NEW WHEAT VARIETIES AND SMALL FARMERS

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Introduction

The distribution of the benefits of new agricultural technologies is the subject of continuing controversy, especially following the widespread adoption of new wheat and rice varieties in developing countries over the last 10-15 years. This paper is motivated by the popular belief that the introduction of the new wheat varieties has benefited the rich at the expense of the poor (see, for example, Pearse; and Simmonds). We believe that the available evidence on the impact of the new wheat varieties supports a quite different conclusion--that the poor have benefited substantially from these new varieties. Here we summarize evidence on only one aspect of the distribution of benefits from new wheat varieties, the distribution of benefits to poor producers relative to larger producers (Byerlee and Harrington). Conceptual issues in analyzing these benefits are discussed and empirical evidence, especially new evidence appearing since 1975, is presented from Mexico, India, and other countries where the new wheat varieties are widely used.

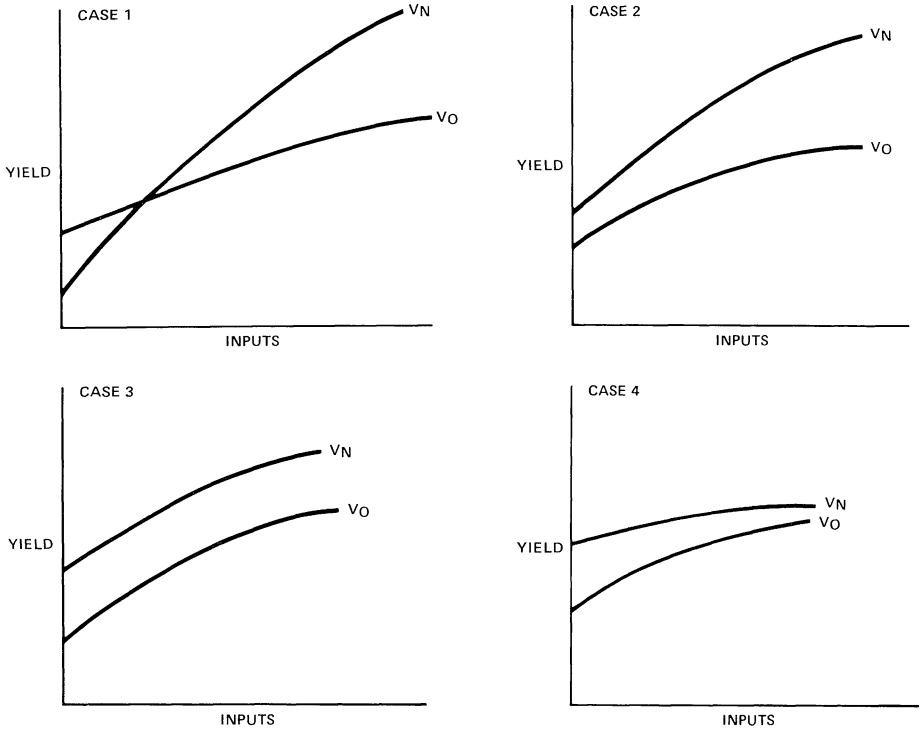
Conceptual Issues in Analyzing Varietal Change by Farm Size

An analysis of the impact of new varieties should begin with a knowledge of their biological characteristics and how these interact with such specific characteristics of small farmers as subsistence production, risk aversion, and capital scarcity. By far the greatest controversy with respect to the new wheat varieties surrounds the question of the interaction between variety and input use, and its implications for small farmers who may not be able to operate at higher levels of inputs because of capital scarcity or lack of access to purchased inputs. Four cases of variety by input interaction are shown in figure 1. The prospects for developing varieties that give substantial increases in productivity independently of changes in input use (Case 3 and Case 4) are limited except where breeding for pests and disease resistance can be substituted for use of pesticides or where an earlier maturing variety allows increased cropping intensity.[2] Through history, productivity increases have largely resulted from increased input levels and improved cultural practices, sometimes independently of varietal changes. New varieties have contributed to productivity increases by exploiting positive interactions between variety and higher input use--Case 2 and Case 1. Increased productivity among small farmers then depends in large part on increasing input use. For small farmers, Case 2 will be preferable to Case 1, since the new variety can be adopted independently of a package with higher input levels, allowing the farmer to benefit in the short run while input levels are increased gradually over the long run. However, in more favoured areas (e.g., where purchased inputs are already widely used or where water is readily available through irrigation), the relevant position of the Y-axis is shifted to the right and Case 1 may be indistinguishable from Case 2.

