Data Collection for Evaluation of Investment in Agricultural Research

A Consultant's Report

by

Dr. Douglas Gollin

AUGUST, 1988

PARC•USAID•MART•WINROCK

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A

Summary

During the six weeks allotted for the data collection project, a considerable quantity of data has been compiled relating to agricultural production in Pakistan. Virtually all the desired materials have been gathered and assembled. The resulting data set should make possible extensive further study of productivity gains related to agricultural research.

Due primarily to the slow pace of data collection in the months prior to the current effort, it was not possible to convert as much of the data set to computer as had been hoped. Nevertheless, a substantial body of information on crop acreage and output has been entered into the computer, along with other valuable materials.

The data set includes particularly strong components on output, irrigation, fertilizer, and tractors and machinery. Generally good data sets cover physical and social infrastructure variables and land use. Data for labor, plant protection, and input costs are relatively weak, as had been expected.

The data collection project encountered some institutional resistance to making materials available. It is recommended that data collection become more institutionalized and centralized, and that training and other activities target the problem of generating an institutional ethos more conducive to sharing data.

I. Introduction

Detailed information about Pakistan's agricultural sector is remarkably difficult to find, either within the country or abroad. The task of rounding up the available materials and assembling them in a central data base would thus represent a valuable goal in its own right.

The current data collection project, however, arose in response to a more specific need for information. Before discussing the specifics of the work which has been completed, it is worthwhile to review the events which gave rise to the data collection project.

As part of an effort to examine the role of agricultural research in generating economic growth, the Pakistan Agricultural Research Council (PARC) initiated in early 1988 a study of returns to investment in agricultural research. Dr. Robert E. Evenson, Professor of Economics, Yale University, was chosen to undertake the study under the auspices of Winrock International's MART Project and the U.S. Agency for International Development.

The goals and methods of Dr. Evenson's study have been outlined in greater detail elsewhere; but in short, the study seeks to calculate changes in productivity in Pakistan's agricultural sector. These changes will then be related statistically to investment in agricultural research.

The underlying analytic technique involves several steps. The first step is to measure changes in output per unit of input over time. This provides some general indication of the efficiency with which inputs are converted into outputs. Of particular interest are changes in this efficiency measure over time; these suggest that changes in technology have occurred. In a second step, these changes in technological efficiency are related statistically to a wide range of variables, including investment in agricultural research and extension, use of high-

yielding varieties, and others.

The resulting product not only casts light on the process of technical change in agriculture; it also can make a contribution to the more practical problems associated with the management of an agricultural research system.

As is perhaps obvious from the description, however, a study of this kind depends heavily on the availability of a wide range of data. This data falls into two categories: information on research and extension, and information on agricultural production.

In Dr. Evenson's initial conceptualization of the study, two data collection phases were incorporated into the project design. These corresponded generally with the two types of data needed.

Phase I consists of the development of a data base describing Pakistan's agricultural research and extension system, drawing on various measures of manpower, expenditure and research output over the study period 1955-87.

Phase II involves the creation of a data base on agricultural production, including output, input, price and infrastructure variables.

Included in the Phase I data base are a number of indicators of research activity at the national and provincial level in Pakistan. Of primary importance are budget and manpower figures showing the investment of financial and human resources over time. Also of interest are publication indexes, varietal release data and other indicators of "research outputs."

For Phase II, a sweeping range of materials relating to agricultural production and productivity is required. This includes, of course, figures on area in production and quantities harvested for different crops. In addition, it includes data on numerous factors affecting production: background variables such as rainfall, soil type and salinization; inputs including

fertilizer, pesticides, irrigation, machinery and animal power; infrastructure both physical and social, such as schools, health centers, roads, markets, and electrification; and prices, both for outputs and for inputs.

According to the original schedule, data collection for Phase I was to be essentially finished by early summer of 1988, and Phase II was slated for completion by early September. Work on data collection was to take place at PARC under the direction of Mr. Qazi Tauqir Azam.

In view of the large volume of material required, however, it soon became evident that the data collection process would require additional personnel and resources -- and particularly a period of uninterrupted and concentrated effort. In consequence, a decision was made to call on a short-term consultant to assist in the data collection process.

The present writer was assigned to spend six weeks collecting, assembling, compiling and organizing the data needed for Phase II of the study. Terms of reference for the consultancy are included as Appendix 1.

II. Objectives

In conversations with Dr. Evenson during May and June, and in discussions with Dr. Bill Wright immediately following my arrival in Pakistan, the following objectives were developed for the six-week data collection project, in accordance with the terms of reference:

-- To locate and identify all data relating to agricultural production and productivity needed for evaluating investment in agricultural research in Pakistan.

-- To compile these materials in usable forms for shipment to New Haven by August 20.

-- To begin the process of converting these materials into a computerized data base suitable for subsequent economic analysis.

-- To evaluate the quality of these materials; to identify gaps in the records; and to check data where feasible for accuracy and/or consistency.

III. Description of Activities

A. Initial Status:

At the time of my arrival in early July, I met with Qazi Tauqir Azam and Shahid Iqbal (Statistical Officer, PARC, who was delegated to the project at the end of June) to discuss the status of data collection. They described to me some of the difficulties they had encountered in finding time and resources to allocate to the project. They also told me of some resistance they had faced in seeking access to certain sources of data.

In fact, they told me, no formal data base for Phase II had been formed at that time. Slightly more progress had been made on Phase I during the three months since Dr. Evenson's visit to Islamabad in March; but here, too, data collection appeared to be lagging seriously behind schedule. Although a survey of scientific manpower had been coded and entered into the computer, little progress had been made in collecting provincial budget data. A survey of institutional budgets and staffing patterns at 65 research organizations also had yielded few results.

Although I had initially planned to assist primarily in compiling and organizing the Phase II data base, it quickly became apparent that it would be necessary to begin the data collection nearly from scratch. The scope of the project thus was expanded to include identifying, locating and assembling the desired materials. Moreover, although I had anticipated working solely on Phase II data collection, I quickly realized that it would also be important to help as much as possible in completing data collection for Phase I.

The slow start of the data collection process thus constituted something of a setback. Since we had counted on the initiation of data collection for Phase II, it was disappointing to discover that not even Phase I had been completed. This setback added an element of time pressure to the project, which was accentuated by the weeklong interruption of the Eid-ul-Azha

holiday -- which reduced the number of working days available for data collection.

B. Progress and Activities:

Despite these initial difficulties, we made rapid progress. I spent my first several days in Islamabad going through published data sources to determine what materials were available, to asses their reliability, and to decide what variables might reasonably be specified from the available records.

Working with Messrs. Qazi and Shahid, I developed a series of memoranda describing our data needs. The first of these, an extended "Note on Data," was completed on July 12. A more clearly specified list of variables was developed during the next week, even as we began the process of assembling data and entering it into the computer.

Over the Eid holiday, which began unofficially on July 19, I worked intensively to enter into the computer data on area and production of major and minor crops.

Dr. Evenson arrived in Islamabad on July 23, and we discussed at that time the delay in initiating data collection. Because so little had been accomplished between March and July, we found ourselves facing significant time constraints. One immediate consequence was a decision to shift emphasis from computerizing the data set to completing it.

Data entry on the computer is a relatively time-consuming process. Data must first be assembled or coded in an appropriate format; and with a single computer at our disposal, the time required for typing in pages of figures was considerable. Under the circumstances, we decided that priority should be given to data collection over data entry. Raw data can be coded and keypunched in New Haven; but there will be little scope for collecting additional materials following the end of August.

