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ABSTRACT

The purpose of this paper is twofold: (1) it presents some empirical findings of the relative importance of both "economic" and "communication" variables in the diffusion of an innovation (dwarf wheats) in an unirrigated region of Pakistan which is densely populated by smallholders. The sample of farmers reported are representative of a class of low-income farmers who were supposedly left out of the benefits of the Green Revolution; and (2) it attempts to generate a nexus of opinion between the "development economist" and the "communication specialist." The study data presented show that both "communication" and "economic" variables are necessary for two main aspects of diffusion: (1) changing farmers' cognitions of new varieties of seed, and (2) influencing innovativeness. It was also found in this study that any program designed to diffuse agricultural innovations must first concentrate on creating awareness among smallholders in general; and (3) the smallholders live in such a situation that cognitive changes in knowledge must accompany economically desirable innovations in order to have a rapid pattern of adoption. For guides in designing future programs, the following are suggested: (1) Channels of communication between research outlets and farmers should be strengthened so that smallholders are kept informed of available innovations; and (2) Since interpersonal contacts are especially needed to reach the smallest farmers, extension efforts should be enhanced. (Author/DB)

# A STUDY OF THE RELATIVE IMPORTANCE OF COMMUNICATION AND ECONOMIC VARIABLES IN DIFFUSION: DWARF WHEATS ON UNIRRIGATED SMALL HOLDINGS IN PAKISTAN

by

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## INTRODUCTION

Developing small farm holdings constitutes a strategic objective of Third World Governments, international organizations and not least, a multitude of academic disciplines. Since the advent of the Green Revolution,[1] it is now widely accepted that an important aspect of the development process is the diffusion of yield-increasing innovations.[2]

The purpose of this paper is twofold. For one, it presents some empirical findings of the relative importance of both "economic" and "communication" variables in the diffusion of an innovation (in this case dwarf wheats) in an unirrigated region of Pakistan which is densely populated by smallholders. Important to this discussion is the realization that the sample of farmers reported in this study are representative of a class of low-income farmers who were supposedly left out of the benefits of the Green Revolution.

Secondly, this paper attempts to generate a nexus of opinion between the "development economist" and the "communication specialist."[3]

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1. Numerous articles and books have now been written about this historic episode. For a couple of recent issues with up-to-date references see: Carl H. Gotsch [9] and Sheldon K. Tsu [24].

2. Organizational forms, technology and/or genetically improved varieties of seed, which are perceived as new by farmers, constitute examples of innovations.

3. It's ludicrous to say that one can distinguish a "development economist" from a "communication specialist" in precise terms. But a distinction can be made in terms of their approach to smallholder problems and the underlying models used in their analysis. Communication specialists generally study how social institutions utilize interpersonal and mass media communication channels to change knowledge, attitudes and belief. Their models characteristically typify the process of communication among social units. The orientation of economists is toward the building of models from which their theories are tested with regard to the way scarce resources are utilized. One of the great pillars upon which economic theory has rested is the concept of the rational economic man, that is, the assumption that man attempts to maximize things like profits and utility. For an allied discussion see John Adams' article which compares the field studies of economists and anthropologists in India [1].

## TOWARDS A NEXUS OF OPINION

Let us look at the difference of opinion first, since it gets at my reasons for studying two main types of diffusion variables, "economic" and "communication."

I'll start with the contention that "development economists" and "communication specialists" per se have apparently different approaches and opinions about the diffusion of innovations. Moreover, while the general objectives of development are similar for both, these professionals continue to talk by one another primarily for lack of understanding each other's professional jargon and the compartmentalization that ensues.

The basis for this argument is the frequent observation that development economists and communication specialists diverge on answers to two fundamental questions: (1) What motivates smallholders to adopt innovations? and (2) What factors or variables should be operationalized in a development planner's program to diffuse innovations among smallholders? Answers to these questions are, of course, extremely important because they serve to guide development planners in Third World Countries to decide on how smallholder conditions can be improved. The answers also help to settle such issues as to whether or not national funds should be: (1) allocated to subsidizing innovations, or (2) maintaining price supports and credit institutions, or (3) establishing specific informational networks, or (4) training large numbers of extension personnel; to name just a few examples of ways to diffuse innovations.

What the development economist would say in response to the above mentioned questions are largely answered by the words of wisdom provided by T. W. Schultz:[4]

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4. Names of some economists who have sought to substantiate Schultz' position are: Krishna, Behrman, D. Sturt, J. M. Mellor, P. T. Bauer, B. S. Yamey, L. R. Brown, L. Pletenuis, Yotopoulos, D. Welsch and W. D. Hopper. For references see: J. R. Behrman [3] and Raj Krishna [13].

> Despite all that has been written to show that farmers in poor communities are subject to all manner of cultural restraints that make them unresponsive to normal economic incentives in accepting a new agricultural factor, studies of the observed lags in the acceptance of particular new agricultural factors show that these lags are explained satisfactorily by profitability. . . . Since differences in profitability are a strong explanatory variable, it is not necessary to appeal to differences in personality, education and social environment. [22, p. 164]

On the other hand, communication specialists would emphasize the need to take account of the wider social system in order to understand what the motivation for adopting innovations is behind farmers. For example, Pool suggests that the development of smallholders will require ". . . the development of a scientific attitude toward the adoption of new practices. It is only that kind of internal change in the latent structure of his [the smallholder's] attitudes that would produce self-sustained movement toward modernization."[5]

By contrast, economists are credited with being interested primarily in specialized or single-interest relations which can be manipulated by national planning agencies; whereas, communication specialists focus attention on the way interrelated variables--attitudinal, social, political--can be altered to motivate smallholders to adopt innovations.[6]

Other examples of the dichotomy that prevails between development economists and communication specialists come from numerous empirical studies which seek to correlate rates of adoption against several independent variables.[7] These

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5. See Ithiel De Sola Pool [17], p. 249. Also quoted in Marion R. Brown [5], pp. 730-731.