The impact of a new variety on the distribution of benefits by farm size depends on three factors: time lags in adoption by different size farmers, final level of adoption of the new variety by farm size, and productivity of the new variety when adopted by different size farmers. Note that a "scale neutral" variety that is widely adopted with equal productivity by all farm size groups will result in equal relative distribution of benefits but greater absolute gains to larger farmers because they control a larger resource base.

Figure 1. Possible Cases of Interaction of Variety and Input Use on Yields

(V_O = Farmer Variety, V_N = New Variety)



Agronomic Characteristics of the Semidwarf Wheat Varieties

Much of the criticism of the new varieties arises out of a misunderstanding of their agronomic characteristics. It is widely believed that breeders of the new varieties have developed varieties represented by Case 1 in figure 1 when they should have emphasized Case 4 in order to benefit small farmers directly.

Although the semidwarf wheat varieties have often been described as a "quick technological fix," their development was based on nearly 20 years of research which preceded their release in Mexico. This earlier work gave initial priority to disease resistance, especially stem and leaf rust, which was the factor immediately limiting productivity at that time in the most important wheat areas of Mexico. The development of semidwarf wheat varieties helped overcome the next major factor limiting yields—the inefficiency of dry matter conversion to grain and heavy lodging as input use increased. These varieties had a greatly increased ability to respond to higher fertility levels and also increased efficiency of nitrogen use, even at relatively low levels of application (Fischer and Wall).

The semidwarfs were developed and diffused under irrigated conditions which characterize well over half the bread wheat production in developing countries. However, evidence from widespread testing of the semidwarfs under rainfed conditions indicates that their yield advantage is still positive, although smaller in drier areas (Laing and Fischer). Of course, the first semidwarfs were not

adapted to all conditions. In particular they were susceptible to some diseases such as septoria, had short coleoptiles which were not suitable for sowing into residual moisture, and in some cases provided less competition against weeds. Later released varieties improved on many of these deficiencies.

The new wheat varieties, then, tend to conform to Case 3 of figure 1, in the sense that they have superior resistance to certain diseases, and to Case 2 in their interaction with higher input levels, particularly soil fertility and moisture availability. That is, they should be appropriate to small farmers, but higher input levels are needed for significant productivity increases. There is little, if any, indication that they conform to the undesirable Case 1.

The semidwarf wheat varieties, by greatly increasing response to moisture and fertility, were a breakthrough in increasing productivity in areas with generally adequate moisture, especially irrigated areas. In dryland areas, moisture is the critical limiting factor and this is most effectively overcome through changing cultural practices to more efficiently utilize available moisture through weed control and fertility, and increased soil moisture conservation through tillage techniques (Bolton).

Adoption and Productivity by Farm Size

Evidence from Mexico: The Yaqui Valley

The introduction of the semidwarf wheat varieties in Mexico in the early 1960s, combined with increased input levels and improved cultural practices, resulted in almost a doubling of wheat yields from 1960 to 1970. Until recently the only detailed study of the impact of the new wheat varieties in Mexico was provided by Alcantara whose work in the Yaqui Valley has been widely cited by critics of the new wheat varieties. According to Alcantara, the release of these varieties created substantial hardship for the ejido sector (the units created by the land reform programme in Mexico and generally recognized as the "small farmer" sector). The official bank which served much of the ejido sector provided incorrect inputs or delivered inputs late and failed to give adeqate technical advice (Hewitt). Because the ejido farmer was not able to use the new inputs effectively, his yields lagged well behind those of large farmers. The net result was that the ejido farmers became indebted to the credit bank, sold off many of the inputs to large farmers and eventually rented out their land to large farmers. Alcantara concluded that this process resulted in 80 percent of the ejido farmers giving up control of their land so that land was eventually concentrated in the hands of a few farmers with 500 ha or more.