During the first week of Dr. Evenson's consultancy, we also made further decisions about the nature of the data needed and about the appropriate ways to specify certain variables.

We travelled on August 1 to Faisalabad to seek out materials on research expenditure, varietal use and other variables. The following day, we drove to Lahore. We spent two days collecting materials from the provincial government of the Punjab; following Dr. Evenson's departure on August 4, I remained in Lahore for three more days to follow up leads and to visit other offices. Among the materials we collected from Lahore were data on extension, on-farm water management, varieties in use, soil salinity and waterlogging, and crop acreage.

Upon my return to Islamabad on August 7, I set in motion the process of pulling together the remaining materials for photocopying, coding, description and evaluation.

This entailed identifying sources for different bits of information and trying to piece together adequate information from various places. For a variable like land utilization, for instance, we would hope to construct some district-wise measure to cover the entire period from 1955 to 1986. But no single source provides this information. Instead, we can find national-level estimates of land use, and provincial-level statistics for the entire time series. We can round this out with district-wise materials from the decennnial agricultural census reports, from provincial agricultural statistics publications, and perhaps from occasional development statistics. Using these fixed points and the background national and provincial series, we can interpolate and extrapolate to construct a reasonably accurate district-wise time series.

The physical process of pulling these disparate materials together requires a laborious routine of evaluating source materials, copying useful sections, collecting and filing the copies, and re-evaluating data needs. Over a week of steady work was needed to put together a complete set if hard copy data with

which to build the final data base.

Although we had initially hoped to have more data computerized, and less hard copy to process in New Haven, we have succeeded in compiling a complete collection of materials covering virtually all the variables we had hoped to incorporate in the study.

The groundwork has been laid for coding and keypunching the data base, and the economic analysis can be based on a solid foundation of data. Furthermore, a substantial computer data base has already been created, covering a wide range of crop data and production data. This will constitute the nucleus of the final electronic data base.

Although much data processing work remains in the project, the essential first steps are complete.

Description of Data

The fundamental objective for the data base is to assemble a complete set of data on agricultural production, inputs, prices, costs, infrastructure and background variables. A full list of these variables is attached as Appendix 2.

To capture sufficient variation, the data base draws on district-level materials wherever they are available. Although district-level data is in some respects less accurate than the aggregated provincial and national totals, it offers a far richer pattern of variation, which is of particular value for the kind of study Dr. Evenson plans to undertake.

The second important structural feature of the data base is that it represents a time series from 1955 to the present. Because investments in agricultural research are assumed to have long-range payoffs rather than immediate returns, the long time series is needed to capture these lags accurately.

In its general format, the data base consists of two component parts: an electronic component and a hard copy component. The electronic component does not currently constitute as large a portion of the total as had been hoped; nonetheless it contains a substantial volume of material.

Most of this material consists of a crop production data set, which has been entered onto disk using the Lotus 1-2-3 spreadsheet software package. A full list of the existing files is attached as Appendix 3. The general status of the electronic material is that it includes district-wise data on major crops for 1979-83, for "major-minor" crops from 1969-83, and for "minor-minor" crops from 1981-83. Provincial-level area and production figures are also available for both categories of minor crops from 1955-85. Some land use statistics are also on computer.

The major crops are wheat, rice, cotton, sugarcane, bajra, jowar and maize. The category of "major-minor" crops comprises

gram, mung and mash, rapeseed and mustardseed, and tobacco. "Minor-minor" crops include mattar, masoor, peanut, potato, guar, onion, vegetables, citrus, and mango.

For wheat, rice and cotton, the data set records area and production by irrigated and unirrigated land, and by varieties. For maize, bajra, jowar, sugarcane and the "major-minor" crops, the data covers area and production by irrigated and unirrigated land. For the remaining crops, the data incorporates only total production figures.

The computerized data has been placed on Lotus spreadsheets. The spreadsheets are structured in a fashion that facilitates entry of data. The first column in each spreadsheet lists district names for each province. Each row represents a single district. Each column represents a single variable. The variables defined thus far represent either area or production data, by year, for a particular crop.

A typical column might thus present hectares sown to Basmati rice in 1980-81. Alternatively, it might present production in tons of irrigated bajra in 1975-76. Each observation thus gives a particular district's acreage or production of a given crop variable in a given year.

No attempt has yet been made to code the variables numerically, or to code district names numerically. Such coding will most efficiently be undertaken when all the data are collected, at which time it will be easier to assess what variables can be developed from the data. Certain other refinements in the data have also not been made. For instance, no attempt has yet been made to convert data entirely to metric form (or imperial form); instead, it is simply labelled clearly which format applies to a given table. Likewise, no effort has yet been made to deal with the more serious problem of changes in district boundaries or definitions.

The information necessary for making these adjustments has been included in the data set, but given the limited time

available for data collection in Pakistan, it was judged more expedient to leave this kind of data cleaning for subsequent work in New Haven.

In an effort to avoid unnecessary data entry, some tables have been edited to exclude districts with zero or insignificant production of a given crop. In some cases, the output of these districts has been aggregated as "(Other)". For each variable, a total reported figure for Pakistan is listed at the top of the spreadsheet; at the bottom, a separate figure is calculated by summing the production reported for different districts. The near-identity between these two sets of figures provides an indication of the unimportance of any data omitted from the tables. It also provides an opportunity to check for errors in data entry. It appears in virtually all cases that the entered data are error-free and complete.

A second set of electronic data has been made available to us through the kind cooperation of the Agricultural Data Collection project (ADC), for which we are particularly grateful to Mr. T.J. Byram and Mr. Naseer Qureshi.

This data set contains materials forwarded to ADC by provincial governments through the Agricultural Information Management System (AIMS). This is a dBase III+ system containing a near-complete set of output and input data from Baluchistan for the years since 1969, along with a similar set of data for the Sind from 1979 to present.

This material is provided on a tape cartridge suitable for use on an IBM-compatible microcomputer. The software and documentation for the data base are included; the bulk of the material, however, is a set of dBase III files containing all the necessary information. The system was originally designed to allow for data entry or retrieval through either dBase III or Lotus; it should be easily possible to convert the same material to SAS format.

The remainder of the data is currently on hard copy. Much of it is in the form of photocopied materials, which will require additional coding and formatting before being entered onto computer. These materials are divided by subject into various categories. Each category of variables has been placed in a separate file, with appropriate labels characterizing the content of the files. Some additional material -- primarily books and publications -- is being included separately.

Crop Area and Production:

The most essential component of the data set is data on actual output levels. As mentioned previously, this data set is divided into an electronic component and a hard copy component. The structure of the data remains the same, however. For major crops, we have collected district-level data from 1955-86 on area and production, irrigated and unirrigated, and variety-wise where applicable. For "major-minor" crops, we have data on area and production, irrigated and unirrigated, by district, for 1969-86. Before 1969, the data set on "major-minor" crops consists of provincial-level totals, with district-level data for selected years. For "minor-minor" crops, finally, we have provincial-level totals for 1955-86, with district-level data for a few selected years.

The hardcopy data includes:

-- The Agricultural Statistics of Pakistan, 1986 (Vol. II). This gives district-level data on all crops for 1983-84 to 1985-86. Since none of the computerized data covers these years, this volume will be essential for detailing production for the most recent years.

-- Data from the Agricultural Statistics volumes for 1975, 1977 and 1979. Volume II of the 1975 statistics is included in its entirety. These volumes are essential for providing major-crop data for the period 1969 to 1979.