6. For more on the communication perspective see: James E. Grunig [10], and Everett M. Rogers in association with Lynne Svenning [21].

7. For instance, the reader is referred to reports of the Diffusion of Innovations in Rural Societies Research Project· namely, those of: Stanfield et al. [23], Hursch et al. [11], and Kivlin et al. [12]. For an example of an economist's study with ample references see: Marvin P. Miracle [15].

variables frequently constitute "bottlenecks" or "barriers" to the diffusion of innovations among smallholders in a "poor" or "traditional" environment. A list of the common variables would look something like the following below.[8] Both lists are notable in at least two respects: (1) They are not all variables in the statistical sense. The communication factors, in particular, often require unique experiments to obtain measurable values, (2) They are subject to more precise definitions. One problem for both disciplines is in defining the concepts the same way consistently so that re-tests can be made of the studies that employ these terms.

INDEPENDENT VARIABLES (OR BARRIERS) IDENTIFIED IN STUDIES OF THE ADOPTION OF INNOVATIONS BY:

| Development Economists: | Communication Specialists: |
|---|---|
| size of farm, fragmentation | lack of motivation |
| inadequate markets | limited aspirations |
| subsistence production | low empathy |
| lack of modern inputs | lack of knowledge of innovations |
| lack of credit institutions | opinion leaders |
| inadequate infrastructure | lack of innovativeness |
| low value crops | perceived limited good |
| conflicting demands for resources | fatalism |
| peak demands for labor | familism |
| underemployment of labor | lack of deferred gratification |
| lack of specialization in production | limited view of the world |
| limited resources | localiteness |
| low level technology | social norms |
| low income | dependence on or hostility toward government |
| lack of monetary economy | antecedent variables |
| ineffective price system | characteristics of innovations |
| risk and uncertainty | ineffective or misdirected channels of communication |
| unprofitable technology | |

On the surface, these differences may appear minor· merely a superficial glimpse at two ways of studying the problems behind smallholder development.

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8. For another comparison between "economic" and "communication" factors see: Francis C. Byrnes [6].

But, in the longer run, arguments as to their relative importance--over the issue that one set of variables is more important than another--with total failure to consider both perspectives, can only be detrimental to the understanding of rural problems and the needs of smallholder agriculture.

The intent of the foregoing observations, while sketchy and subject to further elaboration, has been to stimulate ideas for some new approaches to the study of diffusion and the motivations behind smallholder adoption. In particular, a case for a nexus of opinion has been proposed that both economic and communication variables are important determinants of the rate at which innovations are diffused and adopted. The principal hypothesis of this study is, therefore, that the rate of adoption and the degree of innovativeness can be fostered at a faster rate if both disciplinary approaches (of economists and communication specialists) are utilized by Third World Governments to diffuse innovations. In some situations cognitive changes in knowledge, attitudes and beliefs are required before an economically desirable innovation can be introduced; in some situations an economically desirable innovation will induce cognitive changes so adoption can occur; but in all situations both are required for an effective diffusion of innovations.

## A DUAL APPROACH TO THE STUDY OF DIFFUSION

This hypothesis can best be tested by focusing attention upon a smallholder setting within which a single innovation has been diffused by government efforts. Fortunately, such a study was possible in Pakistan during the height of the Green Revolution before the outbreak of the Pak-Indo War in the summer of 1971.[9]

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9. For complete details of the study see: Refugio I. Rochin [18] and for summary details of the pattern of adoption refer to: R. I. Rochin [19].

The main objectives of the study were: (1) to determine the extent to which smallholders (who farm unirrigated land) use dwarf wheats, a new high-yielding variety of wheat which requires fertilizer, and (2) to identify the factors associated with dwarf wheat diffusion and adoption among smallholders. At the root of the investigation were the following questions: Do barani smallholders[10] represent an inert peasantry or do they represent farmers responsive to economic incentives? Where do barani smallholders obtain their first information on new varieties? What variables correlate significantly with the decision to try a new variety?

Population and Sample

Field surveys for this study were conducted in Hazara District of the North West Frontier Province. The district is characterized by rough and mountainous terrain of the Himalayan foothills. Hazara's agricultural sector holds 95 percent of the district's million and a half inhabitants. Of the district's cultivated acreage, 85 percent is exclusively barani (dependent solely on rainfall as a source of water).

Data for the study were collected during the post-harvest periods for wheat and maize (June and November, respectively) of 1970. The first survey ended up with interviews of 143 heads-of-household, and the second with 98. In both surveys, the sample of respondents was chosen from villages of Oghi and Lora thanas, which are relatively large geographic areas representative of most of Hazara District.

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10. The term "barani" literally translated from Urdu means depending upon rainfall. It is common to identify farmers who depend upon rainfall for crop moisture by the term barani, i.e. "barani smallholders."

Approximately 96 percent of the sample of respondents cultivate less than 15 acres; 34 percent cultivate less than 2.5 acres. About 82 percent of the respondents own their land, 4 percent both own and rent land and the rest are tenants. In addition, nearly all of the farmers struggle with small and widely separated plots of land. Each plot averages around a quarter of an acre in size and farmers cultivate on the average as many as 15 separate plots that are terraced and generally scattered. All field preparation is done by bullock-pairs.

