y) \).

\( D_{12} \) is the interaction between the dummy variables \( D_1 \) and \( D_2 \).

\( u \) represents the disturbance term with \( N (0, \sigma^2) \).

The method of ordinary least squares was used to estimate the yield function.

**RESULTS AND DISCUSSIONS**

Table II shows that the slope coefficients in relation to managed inputs are not significantly different between LSVs and EVs. However, the intercept shift dummies \( (<<) \) and BPH control \( (<<<<) \) are statistically significant.\(^{12}\) We cannot therefore accept our hypothesis that the yield curve of LSVs has shifted non-neutrally in relation to that of EVs. This, *inter alia*, implies that the conventional factors of production are not responsible for the differences in yield between the LSVs and EV. That is, major factors such as variety and BPH control are contributing to this gap.

The contribution of each of these factors to this varietal yield gap was measured by the following way. Assuming the stability of the slope, and only differentiating BPH attack by variety, equation (1) can be reduced to:

\[
\ln Y = << + \sum_{i=1}^{3} <_{i} D_i + <<_{3} D_{12} + \sum_{i=1}^{4} \beta_i \ln X_i + u \quad \ldots \quad (2)
\]

The results (Table III) show that the estimates of coefficients of labour, other inputs and capital are positive and significant at the 5 per cent level. The results imply that a one per cent increase in labour man-days would increase yield by 0.03 per cent whereas a one per cent increase in other inputs is predicted to increase yield by 0.01 per cent, and that a one per cent increase

\(^{12}\) It is possible that multicollinearity among the explanatory variables might have made some of the differential coefficients insignificant.
**Table II—Tests of the Stability of Slope and Intercept between LSVs and EVs Using Cobb-Douglas Production Function**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$ (constant)</td>
<td>0.5240**</td>
</tr>
<tr>
<td>$D_1$ (Location specific variety dummy)</td>
<td>1.2582***</td>
</tr>
<tr>
<td>$D_2$ (Minor BPH problem dummy)</td>
<td>0.1179**</td>
</tr>
<tr>
<td>$D_{12}$ (Interaction dummy)</td>
<td>0.2065**</td>
</tr>
<tr>
<td>$\ln X_1$ (Labour)</td>
<td>0.0503</td>
</tr>
<tr>
<td>$\ln X_2$ (Fertilizer application)</td>
<td>0.0369</td>
</tr>
<tr>
<td>$\ln X_3$ (Capital flow)</td>
<td>0.0108**</td>
</tr>
<tr>
<td>$\ln X_4$ (Other inputs)</td>
<td>0.1253**</td>
</tr>
<tr>
<td>$D_1 \ln X_1$</td>
<td>-0.0562</td>
</tr>
<tr>
<td>$D_1 \ln X_2$</td>
<td>-0.0320</td>
</tr>
<tr>
<td>$D_1 \ln X_3$</td>
<td>0.0026</td>
</tr>
<tr>
<td>$D_1 \ln X_4$</td>
<td>-0.0649</td>
</tr>
</tbody>
</table>

$R^2 = 0.7268$

*Notes:* Figures in parentheses are standard errors of estimates.

*** Significant at 1 per cent level.
** Significant at 5 per cent level.

**Table III—Estimated Parameters of Cobb-Douglas Production Function for Sample Participants Growing LSVs and EVs in Kharif Season**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$ (constant)</td>
<td>0.1005**</td>
</tr>
<tr>
<td>$D_1$ (Varietal dummy)</td>
<td>0.3060***</td>
</tr>
<tr>
<td>$D_2$ (BPH control dummy)</td>
<td>0.1082**</td>
</tr>
<tr>
<td>$D_{12}$ (Interaction dummy)</td>
<td>0.1002**</td>
</tr>
<tr>
<td>$\ln X_1$ (Labour)</td>
<td>0.0258**</td>
</tr>
<tr>
<td>$\ln X_2$ (Fertilizer application)</td>
<td>0.0032</td>
</tr>
<tr>
<td>$\ln X_3$ (Capital)</td>
<td>0.0100**</td>
</tr>
<tr>
<td>$\ln X_4$ (Other inputs)</td>
<td>0.0115**</td>
</tr>
</tbody>
</table>

$R^2 = 0.7309$

*Notes:* Figures in parentheses are standard errors of estimates.

* Significant at 10 per cent level.
** Significant at 5 per cent level.
*** Significant at 1 per cent level.
in capital would increase yield by 0.01 per cent for LSVs and EVs. The results further show that the fertilizer coefficient of 0.01 is significant at 10 per cent level only for both the varieties. All these estimates indicate that the yield of both the varieties could be increased only by small amounts by increasing the application of these inputs. The results further show that the estimates of the coefficients of $D_2$ and $D_{13}$ are statistically significant at the 5 per cent level. This means that the effectiveness of BPH control increased the net yield considerably, but in the case of LSVs the increase was more substantial. The coefficient of $D_1$ is significant at the one per cent level, implying that the net increase in yield from using LSVs was much higher than by using EVs. Thus the significant interaction coefficients of BPH control, $D_{12}$, and the significant varietal dummy $D_1$ show that the higher yield inherent in the genetic characteristics of LSVs, and their other biological characteristics which have a positive influence on BPH control, are the two major factors identified as explaining the varietal yield gap.