-- Data from the Food Statistics of 1969. This pushes the major crop time series back to 1960-61, with the exception of the year 1968-69 and the crop cotton. No irrigation information is given.

-- Data from the Season and Crop Reports for 1965-68. These materials cover all the major and minor crops, and also give irrigated and unirrigated breakdowns.

-- Data from a variety of sources covers the other gaps. Major crop data is available at the district level for the years 1955-61. Irrigation breakdowns are also included. Cotton data is available for all

but one year at the district level. Data for 1968-69 is provided by the 1969 Yearbook of Agricultural Statistics.

All told, the data set on crop area and production is essentially complete in all details as planned. The only information which is not complete is district-wise and irrigation-wise data on minor crops for some early years. These omissions should not in any way detract from the analysis.

Output Prices:

Pakistan's data on agricultural prices is distinctly spotty in quality and scope. An excellent review of the materials available has been produced by Carroll Rock and Kerry Gee for the Pakistan Economic Analysis Network Project (as Special Reports Series No. 2, "An Appraisal of Agricultural Price Statistics in Pakistan," [Islamabad: EAN, 1987]).

Rock and Gee describe the numerous separate (and often conflicting) price series available, along with their collection methodologies. They also note the paucity of certain data -- most notably farm-level prices. Their report is included with the hard-copy data base as an important tool for interpreting price statistics.

The principle component of the data set on agricultural output prices is a time series for commodity prices at selected major markets. For the years from 1955 to 1975, only average annual prices are available. For subsequent years, the data set includes monthly prices -- making it possible to estimate in rough terms the fluctuations due to seasonal crop cycles. This price series covers all the major crops and most of the minor crops.

Although the number of markets for which price data is available is relatively small, and although the data reflects prices at large urban markets rather than small village markets, this probably constitutes a basically sound data set at the wholesale level.

Unfortunately, wholesale prices do not accurately reflect the prices received by farmers. Farm-level prices represent a much more important measure for use in calculating productivity changes and estimating supply functions. Rock and Gee comment briefly in their report on the lack of farm-level price data. They note, however, that there are a few sources of "harvest prices" available, although the accuracy of these sources is

sometimes questionable.

The current project has been promised access to a series of district-level harvest prices for the Punjab, but at this writing no materials have yet arrived from the Crop Reporting Service in Lahore. The data base does, however, include one year's worth of this data (1979-80) from a secondary source. It also contains a three-year sequence of district-level "harvest prices" for 1965-68 taken from three volumes of West Pakistan Season and Crop Reports, but there is no accompanying documentation of sources or methodology. Finally, the data set includes a series for 1960-75 of "average wholesale prices ... at harvest time" from the 1975 Agricultural Statistics. This is based on monthly price data and approximate dates of harvest; although it is not a sufficient data set, it does indicate one means by which harvest prices can be estimated from available data.

Other methods of estimating harvest prices might include extrapolating from the cross-sectional data currently in our possession, or using distances from markets (available in the Mouza Statistics) as a means of estimating price differentials. In addition, the cost of production reports included in our data base provide estimates of farm-level prices for selected crops, districts and years.

Finally, the data set includes support prices and procurement prices for the various crops covered in the government procurement programs. These may be useful in calculating price floors for various districts.

No time series data set on prices would be complete without a set of deflators. The current data set is no exception. It includes a GDP deflator for 1959-60 to 1986-87, and a Consumer Price Index for 1955-56 to 1986-87. The two indices appear to run almost exactly parallel, so they can probably used to equal effect.

Livestock, Animal Power and Animal Products:

Livestock data are notoriously difficult to collect or to evaluate. In Pakistan, data on livestock populations are primarily found in the decennial Agricultural Census reports and the occasional Livestock Census publications, both produced by the Agricultural Census Organization in Lahore.

In addition, the Livestock Division of the Ministry of Food, Agriculture and Cooperatives calculates annual estimates of livestock populations at the national and provincial level. These appear to be based on estimated herd growth rates and interpolations. Proportionality is assumed for geographic distribution of livestock populations. These numbers are probably as accurate as can be expected, given the limitations inherent in counting animals.

More problematic, however, are figures for production of animal products: meat, milk, eggs, wool and skins. No systematic survey of these products appears to be readily available, although some localized studies offer in-depth data for certain periods of time.

At the national level, the Livestock Division has developed a series of estimates for production of animal products. These are based on estimated animal populations and on estimated rates of lactation, egg-laying, off-take of carcasses and hides, and similar measures. The extent to which these estimates reflect reality is probably somewhat limited. Some analysts suggested in conversation that these figures are extremely variable and sometimes quite unreliable. Nonetheless, they probably offer some basis for a general index of production.

The data base assembled here relies largely on Agricultural Census data. From the 1960 census, we have taken district-wise population figures for cows, buffaloes, milch cows, milch buffaloes, sheep, goats and poultry birds. In addition, there are specific figures for district-wise populations of work animals, which are disaggregated into buffaloes and other draught

animals.

Similar data are available from the 1972 and 1980 Agricultural Census reports, and in the 1976 Livestock Census, although these disaggregate the cow and buffalo populations still further. These reports also provide separate figures for populations of horses, donkeys, mules and camels.

In addition, we have taken from various Agricultural Statistics publications national- and provincial-level estimates for livestock populations from the 1965-66 Livestock Census. (Despite repeated efforts, we could not locate a copy of this publication.)

Also included in the livestock file are the Livestock Division estimates of national animal populations from 1955-88. A shorter time series covers output of animal products.

Finally, the data set offers some admittedly sketchy information about the costs of production of animal products and, more useful, for what might be called "operating costs" for work animals. Any information of this type is obviously subject to numerous errors, but it can at least provide order-of-magnitude estimates of relevant costs. One source for this information is the Directorate of Livestock Farms research report for 1969-70. A second source is the 1967 Report on Farm Power, Machinery and Equipment in Pakistan prepared by the Ministry of Agriculture and Works. Both of these studies provide some estimates of the costs of keeping work animals, including expenditures for fodder, concentrates, medicines, ropes and chains, labour, interest and depreciation. The latter report also provides estimates for purchase prices of work animals, distinguishing between "improved" strains and "promiscuous" breeds. Although this material should be viewed with caution, it nevertheless provides useful and important information.

Irrigation:

Agriculture in Pakistan is heavily dependent on irrigation. Since water is the most significant scarce factor in most of Pakistan's agriculture, irrigation plays a particularly critical role as an input. Irrigation effectively increases the area available for cultivation; at the very least, it improves the quality of land already cultivated.

Given the importance of irrigation in Pakistan's agriculture, it is fortunate that we have such a rich data set describing irrigation inputs and infrastructure. The most valuable data we have on irrigation is crop area and production data, which includes figures on irrigated area and production of major and "major-minor" crops. Although this series does not cover every year, we have at this writing full data for the years 1955-59, 1965-68 and 1969-86. We are hopeful that we will shortly obtain this data for most of the remaining years in the series.

These figures for cropwise irrigated area and production, by district, provide a framework for a number of more detailed measures of irrigation.

One rich vein of additional data concerns sources of irrigation. Most of Pakistan's irrigation water comes either from canals or from wells and tubewells. Among other distinctions between the two types of irrigation, canal water supply is essentially a government function, whereas most wells and tubewells are privately owned and operated. Management techniques differ for the two types of irrigation; farmers who have their own tubewells probably have more freedom to regulate the supply of water to their crops. It will be important to control for these differences in assessing the productivity effects of agricultural research. It might also make an interesting side study to examine the differential productivity effects associated with the various types of irrigation.