The extended families average between ten and eleven people, about 2 to 3 per cropped acre. Most extended families have relatives employed outside the village area. Some husbands who work in Karachi city, a thousand miles away, keep their wives and children on the farm.

The heads of household interviewed in the survey averaged 47 years of age. Although 45 percent said they were literate, they appear to read with considerable difficulty. More and more of the younger males are sent to rudimentary primary schools, mostly in anticipation of leaving the farm by the time they reach 20 years of age.

The typical family's total income is about $235 a year.[11] About $150 is the value of the farm-produced crops, wheat, maize, a little rice, with their straw and hay cut from the surrounding hills. Another $25 is earned by the farmer at other jobs in the village. The rest of the income, $60, comes from relatives employed away from the village who send money orders or cash to the family on the farm.

Little of the grain produced by these farmers reaches the market. If a farmer sells any, it is only when debts fall due or when cash is needed to

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11. Estimated on the basis of ten rupees per U.S. dollar.

cover costs of medicine or wedding ceremonies. The poorest families consume practically nothing besides the grain they produce.

Sources of Dwarf Wheats[12]

Dwarf wheats were brought into Hazara District by the field staff of the Regional Department of Agriculture, by the Agricultural Development Corporation, and by some farmers.

The first shipment of 400 maunds (enough seed for about 400 acres) was distributed to different areas of the District in 1966/67 for use on irrigated land and sown by the field extension staff on a number of controlled and carefully selected "demonstration plots." At that time, each bag of dwarf wheat cost the government Rs. 54 per maund, compared to Rs. 20 per maund for the best desi (traditional) varieties.

In 1967/68, nine thousand maunds of dwarf wheat were commercially available to the farmers through the Agricultural Development Corporation. The price per maund dropped to Rs. 36 but this price was still far above the price of desi varieties.

By 1968/69, dwarf wheat seed reached a significant number of the farmers' fields. The Agricultural Development Corporation (ADC) sold a smaller amount (5,500 maunds) than the year before and at a lower price of Rs. 22 per maund.

In 1969/70, the year of this survey, enough seed was trading hands from farmer to farmer and relatively little was sold by the ADC.

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12. General historical coverage of dwarf wheat diffusion and adoption in Pakistan is found in Jerry B. Eckert [7], Chapter II, pp. 12-36.

## TIME PATTERN IN DIFFUSION OF DWARF WHEATS AND FERTILIZER IN HAZARA

The Lora and Oghi areas showed a rapid rate of diffusion of new dwarf wheats, particularly Mexipak-65,[13] and fertilizer.

Table 1 shows the number of respondents who used dwarf wheats and chemical fertilizer for the first time each year since 1966-67. Initially, fewer than one percent of the sampled barani smallholders were using dwarf wheats. During the same year, a slightly larger fraction of farmers used chemical fertilizer. By 1969/70, the majority of barani smallholders had already tried dwarf wheats and fertilizer for the first time.

Overall, these findings clearly indicate that barani smallholders are responsive to innovations and will make rapid adjustments in resource allocation with new varieties of seed and fertilizer.

Only one farmer in the sample tried dwarf wheats and subsequently rejected them. The stated reason for this rejection was the "bad taste and quality" of the unleavened bread (chapatti) made from the new wheat; he had a variety with a red-grain which is considered inferior to white-grain. However, the same farmer said he saw some white-grain types (Mexipak-65) in the village and would attempt to acquire enough seed to sow his entire wheat acreage with it.

In the group of respondents, two farmers said they had never heard of Mexipak until the time of the interview. Their numbers represent less than two percent of the sample. They do, however, point out the need to know more about the way other farmers become aware of the dwarf varieties of wheat.

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13. Mexipak-65 is only one of the commonly used dwarf varieties, but the term "Mexipak" is applied to all dwarf varieties by Hazara's farmers.

TABLE 1

DWARF WHEAT AND CHEMICAL FERTILIZER USED FOR THE FIRST TIME PER RESPONDENT BY YEAR: LORA AND OGHI THANAS HAZARA DISTRICT. WEST PAKISTAN.

| Growing Period for Wheat | Dwarf Wheat[b/] (n=226) | | | Chemical Fertilizer[c/] (n=95) | | |
|---|---|---|---|---|---|---|
| | No. Each Year | Cumulative Number | Cumulative % of "n" | No. Each Year | Cumulative Number | Cumulative % of "n" |
| 1966/67 | 2 | 2 | 0.83 | 3 | 3 | 3.16 |
| 1967/68 | 28 | 30 | 13.26 | 5 | 8 | 8.42 |
| 1968/69 | 45 | 75 | 33.17 | 20 | 28 | 29.47 |
| 1969/70 | 75 | 150 | 66.35 | 30 | 58 | 61.05 |
| 1970/71[a/] | 50 | 200 | 88.47 | 11 | 69 | 72.63 |

a/ Respondents' anticipated use

b/ Data collected from first and second surveys

c/ Data collected from second survey

## METHODS OF DIFFUSION

During the first round of interviews, respondents were asked to name the first source of information telling them of the new dwarf wheats. Generally, there are two main channels of communication, interpersonal and mass media channels.[14] Frequently mentioned, however, was the demonstration plot. Because of its importance as a media for information and because it has been used in Pakistan for years by the Department of Agriculture, a separate sub-heading has been made for the demonstration plot. In particular, it has been grouped with the category for interpersonal channels since demonstration plots serve primarily as topics for discussion between farmers.

In the following, a brief overview will be presented on the channels of communication which first informed respondents of dwarf wheats. The findings are shown in Table 2. More detail is explained below.