In 1981, 10 years after Alcantara's field work, we conducted a survey of over 100 farmers in Yaqui Valley and reached quite different conclusions (Byerlee). In the ejido sector, we estimated that a maximum of 20 percent of farmers were renting out their land. We also found a surprising number of small private farmers with similar farm size to that of the ejido sector. Finally, although we encountered differences in the wheat production technologies between small and large farmers, these differences were not large and resulted in a relatively small yield advantage of 10 percent to large farmers.

The question arises as to why such large differences exist between these two studies conducted 10 years apart. It seems that Alcantara's assessment of the situation 10 years earlier is somewhat overstated. In one widely cited passage, Alcantara notes that the yield gap between the ejido sector and private farmers increasingly widened during the 1950s and 1960s, in contrast with the 1941-1945 period when yields in the ejido sector were similar to private farmers. What Alcantara fails to point out (although the data are presented) is that yields in the ejido sector more than quadrupled from 0.8 ton/ha in 1941-1945 to 3.7 ton/ha in 1970.

Nonetheless, there is no doubt that problems with the official credit bank and lack of an effective extension service slowed productivity increases in the ejido sector, and that one of the major reasons for improved performance of this sector in our 1981 survey is the better performance of the credit system (although problems still exist). Finally, the lower degree of land concentration that we observed is due in part to the land reform of 1976, when some 30 percent of private land held by the largest farmers was expropriated to be worked as collective ejidos with an average of 5 ha for each farmer.

We do not claim that income in wheat growing areas of Mexico is equally distributed--far from it. However, the great majority of farmers in the Yaqui Valley (90 percent) are farmers of the land reform sector or private farmers with 25 ha or less who together control well over half the land area--quite different from Alcantara's picture of a few large farmers of 500 ha or more. Moreover, the substantial inequality in income between the bulk of the small farmers and the large farmers (50 ha or more) is due to the size of the resource base, not productivity differences due to technology.

Evidence from India: The Punjab

There is little doubt that in the wheat growing areas of India, small farmers adopted new wheat varieties with little if any lag behind large farmers (Dasgupta; and Sen). New wheat technology was introduced through mass action programmes in which participation of small farmers was actively encouraged (Sen). Evidence from various measures of productivity indicate that small farmers are using the new wheat varieties and achieving levels of productivity similar to large farmers. Productivity as measured by yields is similar in both small and large farmers (Pearse; and Talib and Majid). Farm income/ha is consistently higher for small farmers (Punjab Agricultural University). Finally, production function analysis of survey data from the Punjab indicates no differences in technical and economic efficiency in wheat production by farm size (Sidhu and Baanante).

The evidence from the Indian Punjab is that small farmer incomes have increased substantially in the last two decades as a result of the introduction of the new wheat technology. Indeed, there is good evidence that both incomes and consumption have become less concentrated over time (Ahluwalia; and Punjab Agricultural University). This seems to relate in part to reduced concentration of land holdings due to new land reform regulations in 1972 (Bhalla).

Evidence from Other Countries

Evidence from the Pakistan Punjab, which has a higher degree of share tenancy, shows an essentially parallel experience to the Indian Punjab, with all farm size groups rapidly adopting the new wheat varieties (Lowdermilk; and Khan). The semidwarf wheats have also been widely adopted under rainfed conditions from Turkey to Argentina. Wheat varieties with similar agronomic characteristics, combined with increased irrigation and chemical fertilizer use, have also rapidly increased wheat productivity in China. However, the most dramatic uptake of the new wheat varieties occurred in Bangladesh from 1975 to 1981 when area under wheat increased from 100,000 ha to over 600,000 ha and wheat yields more than doubled. Over 95 percent of the area was planted with the semidwarf wheat varieties imported from India and Mexico--the majority on rainfed or residual moisture. Average wheat area sown was only 0.5 ha per farmer and about half the wheat was used for subsistence consumption (Swenson et al.). Here the new wheat varieties grown with relatively low costs of inputs--fertilizer is the only major purchased input--have proved particularly appropriate to small subsistence farmers operating under moisture limiting conditions.

Interregional Income Disparities

There has also been considerable discussion of widening interregional income disparities especially in Mexico and India where much of the wheat is grown under irrigated conditions so that the new varieties, at least initially, were adopted in areas with relatively high incomes.