Our data on sources of irrigation begins with a national-level time series covering 1950-87, showing area irrigated by canals, tanks, tubewells and other sources. A comparable data set is available at the provincial level for the same period. The national-level series is taken from the Economic Survey, 1987-88. Provincial-level figures are taken from the Pakistan Agricultural Statistics volumes for 1975 and 1986. Another series, from 25 Years of Pakistan Statistics, shows area irrigated by different canal systems for each province from 1958-68.

District-level data on sources of irrigation is available for selected years for the different provinces. For the whole country, we have sourcewise data at the district level for the agricultural census years of 1960, 1972 and 1980. In addition, we have comparable data for all districts from 1956-57, 1959-60, 1964-65, and 1967-68, from various sources.

For the different provinces, we have additional district-level data for selected other years. For the Punjab, we have sourcewise data for 1964-65, 1969-70, and for all years from 1978-79 to 1984-85. For Sind, we have 1973-78 and 1982-85. For NWFP, the data covers 1964-65, 1969-70 to 1974-75, and 1978-79 to 1983-84. And for Baluchistan, the AIMS electronic data base offers a nearly complete data set for 20 years of production. As though this wealth of data were not sufficient, an added layer of detail exists for a few years for the Punjab. From the Crop Acreage Statistics series, we have sourcewise data at the district level by crop. In other words, the data describes what area of wheat is grown under canal irrigation in a given district, or how much sugarcane is irrigated by tubewell in another locale.

Similar, though not quite so rich, are cropwise/sourcewise irrigation statistics at the provincial level, for Sind. These data are also available at the national level.

Finally, as a general index of irrigation input levels, we have a national-level series on total water availability at the farmgate from 1973-86. Although it is not entirely clear how these data are derived, they ostensibly include estimates both of canal flow and of groundwater availability. As such, they might serve as a helpful index of year-to-year variations in irrigation water availability.

The irrigation data set is thus rich in detail. It is so rich, in fact, that a closely related area of data has been treated separately for purposes of convenience. This separate file covers tubewells, and it provides figures on tubewell counts, use, rental and costs.

Tubewells:

Tubewell counts provide an important measure of irrigation infrastructure. The data set includes national- and provincial-level totals for tubewells for the years 1969-86. In addition, district-level tubewell counts are available for 1966-68, from the Season and Crop Reports for those years; and from 1971, 1980 and 1983 from the Village Statistics and Mouza Statistics for those years. The 1983 data has not actually been included in the Tubewell folder; the 1983 Mouza Statistics volume is in the Infrastructure folder.

The 1984 Agricultural Machinery Census should also provide tubewell counts at the district level, but the only published portion of this census at this time deals with provincial-level data. The Census Organization promises that the district-level data will be available in one to two months; we are pressing for printouts, proofs, or data on tape. I have no confidence that we will get this material in time for the study, however.

We do, however, have additional data for the Punjab at the district level -- to wit, a series extending from 1980-81 to 1984-85. A further tubewell series provides provincial-level figures from 1963-64 to 1984-85. Also available is a division-level count from the 1968 Agricultural Machinery Census, another publication which we were unable to locate. (Divisions represent an administrative level between districts and provinces.)

Finally, we have a valuable set of data concerning tubewell costs. One component of this is a 1972 Survey Report on Economics of Tubewells in Selected Districts of the Punjab. This lists estimates for the capital costs of pump, strainer, engine, and other materials; labour costs for installation and operation; operational costs for oil, depreciation, interest, and repair and replacement charges. Rental charges for hiring out of tubewells are also included, along with a variety of other information. Other data on tubewell costs includes a price series on energising charges for electric tubewells and a price series for

diesel fuel. Finally, the 1984 Machinery Census also includes provincial-level average charges for hiring out of tubewells. Similar figures can also be found in

Taken in conjunction with the rest of the irrigation data, this tubewell information constitutes a valuable source material.

Tractors and Machinery

The data set includes a fairly extensive array of materials on tractor numbers and other ariables relating to farm mechanzation. Although the principle sources are the Agricultural Censuses report of 1960, 1972 and 1980, along with the Agricultural Machinery Census, which would undoutedly contain much valuable current information, have not yet been made available by the Agricultural Census Organization in Lahore. We are hopeful, however, that this material will become available before the end of the fall.

Even without this material, however, we have a solid data set on district-level tractor counts over time. We have numbers of tractors by district from the Village Statistics of 192 and the Mouza Statistics of 1980 and 198. [NOTE: Copies of the relevant pages of the 1972 report are included in the folder for tractor and machinery. Copies of the two Moua Reports are not, however. The 1980 data is located in the tubewell file, and the 98 data is in the Mouza Statistics volume in the infrastructure file] Finally, we have a district-level tractor count from 195-66 in the Survey Report on Farm Power, Machinery and Equipment in Pakistan.

Additional data on tractor numbers are available for selected province and selected years. For Punjab, we have tractor numbers from the 1968 Ag. Machinery report, and also figures for the years 1980-81 to 198-85. For NWFP, we have tractor populations by district for 1970-71 to 1983-84. For the Sind, we have district-wise data on buildoers from 1969-70 to 1974-75; unfortuntely this appears not extend to tractors.

The three Agricultural Census reports do not actually report tractor numbers. They do however, report area covered by tractors per district, which in some ways represents a more useful indicator of tractor input. This same information is reported in the 1975 Agricultural Census.

A wide range of additional information on various types of machinery is also available from the 1975 report. Information on machinery is otherwise relatively scarce. It is available at the provincial level from the 1984 Census report, but not at the district level. For the Punjab, district-level figures are available for certain types of machinery for 1983-85.

In addition to tractor numbers and area covered by tractors, a number of interesting bits of data relate to tractor use. The 1975 Machinery Census contains data on use of tractor time by activity, on use for agricultural and non-agricultural activities, and for hiring-out time. Similar, data are also available at the provincial level from the 1984 Machinery Census.

Of particular interest in the same census reports are data on rental rates for tracrtors for different types of activities and data on purchase prices and financing of tractors. This makes it possible to estimate capital costs and operational costs for tractors for these two years. Similar information is also available from the 1967 Survey on Farm Power, Machinery and Equipment. And a detailed analysis of tractor management is provided in the 1969-70 Research Report of the Directorate of Livestock Farms. This combination of materials allows us to create a reasonably accurate time series on input costs associated with tractors. Additional measures can be obtained from such proxy variables as diesel fuel costs (for which see the Tubewell file).

Inputs:

Three separate variables are included under this heading: labor, fertilizer and pesticides. Other inputs, like irrigation and mechanization, have been considered separately. Most of the infrastructure variables could also be considered inputs of a kind, in the sense that they might figure in a production function for Pakistan's agricultural sector.

For these more traditional inputs, however, we have the following data:

1. Labor and Population: These two variables represent slightly different aspects of a broader concept, which might be called human resources. The use of labor and the level of workers' skills have great importance in the agricultural productive process. Unfortunately, they have also proven to be among the most difficult variables to measure for this study. Data on the agricultural labor force are particularly scarce. The best available figures for the agricultural labor force are probably those taken from the three Agricultural Censuses. These report the numbers of agricultural households and the number of permanent hired laborers. The 1980 report also contains figures on the number of family laborers over 10 years of age.