(1) Mass Media Channels

Mass media channels refer to the radio, television, film, newspaper, magazines, etc.; anything with a capacity to reach large audiences quickly over great distances. Agricultural programs are broadcast daily over the radio in West Pakistan. Many are coordinated with the Bureau of Agricultural Information as part of an Education Extension component. In addition, the Bureau publishes a monthly calendar of the radio programs for their respective areas. Radio programs are presently beamed from Lahore, Rawalpindi and Peshawar. The first two stations broadcast in Urdu/Punjabi and the third in Pushto.

Sixty respondents interviewed in Lora said they frequently heard either the Lahore or Rawalpindi agricultural programs. The same number in Oghi said they listened to the Peshawar station.

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14. Both channels function in different ways and their effectiveness also differs according to the way they are used. Their more distinguishing characteristics are discussed in: Rogers with Svenning [21], p. 125.

TABLE 2

CHANNELS OF COMMUNICATION WHICH FIRST INFORMED RESPONDENTS OF DWARF WHEATS, HAZARA, 1969/70.

| Channels | Number of Respondents | Percent of Total Respondents |
|---|---|---|
| Mass Media | 33 | 23.78 |
| Magazine (in Urdu) | 1 | 0.70 |
| Radio | 32 | 23.08 |
| Interpersonal | 108 | 74.82 |
| Localite | 54 | 35.66 |
| Cosmopolite | 33 | 22.38 |
| Demonstration Plot | 21 | 16.78 |
| Not Aware of Dwarfs | 2 | 1.40 |
| TOTAL | 143 | 100.00 |

It was found that the radio was the mass media channel most often mentioned by smallholders as their source of information on dwarf wheat performance and availability. Further questioning pointed out that 56 respondents out of 143 (39 percent) owned radios. Ten farmers (7 percent) who did not own radios stated that they were first made aware of the dwarf wheats over this media.

Altogether, only one smallholder in the sample learned of Mexipak from written media, a magazine written in Urdu. No other type of mass media channel was mentioned by the respondents as a first source of information on the new wheat varieties.

(2) Interpersonal Channels

There are essentially three types of interpersonal channels which informed the barani smallholder of dwarf wheat yields:

(i) "interpersonal localite," or those originating within the social system of the receiver, i.e. the neighbors, village shopkeepers, etc.

(ii) "interpersonal cosmopolite," or those channels which have their origins outside the immediate social systems, i.e. agricultural extension personnel and distributors of farms supplies. Both Lora and Oghi cities have offices of the Department of Agriculture, each headed by an Agricultural Assistant. Each Agricultural Assistant, in turn, supervises 3 or 4 Field Assistants. A Field Assistant is expected to be the Government's principal contact with farmers in the area of 10-20 villages, or 10 - 25,000 people.

(iii) demonstration plots, or visual field displays of agricultural innovations that lead to some discussion among farmers. Both Lora and Oghi areas had the same number of demonstration plots installed on farmers' fields by the Field Assistants· six plots

in each area of Lora and Oghi in 1967/68 and five plots in the following two years. For 1970/71, the number was reduced to one plot for each area. Their locations were all near the market centers of Lora and Oghi.

The interpersonal localite channels had the largest impact on the farmers; that is, 35 percent of the respondents first learned of dwarf wheats from this source. This shows that verbal exchanges between barani smallholders carry the most messages to smallholders. The dwarf wheat demonstration plots (which showed striking differences next to desi plots) were also effective transmitters of the dwarf yield message.[15]

In addition, Field Assistants (lowest level of extension agents of the Agriculture Department) were very instrumental in diffusing dwarf wheat varieties. Besides personally informing farmers of dwarf wheat potential, they were responsible for the installation of many of the demonstration plots on farmers' fields which, in turn, were catalysts in dwarf wheat diffusion.

## SMALLHOLDERS' REASONS FOR ADOPTION

When asked why they adopted dwarf wheats, all smallholders responded "higher yield" as the main reason. A number of secondary characteristics about the variety were also mentioned by the farmers: i.e., (1) dwarf wheats fit the cropping pattern of the smallholders and grew faster than traditional (desi) wheats, (2) dwarf wheats did not call for complex changes from traditional farming practices and were subject to experimentation with handfuls of seed, and (3) dwarf wheats had beards which apparently protected the grain against birds before harvest.

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15. It should be noted that dwarf wheat with fertilizer gives a dark bluish-green appearance; desi wheat is light green. Moreover, desi varieties stand taller, have thin stems, and sway freely with the wind, while the high tillering dwarf wheat is short and sturdy against the wind.

A further note about yields. All farmers in the sample know the size of their cultivated acreage and measure grain that has been sun dried on the threshing floor with a wodi (a wooden or metal measuring bowl). Each farmer knows how much wheat, maize and rice weigh in his own wodi in terms of seers.[16]

Table 3 gives comparative yields on a per acre basis between desi and dwarf wheat (in terms of maunds). It can be seen that each year dwarf wheats out-yielded desi wheats by a consistently wide margin. In 1967/68 both temperature and rainfall were within the range conducive to good yields with the new varieties.

In subsequent years, dwarf wheats were grown on more and more acreage which apparently included a mix of factors resulting in reduced yields: (i) poorer land under dwarfs, (ii) poorer farm managers growing the new varieties, (iii) less ideal weather, and (iv) less fertilizer per acre on dwarfs. Yet, dwarf wheats continued to yield more than desi wheats in all periods.

It was clearly evident to the respondents that dwarf yields are greater than desi yields. Respondents also claimed that there is less risk and more certainty in sowing dwarfs; they at least "got their seed back." On the other hand, farmers said that many times they had to feed their desi wheat as fodder to the animals and they "got no seed back."