This may widen relative income disparities but should not adversely affect absolute income levels in poorer regions unless public investment allocation is distorted toward the better endowed regions by the new technology, or the increased production in better endowed regions reduces prices to producers in poor regions. The latter case, however, benefits poorer consumers. Research whose specific objective is to increase the incomes in poorer regions might have had different crop priorities and emphasized different problems (e.g., improved management for maize in highland areas of Mexico).

Conclusions

Critics of the impact of the new wheat varieties have correctly drawn attention to the fact that technology does not solve rural problems rooted in long-standing social inequities. They have also highlighted the need for agricultural institutions to efficiently serve all classes of farmers--not just the large and influential. Nonetheless, they have done a disservice by claiming that the new varieties have increased rural poverty and inequality. Small farmers have gained substantially from the new wheat technology--in some cases relatively more than large farmers. The critics have also been misleading in describing the new varieties as input dependent, and raising the prospect that new varieties can be developed for low input conditions that will significantly contribute to improving small farmer welfare. Development of varieties for some low input conditions, especially low moisture and nitrogen fertility, is likely to give relatively small gains at a high cost compared to efforts to improve cultural practices through greater use of purchased inputs such as fertilizer. Agricultural development, whether for the small subsistence farmer of Bangladesh or the commune farmer of China, is characterized by increased management intensity, usually associated with greater use of capital per unit of land area in land scarce areas. The new wheat varieties, by providing a dramatic jump in input responsiveness--especially water and fertilizer--have served as a catalyst, both to higher use of purchased inputs by farmers and to government institutions to provide the appropriate inputs. In less favourable environments, considerable investment in research, especially on-farm research with a farming systems perspective, is needed to develop improved agronomic practices if productivity is to be increased. Finally, in the wheat growing areas of both India and Mexico, there have been significant shifts in land ownership toward small farmers associated with land reform programmes of the 1970s. One might speculate that sharp increases in land values as a result of the new technology have in part stimulated pressure from the landless for these reforms.

Increased production of wheat resulting from technological change also benefits poor consumers to the extent that wheat prices fall, and wheat is relatively more important in the diet of poorer consumers than higher income consumers. Elsewhere we have shown that in both India and Mexico, the real domestic wheat prices to producers and consumers have fallen significantly over the last two decades relative to the real prices of imported wheat (Byerlee and Harrington). Wheat consumption has also increased relative to other cereals, particularly for the poorer consumer groups in India. Finally, the increased supply of wheat in both Mexico and India has been used in part to substitute for imports. There is no doubt that the rapid and widespread increases in wheat production in the developing world have been large enough to affect world wheat

prices. Since developing countries account for two thirds of world wheat imports, reduced wheat prices have widespread benefits for consumers in many countries.

Notes

[1]Economics Program, CIMMYT, Mexico. The views expressed are not necessarily those of CIMMYT.

[2]A pest resistant variety may exhibit a Case 4 response to pesticide inputs but still show a Case 2 response with respect to other inputs such as fertilizer.

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OPENER'S REMARKS—G. W. Furness

The authors are to be congratulated on the presentation of two papers which refreshingly report activities and findings at the farm level (in contrast to the more general papers delivered at the earlier sessions).

Best's extension project is particularly interesting in being directed to the poorest group of farmers in Sarawak. It would, however, have been valuable to have some indication of the ranges of farm sizes represented by the model profiles given in table 1. While it was good to hear that the local farmers had been consulted concerning the improvement options which might be adopted, it is surprising that, apparently for equity reasons, Best suggested that the prime objective should be individual producers' self-sufficiency in rice production. Are there no cases in which the alternative of concentration on cash crops would provide the income with which to purchase rice? Also, it would be of interest to know what economic appraisals were made of the proposed courses of action and to hear what have been the initial responses of the 1,900 households to the messages being carried to them.