The 1981 Population Census contains occupational information by district; it also contains data from the previous censuses on population by district. The historical statistics volumes 25 Years of Pakistan Statistics and 10 Years of Pakistan Statistics include lengthy time series on the national-level size of the agricultural labor force; these have not been photocopied, and must be found in the original volumes. Similar national-level time series data is contained in the 1987-88 Economic Survey; this, too, has not been photocopied.

Since it is not entirely clear what distinctions exist between rural population and agricultural labor force, figures for rural population have also been included. These are available at the district level for 1951 and 1961 from the 25

Years of Pakistan in Statistics. Data for the 1971 and 1981 Population Censuses were sent to be photocopied shortly before this writing; unfortunately, due to recent events, they probably will not be available until after my departure from Pakistan. I have left instructions for this material to be included with the present collection of documents.

Useful estimates of actual labor inputs, as opposed to work force, can be obtained from the Cost of Production series. These volumes list the approximate use of labor for different tasks in production of different crops. The Cost of Production series is useful for another reason, as well: it contains some of the rare data on rural wages.

In general, data on agricultural wages is even more scarce than data on the agricultural work force. Several sources provide some sketchy information, however. Perhaps the best general series is an interrupted table of rural wages in the Punjab. This lists both daily wages and per annum wages of permanent hired labor. The table covers the years 1965-87, but a number of years are left blank.

A second table is taken from a report by the International Labor Organization. Although it lists no sources or methodologies, this table reports average national wages in agriculture for the years 1967-1975.

Finally, wage data can be found in the Cost of Production series and in a 1967 Survey Report on Farm Power, Machinery and Equipment. Like the Cost of Production reports, this latter source also provides some estimates of labor use in production of different crops and by different classes of farm operators.

2. Fertilizer: Far more complete information is available on fertilizer use. The data set includes district-wise offtakes of fertilizer for the period 1972-73 to 1986-87. This material comes from NFDC publications, and includes separate measures for nitrogen fertilizers, phosphatic fertilizers, and potash. Total nutrient tonnes are also provided.

The fertilizer data also comes in another shape: month-wise offtakes by province. This may allow some calculations of crop-wise use of fertilizers; at the very least, it should make it possible to estimate season-wise use of fertilizers.

The 1960 and 1972 Agricultural Census reports provide figures for the number of farmers reporting use of fertilizers and manures. The 1980 report also includes a measure of fertilized area for each of the major crops by district. Although this doesn't indicate the quantity of fertilizer used for each crop, it does offer a useful glimpse at the relative distribution of fertilizer between crops. Data on fertilizer use by crop can also be found in the Cost of Production studies.

For years before 1973, we have a province-wise data set giving the total consumption of chemical fertilizers from 1955-76 in N,P, and K tons. We can probably assume some kind of proportionality for extrapolating the district-wise data to this period.

Finally, we have a reasonably complete set of data on fertilizer prices. Retail sale prices of fertilizer were theoretically controlled by the government until 1986, so only one price series is provided. There were presumably some regional differences in fertilizer prices paid, if only due to transport costs. These are not available, however.

3. Pesticides: Pesticides have played an important role in Pakistan's recent burst of productivity in cotton, according to many observers. It is unfortunate, then, that so little information is available on pesticide use at the district level. The only available district-wise information on pesticide use comes from the Agricultural Census reports of 1972 and 1980. These both provide estimates of area covered by plant protection measures during the respective survey years. Again, this tells us little about the intensity of use. It probably does provide the basis for estimating an index of pesticide use, however.

At the national level, estimated breakdowns of plant protection measures are available by crop for 1975-86. For a few years, cropwise data are also available at the provincial level for Sind and Punjab.

Finally, the same data from the Sind provides estimates of quantities and value of pesticides used for selected years; this provides a basis for calculating some kind of price index for pesticides. A similar index could be constructed from a table showing national-level pesticide imports in quantities and value. Unfortunately, this does not provide any disaggregation by types of chemicals used for plant protection; since many of the chemicals currently in use require far smaller quantities for effective use, this may be a misleading method for calculating prices.

Infrastructure Variables:

A broad array of subject areas is subsumed under the category of infrastructure variables. These variables are conceived as measures of a number of physical and social inputs into agricultural production that are not directly part of the agricultural sector. The goal here is to account for inputs into agricultural production that are not captured by measuring fertilizer use or irrigation intake.

Among the variables lumped together under the "infrastructure" heading are: road mileage, electrification, education, health and markets. Obviously any one of these variables could generate a vast quantity of statistical information. But the purpose of this study is not to measure in any detail the returns to investment in road-building or in education. Such questions would require full-scale studies in themselves. The goal instead is to provide some general indices of social and physical infrastructure in the various districts over time.

In collecting data to define these variables, we have sought to focus on measures which can be transposed relatively easily to index form. We have not sought to gather continuous time series data, on the assumption that infrastructure stocks tend to accumulate in fairly regular fashion. This allows us to assume some degree of proportionality between districts over time, and to interpolate missing years with reasonable confidence that we will not be overlooking significant deviations.

Our infrastructure data includes the following:

1. Roads: The data set on roads is quite extensive; in fact, it is sufficiently voluminous to have earned a separate folder. Despite this, however, it should be considered as part of the infrastructure data set.

The primary resource for roads is a series taken from the 1984 Transportation Statistics, Vol. I. This includes figures

for the number of kilometers of roads in each district of Pakistan, by different types of roads. The principle distinction in road types is between "high type" and "low type." The former are paved roads; the latter are disaggregated into "earthen" and "shingle." Paved roads are disaggregated into different width categories. For the purposes of our study, the simple high-low distinction should suffice.

Also included in the data set is a national-level series on road mileage, extending back to 1955. Another potential source of data relevant to this topic is found in the three volumes of Mouza or Village Statistics. These materials, found in the main infrastructure file, provide distributions at the district level showing the distances from mouzas to metalled roads. This might in some ways provide a more appropriate indicator of the accessibility of major roadways than simple length counts. Either of these sources, however, should provide sufficient detail to construct a suitable index for road infrastructure.

2. Electrification: The data base includes have two broad indicators of electrification at the national and provincial level. One is a WAPDA data set extending from 1959-60 to 1980-81 showing for each year the number of electricity consumers by category e.g., domestic, commercial, agricultural) for Pakistan as a whole. The second is a province-wise record of villages which have newly received electricity for each year from 1970-71 to 1985-86. These two series provide good indices of progress in electrification and of the relative distribution of electrification across provinces.

At the district level, a valuable 1971 survey is provided in the 1972 Village Statistics published by the Agricultural Census Organization. This shows for each district the number of mouzas, or villages, electrified as of August 1971. It also shows the percent of total mouzas by district which this number represents. Two comparable surveys are included in the Mouza Statistics of 1980 and 1983.

Since the vast majority of rural electrification in Pakistan has taken place since 1972, these three surveys form an excellent basis for an index of electrification at the district level. We can round this out with isolated data from other sources. For NWFP, for example, we have district-wise numbers of villages connected to electrical supplies for 1977-85.

3. Health: Measuring health directly -- in terms of the physical and emotional well-being of individuals -- is virtually an impossible task. It certainly lies outside the scope of this project. A more easily measured variable, and one which meets the needs of the study, is the availability of health care.

The nucleus of the health care data set is a time series at the national level on numbers of hospitals, dispensaries, maternity and child welfare centers, and hospital beds, from 1955-81. The data set also includes figures for the same period on numbers of doctors, nurses, midwives and "qualified lady health visitors."