## CORRELATES OF AWARENESS AND INNOVATIVENESS IN THE DIFFUSION PROCESS

Its been argued that whether or not an innovation is adopted depends upon a number of factors involving economic stimuli and communication. In this section of the paper an examination is made (by way of correlational

16. One seer equals 2.057 lbs. or 1/40 of a maund. One maund equals 82.286 lbs. One wodi holds approximately 5-1/2 seers of wheat grain.

TABLE 3

COMPARATIVE YIELDS FOR DESI AND DWARF WHEAT ON BARANI LAND, HAZARA DISTRICT, WEST PAKISTAN.

| Year | Dwarf Wheat | | Dei Wheat | |
|---|---|---|---|---|
| | Number of Growers | Yield/ Acre (mds) | Number of Growers | Yield/ Acre (mds) |
| 1967/68 | 26 | 23.92 | 17 | 9.08 |
| 1968/69 | 60 | 17.52 | 28 | 10.24 |
| 1969/70 | 98 | 15.12 | 62 | 8.48 |
| 3 Year Average 67/68 - 69/70 | 61 | 18.85 | 39 | 9.27 |

analysis) of communication and economic variables associated with dwarf wheat diffusion. Specifically, zero-order correlational analysis is used to test which variables correlate highest with two dependent variables, "awareness" and "innovativeness" (defined below).

Awareness and Innovativeness: The Dependent Variables

Two important components of the diffusion of innovations are (1) the creation of awareness and (2) the rate of adoption, as indicated by the innovativeness of individuals. The survey pointed out which communication channels were instrumental in making smallholders aware of dwarf wheats. Barani smallholders, in turn, were very responsive to the message that dwarf wheats were higher yielding than traditional or desi varieties. What, then, are the significant factors which determine "awareness" and "innovativeness" in a smallholder setting?

By awareness, as used herein, is meant the degree to which a barani smallholder first hears of or sees dwarf wheats before others in his community. Obviously, smallholders became aware of dwarf wheats at different times. The surveys recorded this information on each person interviewed. Specifically, they were asked in their language: "When did you first become aware of mexipak?" Most could only give the year (but all respondents seemed certain of the source).

For correlational analysis, the following operational numbers are used to measure the degree of awareness among smallholders, i.e., those with a number of 6 were the first to become aware of dwarf wheat among the sample of respondents.

| Operational Numbers | Explanation | Sample Size |
|---|---|---|
| 6 | First heard of or saw dwarf wheats in either 1965/66 or 1966/67 | 27 |
| 5 | First heard of or saw dwarf wheats in 1967/68 | 71 |
| 4 | First heard of or saw dwarf wheats in 1968/69 | 41 |
| 3 | First heard of or saw dwarf wheats in 1969/70 | 2 |
| 2 | First heard of dwarf wheats at time of interview, 1970 | 2 |

By innovativeness, as used herein, is meant the degree to which a barani smallholder is relatively earlier than others in his community to try dwarf wheats. Specifically, the survey question for those who were using the variety was: "When did you first plant mexipak?" For those who had not yet tried the variety, they were asked if they would grow mexipak in the following year. Thus, we have some responses indicating anticipated usage. Of course, some non-users of the dwarf variety had not made up their minds at the time of the interview about trying the seed.

The following operational numbers are used to measure the degree of innovativeness. Notably, the larger the number the higher the degree of farmer innovativeness.

| Operational Numbers | Explanation | Sample Size |
|---|---|---|
| 6 | Began using dwarf wheats in 1966/67 | 2 |
| 5 | Began using dwarf wheats in 1967/68 | 28 |
| 4 | Began using dwarf wheats in 1968/69 | 45 |
| 3 | Began using dwarf wheats in 1969/70 | 75 |
| 2 | Anticipates using dwarf wheats in 1970/71 | 50 |
| 1 | Has not yet decided to try dwarf wheats | 26 |

To avoid any possible bias of exceptionally small samples, operational numbers 3 and 2 of the analysis of "awareness" were combined. Likewise, operational numbers 6 and 5, under "innovativeness" were added together.

The result of defining our dependent variables in this way is unique in a few respects. For one, we have clear patterns of "awareness" and "innovativeness" that occurred with a single innovation.[17] For another, we have recent time periods to observe into which farmers can be categorized and which are quite analogous to the categories of adoption which have been developed for many diffusion studies.[18] The timeliness of this study alone, gives reason to believe that the information provided by the sample of respondents is exceptionally accurate compared to other studies of a similar nature. Finally, testing procedure is simplified in that the respondents of the sample do not have to be placed into a "typology" in order to measure "awareness" and/or "innovativeness."[19]

## Independent Variables

"Awareness" and "innovativeness" are hypothesized to depend on two main types of independent variables, "communication" and "economic." A summary of the independent variables is presented in the following paradigm. Each, in turn, is identified by a code name as shown. Information from each respondent on each of the several independent variables were, thus, correlated against their respective operational numbers for "awareness" and "innovativeness."

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17. Notice that the cumulative percentages of the sample of observations for each time period (of awareness or innovativeness) are S-shaped.