Byerlee and Harrington examine some empirical evidence of the benefits of new wheat varieties to farms of different sizes. In this paper, it could have been helpful to have a definition of "small farms," and it is somewhat disconcerting that improved yield per ha is the chief measure of productivity; this may inadequately measure benefits. Although it is demonstrated that those small farmers who have adopted new wheat varieties, and used appropriate inputs, have achieved yields as high as those of large farmers, the benefit to small farmers generally may not be so great, where a smaller proportion has been able to adopt the new varieties or where some, for reasons of palatability, choose to grow the traditional varieties for their own consumption. Also, is it possible that farmers in the areas of Mexico and the Punjab quoted have received comprehensive extension aid and that elsewhere fewer small farmers may have responded?

OPENER'S REMARKS—M. G. Chandrakanth

Best's Paper

The revenue obtained from felling the mature rain forest could be considered as an income; who realizes this income if the farm household does not?

Perhaps it is the adoption of new technology which has resulted in the ecological crisis, rather than vice versa.

The optimum time of replanting and optimum rate of harvesting should be examined. The social optimum (considering the social profits and ecological balance) approach could be used instead of pure private profit considerations.

The paper also raises the issue of ecological optimum in rural land use planning, indicating the allocation of land to wood and food.

What are the specific programmes designed to improve the tribals? Can they not be motivated to shift from their present practices?

Byerlee and Harrington's Paper

New wheat varieties, poor producers, and poor consumers: no development effort, be it through HYV, credit and marketing facilities, insurance or any other infrastructural facility, or its multiplier effects, can percolate down to the have-nots unless the magnitude of inequality is reduced. In India, 14 percent of medium and large farmers account for 61 percent of the total area operated, while 51 percent of submarginal and marginal farmers operate only 9 percent of the area, which reflects the huge degree of land resource inequality.

As the authors indicate, it is not the scale neutrality of modern technology but the degree of accessibility to it which creates huge inequalities in developing countries.

Regarding the price advantage to poor consumers and producers, in the developing countries, due to the presence of a large number of middlemen, and irregularities in the operation of regulated markets and cooperative marketing institutions, would consumers, farmers, or middlemen benefit from price falls or rises? Even in the so-called public distribution system, to what extent are such facilities really serving the rural poor?

It is usually large farmers who are the innovators in adopting HYV. Perhaps the only alternative would be to accept Hirschmann's unbalanced growth approach of deliberately unbalancing the economy, and then realize the multiplier effects later.

RAPPORTEUR'S REPORT—G. O. Hughes

The discussion of Best's paper concentrated on other potential sources of income, including nonagricultural sources, alternative cash and subsistence crops, and new technology.

Income from "jungle produce" was suggested, but the author believed that this offered little scope for any real improvement. The production of wet rather than hill rice as a means of overcoming the farmers' rice deficit was proposed, but the author had doubts as to the viability of such a policy, given the large capital investment required. He suggested that maize, legumes and even tobacco might be more feasible. Fast growing softwood might be another possibility. At the moment, there is no exploitation of the timber cut under the forest-fallow system and this could have some future potential.

The development of permanent cultivation would reduce the land available for the practice of forest-fallow, thus posing a further threat in the system. The author disagreed with the suggestion that the ecological crisis in forest-fallow areas was due to the planting of cash crops, and attributed it rather to the insufficient fallow period resulting from population pressure. There was general agreement that research on new technology for tropical farming under rainfed conditions had been neglected in the past and that greater priority should be given to this matter in the future.

The definition of small farmers and productivity was considered in the discussion of Byerlee and Harrington's paper. Questions on the palatability of the new wheat varieties were asked, but the authors had not found this a serious problem, as it had been with some of the new rice varieties. The question of whether the diagrams represented experimental on-farm data arose, and the authors pointed out that they were in fact neither, but rather four possible cases of interaction between varieties and inputs. It was also explained that the management caption was misleading and that the input axis was essentially fertilizer and water. It was suggested that their findings might be invalidated because of large numbers of nonadopters in the study areas. This was rejected by the authors who had found fairly rapid and widespread adoption, and that "word of mouth" had been important in the spread of the new varieties. Finally, the extent to which the new varieties could save rural poverty was discussed and the view was that new technology was not sufficient, and that, ultimately, the solution lay at the sociopolitical level, particularly with respect to land reform.

Participants in the discussion included Elisabetta C. Angelini, Wilhelm Brandes, D. K. Britton, R. J. Dancey, A. K. Giles (Session Chairman), Laurent Martens, and C. L. J. van der Meer.