This broad time series is rounded out by district-level data from the various provinces for selected years. For Sind, there is data from 1973-75 and 1982-85. For the Punjab, figures are available for 1982, and for NWFP for 1984. Also valuable are district-level figures from the 1980 and 1983 Mouza Statistics showing the distribution of distances from mouzas to the nearest hospital or dispensary, for all mouzas in each district. This will form an excellent basis for an index of district-wise health care.

4. Education: Data on education is similarly structured, with national-level time series data rounded out by district-level data for selected years on numbers of schools, enrolment, and teachers. From the 1961, 1972 and 1981 Population Census reports, we also have measures of literacy by district, which in many ways are more accurate reflections of education than numbers of school buildings or teachers. Although definitions of literacy are inherently arbitrary and ambiguous, these data will

be of great value.

Again, survey data from the 1980 and 1983 Mouza Statistics adds detail to our data set. This material includes district-wise distributions for the distances between mouzas and the nearest primary, middle and high schools. Again, these data should be sufficient to construct an index of educational infrastructure.

5. Markets: Data on markets are difficult to find. They also tend to be somewhat unreliable, since not all markets are formal, geographically fixed locations for exchange. (Economists, at least, prefer to view "the marketplace" as a somewhat more abstract and intangible entity.)

Nonetheless, it is of considerable value to know the number and location of markets. Distance from markets is associated with important transactions costs, and it will affect the prices paid and received by farmers. The number of markets also provides an indication of the extent to which agricultural production is divided between market production and home production.

The three surveys of villages -- the Village Statistics of 1972 and the Mouza Statistics of 1980 and 1983 -- include district-wise distributions of the distances from mouzas to cattle markets, grain markets, and fruit markets. These should allow us to construct suitable indices.

Land Use:

Land is the fundamental input in agriculture (although increasing interest in aquaculture, hydroponics and other technologies challenges that notion somewhat). Consequently, measures of land use are of great importance for studying agricultural productivity.

Contrary to popular belief, expansion of land under cultivation has not halted, even in a country like Pakistan where little fertile land appears to be left out of production. Although it is probably true that little new land exists, many technologies have the effect of increasing the land available for crop production. Irrigation makes land more productive and reclaims land otherwise unusable for certain types of crops; short-season varieties make it possible to increase the number of crops produced on a given plot of land in a year. Tractors replace draft animals, and less land needs to be used for grazing and fodder production. All of these technologies can, in some way, be said to increase the land available for farming. And all of these have played significant roles in increasing Pakistan's agricultural production over the past decades.

One way of measuring these changes -- the changes actually due to increased area under production -- is to examine indicators of land use. In their most usual format, these figures divide up a total area into cultivated area (composed of net sown area and current fallow); uncultivated area (which includes forest, culturable waste and land not available for cultivation); and cropped area (which includes area sown more than once). The present data set includes a fairly extensive set of these land use indicators, with excellent detail at the district level. For Pakistan as a whole, the data set contains district-wise land use figures for 1954-55, 1959-60, 1960, 1964-65, 1967-68, 1969-70, 1972 and 1980. The data from 1960, 1972 and 1980 comes from the Agricultural Census reports; for the other years it comes from a variety of sources.

In addition, a national-level time series provides data for

1955-67, and two provincial-level series cover the years 1955-73 and 1975-86.

Land use data is also available at the district level for selected years for the different provinces. For the Punjab, the years 1980-81 to 1984-85 are represented; for Sind, data is available for 1970-71, 1972-73 and 1979-82. Figures for NWFP cover the years 1970-71 to 1976-77. And for Baluchistan, the AIMS data set covers a number of years. All in all, this makes for a remarkably complete set of data on land use.

District Changes:

One of the problematic aspects of putting together a district-wise data set for Pakistan covering the years since 1955 is that district numbers and boundaries have changed repeatedly over the interval. Maintaining comparability in time series observations thus demands some system for adjusting cross-sectional data from different periods.

In general, there are several approaches to tracing and correcting for these changes. One is to aggregate districts into larger units which can be treated as essentially constant in boundary over time. Alternatively, districts can be broken down into component tehsils, if these tehsils remain constant over time. Each of these alternatives has advantages and disadvantages. For the purposes of data analysis, however, the district will be the most useful administrative unit to study.

Since districts will constitute the fundamental units of the analysis, a data set has been included here which provides information on district changes over time. The chief component of this data set is a computerized list of the districts and tehsils in Pakistan at various points in time. This list, compiled from PARC records and updated during the current data collection project, provides a means of documenting changes in district boundaries and content since 1947.

Each district in this data set is listed with a three-digit code; the first number indicates its province, the second its division, and the third its code number within the division.

Based on this system, the tehsils are also coded; for each district, the tehsils are coded with one additional reference number, so that each tehsil has a four-digit code. Thus, Jampur Tehsil has a four-digit code number of 1413 in the list of districts from 1961. The first digit signifies that it lies in Punjab, the second that it is in the Multan Division, and the third that it is in DG Khan district.

Using these codings, it is possible to trace changes in district make-up over time. Although the computerized list itself provides only "windows" at certain intervals, the data set on district changes also contains information on the exact timing of each such change.

Fortunately, most of Pakistan's district changes appear to have consisted of district splitting. The old district becomes a division, with several new districts created from its subdivisions. This kind of change is relatively easy to identify and to trace; and the procedures required to compensate for such changes are relatively simple.

Waterlogging and Soil Salinity:

One frequently-cited constraint on Pakistan's agricultural production is the challenge posed by soil salinity and waterlogging. The two problems are closely related and have been the subject of numerous studies, remedial efforts and development programs.

In simple terms, soil salinity results from the buildup over time of mineral salts in the soil as a consequence of the evaporation of mineral-rich waters. This process is a nearly inevitable concomitant to irrigation, particularly under arid conditions. Under normal circumstances, however, these salts do not pose major problems for agriculture. With adequate drainage, these salts will periodically leach out of the soil either from occasional heavy rains or from deliberate flooding by irrigation water. Either of these processes serves to dissolve the salts and to leach them from the soil.

In areas of poor drainage, however, the problem is more acute. Occasional rainfall or additional use of irrigation water will simply accentuate the problem by bringing salts to the surface. Even here, though, the problem need not be a severe one for agriculture. Most salts pose only minor problems for crops; but in some areas, sodic salts are prevalent, and these are indeed detrimental to crop production. Furthermore, sodic salts have a tendency to alter the physical structure of the soil in such a way as to decrease the soil's permeability. This adds to the waterlogging problem and sets in motion a vicious cycle of sorts.

Sodic salinity is a significant problem in parts of Pakistan. Although some experts believe that most of Pakistan's soil sodicity is ancient in origin, much concern exists that the relatively recent intensification of irrigation has raised water levels and thereby contributed to problems of poor drainage and saline accumulation. (For a more detailed account of this problem as it is manifested in Pakistan, see the mimeographed manuscript Soil Resources, Conservation and Development; and

Waterlogging and Salinity, report of National Commission on Agriculture Committee on Soil Resources Conservation and Development, June 1987.)

For the purposes of this study, it will be of considerable interest to examine the extent to which salinity and waterlogging have affected productivity changes in different areas of Pakistan. Some research has targeted affected geographic areas, and other work has focused on the generalized problems of salinity (e.g., development of resistant varieties). Moreover, extensive investment has been made in reclamation and control projects, which function as inputs in those areas. The analysis of these projects could form an interesting side study for the project as a whole. In any event, it will be necessary to control for soil salinity in looking at the overall impact of research investment on agricultural productivity.