The critical factor explaining the difference in the effectiveness of BPH control between the varieties appeared to be the difference in their maturity period. The LSVs mature earlier (105-110 days) and the shorter season effectively cuts off part of the build-up period of BPH. By contrast, there seems to be a coincidence between the build-up of BPH and the longer maturity period (130-135 days) of EVs that is favourable to the BPH and results in greater damage. The pesticides are not able to control BPH successfully in the case of EVs, owing to the greater intensity of the build-up over the longer period of maturity, while the shorter duration of the LSVs enables pesticides to work more effectively.\(^\text{13}\)

The results show that there was a neutral upward shift in paddy production with the substitution of LSVs for EVs and BPH reduced the yields of EVs more than LSVs. Thus the identification of the LSVs suitable to locational environment which brings out the higher yielding characteristics inherent in their genetics and their shorter duration were the important factors explaining the varietal yield gap. The combination is of great importance in the quest for increased paddy production in the country. It also brings increased income to farmers cultivating LSVs, and an increased supply of rice to the market. Further, it is interesting to note that the sample farmers obtained a yield of 2.83 tons/acre (estimated from the yield function) using LSVs, whereas the experimental station’s yield was 2.92 tons/acre. This implies that the ‘yield gap’ defined by De Datta et al.\(^\text{14}\) is very small in the study area. It therefore seems reasonable to assume that the lack of LSVs was previously the major constraint restricting the farmers from achieving the potential of the HYVP.

CONCLUSIONS

The analysis shows considerable achievements have been realised in the production of paddy in Coimbatore district through the location specific

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14. op. cit.
research: (i) appropriate identification of the local growing conditions by the paddy breeding research station; and (ii) effective evolution of LSVs to suit these local conditions. These LSVs cannot be considered as some newer HVV with high potential in general. The fact that there is a substantial yield difference between the experiments conducted using ADT 31 at the Aduthurai Research Station in Tanjore district (2.02 tons/acre) and Paddy Breeding Station in Coimbatore (2.92 tons/acre) implies that the genotype attains its maximum biological performance only in Coimbatore irrigated areas. However, these performances do not mean that there is no technological and institutional hurdles in the study area in the cultivation of LSVs in the kharif season. The introduction of LSVs, for example, only partially helped to lift the major biological constraints (BPH) on IR20 yields. The current LSVs, however, were by no means the final answer to the control of BPH in the kharif season. It it often argued that a variety whenever is promoted as being resistant to some insects, is not resistant to others, and as a consequence multi-factor, integrated, pest control research measures may lag. However, the existence of different bio-type of BPH requires that research on insect resistance should be dynamic in nature requiring the breeders to evaluate the materials in these environments for which the varieties are intended. That is, the breeder must appreciate the problems of the site.

If short duration LSVs were available, Gobichettipalayam block might possibly be converted from a two to a three crop area, without changing existing irrigational facilities. The location specific research might thus be able both to increase the productivity of land and to transform the cropping system. Thus, the present study, limited though it was in terms of survey, season, area, and sample has served to provide some indication of an optimistic account of the prospects for accelerating agricultural growth in the near future. However, in the long run the prospects depend on the policy options of the Government. It is argued that policy making and resource allocation has to make the difficult choice of a balance in emphasis between the two directions of adaptation of the technology: (i) the degree to which a nation should depend on research for the continuous evolution of varieties to better fit the existing environment; and (ii) the extent to which it should distribute its


16. It would have been interesting, had we compared these LSVs with the later IRRI varieties such as IR26 and IR28 which are resistant to BPH. But they were not popular and also did not show the expected resistant qualities.

17. Herdt and Barker, op. cit.


resources to modify the environment with improved infrastructure to realise the potential of the existing varieties.

A cost-benefit analysis would have given more insights to this problem, but owing to our data constraint, it could not be attempted here. However, it is not rational for a country like India with differing dimensions and characteristics of agricultural growth in different regions to depend entirely on anyone of these two alternatives of investment and research. As Dantwala has argued, in the long run the best policy-mix could be a combination of technology and public investment in agricultural infrastructure depending on the specificity of the country’s temporal and spatial situation.

A STRATEGY FOR AGRICULTURAL GROWTH IN THE DRYLAND FARMING AREAS OF HARYANA

I. J. Singh and K. N. Rai*

The usual definition of growth of a particular sector is a sustained increase in its total and per capita product, most often accompanied by a sustained and significant rise in population. In order to have a sustained increase in a particular sector, stability in its production is the primary requirement. Therefore, between the twin problems of increased and stabilised agricultural production in the dryland tracts, stable agricultural production comes first in the planning priorities. As such, the present paper attempts to suggest suitable agricultural growth strategy via farm income stabilisation in dryland areas of Haryana.

METHODOLOGY

The data for this study were obtained both from farmers and secondary sources. Hissar, Sirsa, Bhiwani and Mohindergarh districts which form the major part of dryland tract of Haryana State were selected. The dryland tract selected for this study was divided into two zones based on average yearly rainfall. The Hissar zone had 328 mm. annual rainfall. The Narnaul zone had more than 328 mm. annual rainfall. Field data on input and output for crops and dairy enterprises on farms were obtained from 240 randomly selected farmers (78 small, 42 medium and 30 large from Hissar zone; and 52 small, 23 medium and 15 large from Narnaul zone). Secondary data on yield and prices of food and non-food crops for ten years (1965-66 to 1975-76) were obtained from the Statistical Abstract of Haryana. Secondary data on dairy enterprise were collected from the office of the Chief Superintendent, Government Livestock Farm, Hissar. The input-output coefficients for the recommended crops


* Professor and Head, and Assistant Scientist, respectively, Department of Agricultural Economics, Haryana Agricultural University, Hissar.