18. For an early description of the categories refer to Everett M. Rogers [20], pp. 148-192.

19. A good example of this problem is found in James E. Grunig's article [10], pp. 580-597.

PARADIGM OF CORE VARIABLES RELATED TO AWARENESS AND INNOVATIVENESS

| Dependent Variables (Yi) | Independent Variables (Xi) | Code Name |
|---|---|---|
| | I. Economic Variables | |
| | a. Total area cultivated per farm (acres) | AREA |
| | b. Percentage of area owned by respondent (%) | OWNER |
| | c. Size of family on the farm | FAMILY |
| | d. Cash earned in the village (rupees/yr) | CASH |
| | e. Total cash income (CASH + MREMIT) | INCOME |
| | f. Income per capita (INCOME ÷ FAMILY) | Y/CAP |
| 1. AWARENESS | g. Dwarf wheat yield per acre | YIELD |
| 2. INNOVATIVENESS | | |
| | II. Communication Variables | |
| | a. Awareness | AWARE |
| | b. Mass Media Contact | MMC |
| | c. Interpersonal Localite Contact | ILC |
| | d. Interpersonal Cosmopolite Contact | ICC |
| | e. Demonstration Plot | DEMO |
| | III. Intermediate Variables | |
| | a. Migrant Remittances | MREMIT |
| | b. Absence of male family member | MIGRANT |

Though most of the independent variables appear self-evident, a few words of explanation are necessary for some of the variables.

(1) With regard to the Economic Variables:

(a) Some barani smallholders earn cash in the village by selling milk, butter and eggs. Others have odd jobs like carting packages and bundles. A large percentage of the farmers interviewed received military pensions. Altogether, these forms of income constitute CASH; which should be an important determinant of innovativeness. But, on the other hand, the size of family determines the real spending power of potential adopters. Hence, income per capita should also be an important determinant of innovativeness.

(b) It should be explained that YIELD represents the actual yield per acre with dwarfs in 1969/70. Conceptually, this variable is inserted as a proxy for the joint effect of two variables which are ordinarily difficult to measure: (i) It is a proxy for "management" in that the best farm managers are usually distinguished from the worst managers by their higher levels of farm output per unit of input. Such farmers may be expected to be more

efficient and innovative than others and we would expect to find a high correlation coefficient between a measure of innovativeness and management.[20] (ii) It is a proxy for land quality. It is felt that the best farm managers also had the best land in terms of location, amount of farm yard manure applied and nutrient content of the soil (or soil fertility).

(2) With regard to the Communication Variables:

(a) Those first sources of information on dwarf wheats, or the channels of communication, were the only communication variables considered in this study. For purposes of correlational analysis, these factors were entered into the computer program as "zero-one" values. As such, all of the communication variables, save that of awareness, are mutually exclusive. For example, a farmer either became aware of dwarfs by MMC, ILC, ICC, or DEMO, but not any two. For each farmer interviewed, the value of one is given to the first source of information on dwarfs and a value of zero for the rest. The number of observations on these variables are 143. Hence, under the awareness component the mean values for each category of farmers sums to one. Under the innovativeness component the sum is less than one since the observations of 143 farmers are spread over 226 respondents. For example, from Table 4, it can be seen that in 1966/67, 44 percent of the 27 respondents first learned of dwarfs via ICC, 30 percent via MMC, 15 percent from DEMO and 11 percent from ILC. At the other extreme for 1969/70, all respondents first learned of dwarfs from ILC.

(b) Since "awareness" precedes "innovativeness," it too becomes an independent variable of innovativeness in this particular instance. By now it should be recognized that the difference between "awareness" and "innovativeness" for each observation is nothing more than the adoption period. Innovativeness, then, correlated against awareness gives us an indication as to whether "the first to become aware of an innovation are also the first to try it."

(3) With regard to the Intermediate Variables

(a) Notice that there is a third category for "Intermediate Variables." One characteristic of Hazara District is a high rate of migration from the sampled locations to urban centers in West Pakistan. Since migration is a back-and-forth phenomenon, whereby only males leave and remit money to the villages, migrant exodus influences the farm production/subsistence environment of the barani smallholders. Moreover, it was thought at the time of the interviews that families with relations working outside of the village are more open to news of innovations than other families. Hence, migrants and their remittances were hypothesized to be important financial contributors to farm-family subsistence as well as important sources for first information on innovations. Again, for computational purposes, the variable, MIGRANT, also enters as a zero-one variable. The value of one is given to each family that had at least one family member working away from the farm at the time of adoption, and zero for all other families. Concommitantly, the last set of families received no migrant remittances.

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20. A similar argument is posed by S. P. Bose, except that he apparently confuses the economic definition of "efficiency" with that for "productivity." See Bose [4].

Interpreting from the Tables

Tables 4 and 5 are drawn up expressly for the purpose of showing: (1) the zero-order correlation coefficients between "awareness" and "innovativeness" and each of the identified independent variables[21] and (2) whether or not the correlation is linear or not. For example, on Table 4, the zero-order correlation coefficient between the variable FAMILY and "awareness" is 22.82 percent. This relationship is statistically significant at the 0.02 level. If we concentrate on FAMILY for the time being, Table 4 also shows that during 1966/67, twenty-seven smallholders out of 143 became aware of dwarf wheats for the first time. The same farmers had an average of 15.1 "extended" family members living in their households. In 1967/68, seventy-one farmers became aware of dwarfs and the size of their extended families averaged 12.4 persons per household. Forty-one respondents learned of dwarf wheats in 1968/69 and their families averaged 10.2 persons. Four farmers out of 143 first heard of dwarf wheats in 1969/70 and their families numbered 8.3 persons on the average. Scanning the data once more, it can be seen that family size decreases from 15.1 to 12.4 to 10.2 to 8.3 over the periods of awareness from 1965/67 to 1969/70. Clearly, the relationship is linear and highly significant.

Notably, the other relationships of Tables 4 and 5 should be read in like manner. In this way the principal interpretations of the findings can be understood. Next, results of the zero-order correlational analysis are summarized.