To this end, a data set has been assembled that identifies saline-affected areas over time. For Pakistan as a whole, the data set includes estimates of areas affected by waterlogging and salinity since 1955. These are taken from the Agricultural Statistics series and from WAPDA's occasional statistical reports. Rainfall:

The largest single source of "noise" in agricultural production statistics is weather-induced variation. Within this category, rainfall probably accounts for more variation than any other single factor. Although meteorological data are sometimes hard to interpret -- rainfall, for instance, is invariably highly localized -- it is important to use these materials to control for variations in output.

This data set is intended to include a historical data set giving monthly rainfall totals for selected stations for the period since 1955. Monthly rainfall figures are more useful than annual totals, because the timing of rainfall is of great importance to crop production in Pakistan. A delayed monsoon can have virtually the same effect as a failed monsoon. For this

reason, we have sought to assemble data on a monthly basis.

Unfortunately, however, this data is not currently in our possession at the time of this writing. We have a handwritten data series covering 20 years of the period, which has been sent for photocopying; but it remains to be seen whether the copies will be readable. We have been attempting to get this material in electronic format; the data apparently exists, but we have not yet been able to locate or copy the necessary files. With some luck, it will be available within a period of days.

Other Materials:

Additional materials have been included in the data set on topics not directly related to the main body of inquiry. These include: data on the on-farm water management program in the Punjab, data on varieties in use in the Punjab (for wheat, rice and cotton), data on credit, data on ecological zones.

Also included is a separate file containing the various materials taken from Cost of Production surveys. This material covers too many separate input areas to be usefully filed in any one place; therefore it has been given a file of its own. Although these studies appear to have some serious flaws, they appear to provide much useful data along the way.

Some of the other variables may prove to be of interest, also. The varietal use data, for instance, is of particular interest because it provides an indication of research output. It can also be used to generate some interesting results concerning the genetic component of agricultural productivity change. Varietal data, in short, provides insights into the roles of both "intellectual germplasm" and "biological germplasm" in generating growth in productivity.

IV. Description of Data

Basic idea to construct district level time series from 1955 to present -- list of variables appendix 2 -- two parts: computer and hard copy

V. Constraints

The data collection project faced a number of non-trivial constraints that impeded progress and eventually limited the process of generating a computerized data base. Roughly speaking, these constraints can be lumped into three categories: time constraints, access constraints, and constraints on obtaining data in electronic format.

A. Time:

By far the biggest constraint on data collection proved to be a time constraint. As mentioned earlier, the near absence of data collection between March and July probably determined in advance that relatively little data would be computerized during the available time. The time constraint was compounded by a one-week delay in gaining access to a computer and by the loss of one work week to the Eid-ul-Azha holiday.

A further time-related obstacle was posed by the lack of skilled keypunch operators for entering data. Although PARC made available the services of several stenographers/keypunch operators, none proved to be sufficiently familiar with Lotus software or with the project data needs to work directly from the published materials into spreadsheets.

Consequently, I ended up performing virtually all the data entry myself. Since I was able to enter data far more rapidly than anyone else, it proved to be most productive for me to work the keyboard and use support staff to locate and assemble materials. But little progress was made on data entry in my absence or during the time when I was not physically at the keyboard.

B. Access:

The second category of constraints faced by the project was perhaps more serious and certainly more frustrating. This was the difficulty encountered in seeking out materials from other organizations and institutions. A surprisingly small amount of

data was available directly from PARC, and consequently we had to turn to numerous other organizations to supply missing materials.

Some of these organizations proved helpful and cooperative; some were passively unencouraging; and a few acted in a fashion that could almost have been viewed as obstructionist. Despite the strong support provided to the project from PARC, international agencies, and other influential institutions (such as the Punjab Department of Agriculture), we encountered far less cooperation at lower levels. Glasnost appears to take longest to reach the lowest levels.

On a number of occasions, we were told outright that materials we needed were not available at all or could not be made available to us. In other instances, we were told that we would be provided with data only after going through complex and time-consuming official request procedures. And in still other cases, we were given access to materials under extremely inconvenient conditions; or given partial or incomplete data in lieu of the materials we had requested.

Even when we were well received and offered active cooperation, the process of getting access to data generally proved extremely time-intensive. Each request had to be accompanied by an elaborate discussion of the project goals and methods. And in many cases, the agencies involved lacked the facilities (e.g., computers, photocopying machines, extra issues of publications) to meet our requests easily.

Finally, it is worth noting that a persistent institutional ethos within government circles appears to view information as a commodity to be guarded rather than a public good to be disseminated. This attitude seemed to underlie our problems in getting access to materials. In some cases, it even limited our ability to get copies of published documents.

C. Computers:

All the problems concerning access to materials appeared to be compounded when we attempted to acquire materials in computerized form. As a means of avoiding the time-consuming process of entering data by hand, we had hoped to obtain a significant amount of material already on disk or on tape in different agencies.

Among the materials which we identified as being available in electronic form were data on: recent crop area and production, commodity prices, credit, and fertilizer, along with virtually all the materials produced by the Agricultural Census Organization. In the final analysis, we obtained none of these materials in electronic form.

Even at PARC, we found ourselves unable to make use of a computerized data base containing area and production data on major crops, along with land use data, fertilizer data, and other useful information. Despite the hard work and full cooperation of the PARC computer section, this material proved almost completely unusable because the computer operates on a system that is effectively incompatible with any other machines in common use.

Problems of computer incompatibility cropped up elsewhere, too (although it is not entirely clear that the incompatibility was everywhere real). At the Agricultural Census Organization, for example, we were told that some early materials were available only on keypunch cards. Other census materials were reportedly available only at the household level; for district-level aggregates, we were told, hours of mainframe processing would be required. Here again, problems of institutional attitudes towards data dissemination appeared to intrude.

D. Comment:

With sufficient goading from above, we could undoubtedly have acquired all the materials that we sought, in the forms that we wanted. But this probably would have proven, in the final

analysis, to be more time-consuming and complicated than simply gathering the materials as we did. There are times when the path of least resistance is also the most efficient avenue for achieving a given goal; and despite a few frustrations en route, our methods have succeeded in bringing together all the needed materials. It is not clear that any other approach would have yielded better results.

Recommendations

The difficulties encountered in gathering and compiling data for this study hint at some extensive and serious problems with the research process in Pakistan's agricultural institutions.

Any policy-making process depends ultimately on information. Policy makers must have access to accurate information in a timely fashion. Moreover, they must be able to place confidence in the ready availability of this material. Without such confidence, they will be tempted to base their decisions on incomplete materials that are close at hand, or to rely on general impressions.

In the agricultural sector, at least, there appear to be some real problems on this point of making materials readily available. Although quite a large quantity of data is collected on a regular basis, much of it is kept in different places, and little effort is made to disseminate materials.

Different agencies and institutions are sometimes reluctant to make materials available; at worst, they hoard data or force researchers to spend unnecessary time on procedural matters.

If more data on agriculture is to be made more readily available, there must be some changes in this institutional system. Specifically, it would be extremely helpful if a single organization would assume responsibility for collecting materials related to agriculture. This organization could then institutionalize the process of acquiring information from different agencies. If collection took place on a regular basis -- or better still, if other organizations could be induced to provide materials continually to this central organization -- then data users would have a much simpler task.

Logically, PARC and NARC are the logical institutions to head this kind of data collection. Both organizations already collect materials from other institutions, but this collection

should be far more regular and extensive. The PARC library currently holds only a small number of volumes; it should take a more active role in seeking out published materials and unpublished documents from national and provincial organizations. This might require granting the library more space; if possible, these space requirements should be met.