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21. If we find a perfect and positive correlation between Yi and Xi, the value of the zero-order correlation coefficient will be +1. For a perfect and negative correlation the value will be -1. If there is no relationship at all between Yi and Xi, the coefficient's value will be zero. Thus, the coefficient can take on any value between +1 and -1. Moreover, when two variables are correlated with each other and significantly different from zero, then the independent variable is said to "explain" variance in the other.

Correlates of Awareness

Awareness was correlated across 143 respondents with most of the variables shown in the paradigm. In Table 4, the results are given along with the code name of each variable and the mean values found for the farmers who became aware of dwarfs in different time periods. Asterisks denote the correlations which are significantly different from zero. Of the economic variables, farmers who owned most of their land and those with large families were relatively sooner than others in becoming aware of dwarf wheats. The mean values indicate linear relationships for these two variables also.

None of the other economic variables are significantly correlated with awareness. However, the variable AREA is obviously non-linear and to some extent it appears that farmers with medium size farms score relatively higher in terms of awareness than farmers with large farms. Though the mean values for INCOME and CASH show linear relationships with awareness, they are not significantly correlated since the actual observations record rather large standard deviations from the mean values (not shown in the table). Judging from the zero-order correlation coefficients, it is quite probable that "wealth" (the combination of farm area and income) in a smallholder environment does not have a significant association with awareness.

Two communication variables are significantly correlated with awareness at the .01 level, and one variable at the .10 level of significance. Namely, both interpersonal cosmopolite channels (ICC) and mass media contacts (MMC) were important for creating awareness among smallholders. Those who scored low on awareness (i.e., were later to adopt), became informed of innovations primarily through interpersonal localite contacts (ILC); a very significant association.

TABLE 4

CORRELATES AND MEAN VALUES OF INDEPENDENT VARIABLES (BY TIME PERIOD) ASSOCIATED WITH AWARENESS (N=143)

| Independent Variables | MEAN VALUES OF VARIABLES AND TIME OF AWARENESS 1966/67 (n=27) | 1967/68 (n=71) | 1968/69 (n=41) | 1969/70 (n=4) b/ | ZERO-ORDER Correlation Coefficient (Percent) |
|---|---|---|---|---|---|
| ECONOMIC | | | | | |
| AREA (Acres) | 7.0 | 5.2 | 4.5 | 8.1 | 12.17 |
| OWNER (%) | 93.59 | 91.93 | 79.68 | 77.25 | 19.17*** |
| FAMILY (No.) | 15.1 | 12.4 | 10.2 | 8.3 | 22.82** |
| CASH (Rs) | 1,149 | 862 | 812 | 165 | 11.02 |
| INCOME (Rs) | 1,913 | 1,822 | 1,645 | 920 | 7.85 |
| Y/CAP (Rs) | 145 | 159 | 163 | 124 | -1.53 |
| COMMUNICATION | | | | | |
| MMC (%) | 0.30 | 0.26 | 0.15 | 0.0 | 15.77**** |
| ILC (%) | 0.11 | 0.37 | 0.56 | 1.0 | -37.21* |
| ICC (%) | 0.44 | 0.24 | 0.10 | 0.0 | 28.33* |
| DEMO (%) | 0.15 | 0.13 | 0.19 | 0.0 | -1.78 |
| INTERVENING | | | | | |
| MIGRANT a/ (%) | 0.63 | 0.61 | 0.61 | 0.75 | -0.42 |
| REMIT (Rs) | 764 | 960 | 833 | 765 | 0.46 |

a/ Figures shown are percentages of the respective values of n.

b/ Unreliable sub-sample figures due to small number.

* Statistically significant at the .01 level.

** Statistically significant at the .02 level.

*** Statistically significant at the .05 level.

**** Statistically significant at the .10 level.

The correlation coefficients for migrants (MIGRANT) and migrant remittances (MREMIT) are not significantly different from zero; which means that these two factors did almost nothing to influence the rate at which smallholders became cognizant of dwarfs. However, the mean values for migrant remittances show a curvilinear relationship with different categories of awareness. But since the percentages shown for migrants are uniform, over time, the relationship is not statistically significant.

In sum, it can be seen that farmers who become aware of innovations before others are generally those who own most of their land, have large families, frequently listen to the radio and have more contact with change agents and sales representatives of farm inputs (the interpersonal cosmopolite channels of communication). Moreover, of the sets of variables proposed, both ILC and ICC were the most significant of all in correlating with "awareness." In addition, three communication variables were to some degree correlated with awareness, whereas two economic variables were also correlated but less significantly.

## Correlates of Innovativeness

Innovativeness was correlated across 226 respondents with all of the variables shown in the paradigm. It should be remembered that YIELD represents, conceptually, a proxy for land quality and a proxy for "management" in that the best farm managers are distinguished by their higher levels of productivity with dwarfs. As such, we would expect to find a significant correlation with innovativeness. As seen in Table 5 this is the case and the relationship between YIELD and innovativeness turns out to be the strongest among all the variables considered. Though this one piece of information can be questioned on the assumptions, the author's impression is, that the best farm managers were the first to try the new varieties; their plots of land also "looked better" than others.

TABLE 5

CORRELATES AND MEAN VALUES OF INDEPENDENT VARIABLES (BY TIME PERIOD) ASSOCIATED WITH INNOVATIVENESS (N=226)

| Independent Variables | MEAN VALUES OF VARIABLES AND TIME OF INNOVATIVENESS 1966/68 (n=30) | 1968/69 (n=45) | 1969/70 (n=75) | 1970/71[a] (n=50) | None[b] (n=26) | ZERO-ORDER Correlation Coefficient (Percent) |
|---|---|---|---|---|---|---|
| ECONOMIC | | | | | | |
| AREA (acres | 8.5 | 5.6 | 4.2 | 4.6 | 3.1 | 24.48** |
| OWNER (%) | 95.13 | 86.67 | 88.00 | 80.68 | 69.58 | 10.63 |
| FAMILY (No.) | 17.8 | 12.1 | 10.4 | 9.1 | 8.3 | 33.54* |
| CASH (Rs) | 1,691 | 765 | 854 | 533 | 408 | 24.85** |
| INCOME (Rs) | 2,965 | 1,548 | 1,537 | 1,206 | 995 | 27.03* |
| Y/CAP (Rs) | 171 | 155 | 148 | 148 | 130 | 5.22 |
| YIELD (Mds) | 18.48 | 16.43 | 14.17 | NA | NA | 56.63* |
| COMMUNICATION | | | | | | |
| AWARE (Score) | 4.8 | 3.7 | 3.0 | 2.8 | 0.5 | 46.33* |
| MMC (%) | 0.20 | 0.27 | 0.09 | 0.16 | 0.0 | 8.16 |
| ILC (%) | 0.10 | 0.16 | 0.37 | 0.30 | 0.12 | -35.57* |
| ICC (%) | 0.40 | 0.24 | 0.08 | 0.06 | 0.04 | 29.07* |
| DEMO (%) | 0.17 | 0.09 | 0.12 | 0.08 | 0.0 | 4.73 |
| INTERVENING | | | | | | |
| MIGRANT (%) | 0.70 | 0.40 | 0.59 | 0.64 | 0.58 | -3.58 |
| MREMIT (Rs) | 1,274 | 783 | 683 | 673 | 587 | 12.32 |

a/ Anticipated use of dwarfs.

b/ Have not yet decided to try dwarfs.

* Statistically significant at the .01 level.

** Statistically significant at the .02 level.

NA Not applicable.

Most of the other variables which are significantly correlated with innovativeness do not need particular explanation except to say that the economic variables predominate in explaining innovativeness. Judged by the correlation coefficients, income per capita, mass media channels, demonstration plots, percentage of migrants and migrant remittances seem to have the least influence on farmers' innovative behavior. Respondents with an average size farm of 5 acres or above, with large families and relatively higher incomes (as indicated by the economic variables) are usually more innovative than others. Similarly, the communication variables show that farmers who score high on awareness and interpersonal cosmopolite contacts are more likely to adopt innovations before others in their community.[22]

It should be pointed out, that all of the variables which were significantly correlated with innovativeness show linear relationships among the mean values. As such, the zero-order correlation coefficients appear to be fairly reliable indicators of the relationships between the variables identified.

Finally, when it comes to innovativeness, relatively more economic variables are significantly correlated with this dependent variable. Namely, five economic variables are significantly correlated with innovativeness and three communication variables are accordingly correlated.

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22. In particular, with regard to the correlation coefficient for AWARE, there is strong reason to believe that the faster smallholders become cognizant of innovations, the more rapidly they would be willing to try them.

## CONCLUDING ASSESSMENT OF THE EVIDENCE

Notwithstanding shortcomings of the analysis, the survey data of Pakistan provide a considerable amount of information about barani smallholders and appear to be reasonably catholic in their implications. More specifically, the significant relationships discussed herein might reasonably apply to Third World Governments desiring to diffuse new, high-yielding varieties of seed to low income farmers. Several kinds of conclusions emerge from the study.

First of all, the data presented support the general hypothesis proposed earlier. That is, both "communication" and "economic" variables are necessary for two main aspects of diffusion: (1) changing farmers' cognitions of new varieties of seed and (2) influencing innovativeness. This conclusion suggests the importance of studying the joint effect of both types of variables for understanding the needs of smallholder agriculture.

Secondly, it was also found in this study that any program designed to diffuse agricultural innovations must first concentrate on creating awareness among smallholders in general. The findings show that barani smallholders who own most of their land and have comparatively larger incomes and families, can be informed most effectively of agricultural innovations by the radio and the interpersonal cosmopolite channels of communication. Barani smallholders who rent proportionately more of their land, have smaller families and relatively little cash earnings, depend almost entirely on interpersonal localite channels for information on innovations. The larger (in terms of numbers) intermediate category of farmers can be informed of innovations by both the radio and interpersonal types of communication.

For operational guides in designing future programs, the following suggestions appear to be most important:

(1) Channels of communication between research outlets and farmers should be strengthened so that smallholders are kept informed of available innovations. That is, Third World Governments should invest in efforts to change farmers cognitions of available technology.

(2) Since interpersonal contacts are especially needed to reach the smallest farmers, extension efforts should be enhanced. The findings indicate that it behooves the extension staff to select those smallholder farmers who exemplify the "best" farm management practices (not necessarily the "biggest" of these small-scale farms), to serve as demonstrators of further innovations.

Thirdly, the argument that dwarf wheats merely "sold themselves" on the basis of high yield alone is simply not true. Concerted efforts of many were influential in changing farmers' cognitions and innovativeness. The findings point out, that barani smallholders live in such a situation, that cognitive changes in knowledge must accompany economically desirable innovations in order to have a rapid pattern of adoption.

An important message of this result is that special diffusion programs are needed to gain adoption and wide scale use of new ideas. In addition, as noted in this case from Pakistan, small farmers have shared rather uniformly in the benefits of the new varieties and greater fertilization. But an important reason for this participation was undoubtedly strong government involvement in diffusing dwarf wheats.

Finally, this paper has had as its focus the relative importance of two sets of variables. Its implicit intention has been to nudge development economists and communication specialists in the direction of a common, mutually intelligible study of diffusion.

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