Special priority should be placed on collecting statistical materials of various kinds. A research library on agriculture should have at its metaphoric fingertips a full range of data on all the subjects included in this data set, and more. A particular effort should be made to gather statistical data from the provincial governments, and to fill historical gaps wherever possible.

Clearly, much of this kind of data should also be made available on computer. Since most of the use of this material in the future is likely to involve computer analysis, it will be increasingly vital to have electronic data bases that cover the useful range of materials. The current data base will provide a useful beginning when it is in fully electronic form. But clearly, more materials should be entered into electronic form. As part of this goal, a major effort should be undertaken to collect computerized materials from other agencies and to create a large centralized electronic data base on agriculture. Again, PARC is the logical institution to undertake such a project. Although there are problems with incompatibilities between the computer systems used by different organizations, these should not be too difficult to overcome. Moreover, if a centralized data base were being maintained, there might be greater incentive for other organizations to adopt compatible data systems.

Needless to say, PARC's current electronic data base needs to be revamped and converted into some format less unwieldy than the current CPM system. The present system is incompatible with virtually all other machines used in Pakistan or western countries. The cumbersome nature of the system appears to have discouraged people from using the computer for social scientific

studies; this is clearly counterproductive.

Another major step must involve bringing down the current institutional barriers to disseminating data. Much of what is required is a change in institutional attitudes towards data. Many of the people responsible for maintaining data collections appear to feel obligated to guard the materials, rather than to distribute them.

It would be helpful if some kind of consensus could be built throughout the system that sharing data is ultimately a positive and useful function of institutions. Perhaps some training programs could be developed to instil this attitude. Certainly it would be useful to provide more institutions with the kind of resources that would facilitate this (e.g., photocopying machines, computers with appropriate software packages).

Finally, it is worth noting that there are two specific variables for which data should be collected regularly and for which there is currently no source. One of these variables is agricultural wages; the other is harvest prices. At present, neither of these is available in any kind of time series or published format. It would be extremely useful if data collection on these variables could be initiated as soon as practically possible.

Terms of Reference

To assist in collecting and organizing data for study of returns to investment in Agricultural Resources in Pakistan. Work closely with Qai Tauqir and other PARC staff in carrying out this assignment. If necessary, travel to pertinent locations where data are kept to help identify and assemble data. He will also assist in organizing these data into forms appropriate for further manipulation in manner required by Dr. Evenson's resource strategy. Mr. Gollin's visit will overlap approximately the last two weeks of July with that of Dr. Evenson.

During this consultancy, Mr. Gollin will report to the MART/Winrock Chief of Party. The consultant will prepare a report before leaving Pakistan, giving an account of his activities during this consultancy and making recommendations for steps needed in the future for data collection in this project.

Variables

The following lists of variables are intended to provide more specific information on the types of data we require. Where possible, I have indicated the known source for this data, and the status of our efforts to collect it. (Parentheses indicate residual variables which can be calculated from other data.)

Crops:

A. Wheat, Rice and Cotton:

1. Area Sown

a) total
b) (unirrigated)
c) irrigated total, by source (canal, well, tubewell, canal/tubewell, [others])
d) variety-wise, at least for major variety categories

2. Production

a) total
b) irrigated
c) (unirrigated)
d) variety-wise

B. Maize, Bajra, Jowar, Sugarcane, Gram and Barley:

1. Area Sown

a) total
b) irrigated
c) (unirrigated)

2. Production

a) total
b) irrigated
c) (unirrigated)

C. Minor Crops (Mung, Mash, Masoor, Tobacco, Rapeseed and Mustardseed, Groundnut, Sesamum, Onion, Potato, Other Vegetables, Citrus Fruits, Mangoes)

1. Area Sown Total
2. Production Total

Livestock:

A. For Census Years Only

1. Numbers of cattle and buffalo by kind
2. Numbers of sheep, goats, camels, asses, horses and mules
3. numbers of poultry
4. available information on production of animal products (meat, milk, eggs, wool, skins)

B. For Non-Census Years:

1. National-level counts of animal population, estimates of animal product levels; to be assigned district-wise on the basis of census counts.

Prices:

A. Farm-level Prices:

1. For the Punjab, to be obtained where available from Crop Reporting Service.
2. Wholesale prices and procurement/support prices to be obtained from Federal Bureau of Statistics and/or Ministry of Agriculture computerized data bases.

Credit:

A. Agricultural Development Bank:

1. Loans extended by district by time

B. Commercial Banks:

1. Loans extended by province by time

C. Cooperative Societies:

1. Number by district
2. Credit extended to and by, districtwise

D. Taccavi loans:

1. By district, by time

Markets:

A. Numbers/Frequency

1. By district

Fertilizer:

A. Use

1. Offtakes by district by year, by type of fertilizer
2. Offtakes by month, by type, selected years
3. Cropwise use, percentages of total, district level if available

B. Costs

1. For different types of fertilizer, different markets, wholesale and retail, by month

Pesticides:

A. As for fertilizer

Irrigation:

A. Cropwise

1. This will be included in area and production data, as mentioned above

B. Infrastructure

1. Measures of irrigation availability by district by year.

a) wells
b) tubewells
c) canals
d) other

2. Census Data

a) tubewells and surface pumps owned, electric and diesel
b) area irrigated by tubewells and surface pumps
c) use and renting time by district, electric and diesel
d) hiring rates for tubewells and pumps

C. Fee Schedules for Canal Water

D. Water Availability

1. Canal Water, by season
2. Groundwater, by season
3. Total

Tractors and Machinery:

A. From Census Data

1. Numbers of Tractors and other implements
2. Use of Tractor Time
3. Tractors Reported Used for Various Activities
4. Amount Paid for Tractors and Other Implements
5. Physical Area Covered by Tractors, by District
6. Renting Out of Tractors for Various Tasks
7. Rental Rates

B. Other

1. Retail prices, major markets, petrol and diesel

Roads:

A. Kilometers by district

1. High
2. Low

Health:

A. Infrastructure

1. Numbers of hospitals
2. Numbers of rural health centers
3. Numbers of doctors
4. Numbers of nurses and lady health visitors

Education:

A. Primary School

1. Teachers and enrollment

B. Secondary School

2. Teachers and enrollment

C. Post-Secondary

3. Teachers, enrollment, degrees offered

Electricity:

A. Numbers of customers

B. Percent of villages electrified, by district

Seed Distribution:

A. For Major Crops

Population and Labor Force:

A. Population by District

B. Agricultural Labor Force by District

Wages:

A. Estimated Wage Rates, selected areas, selected years, from cost of production surveys

Land:

A. Agricultural Census Data

1. land utilization by district
2. cropping intensity
3. cropped area
4. irrigation status by crop seasons
5. number and area of farms, by size of farms

B. Agroecological

1. Zone information
2. Rainfall averages

List of Files

August 20, 1988

The following is a list of files contained in the data base for our study of returns to investment in agricultural research.

File Name	Directory	Disk No.	Description

Agricultural Production Series

BAJRA2A.WK1	Area and Production, 1979-81 irrigated and unirrigated
BAJRA3.WK1	Area and Production, 1981-83 irrigated and unirrigated
BARLEY.WK1	Area, 1969-75 irrigated and unirrigated
BARLEY2.WK1	Production, 1969-75 irrigated and unirrigated
CITRUS3.WK1	Area and Production, 1981-83
COTTON2A.WK1	Area and Production, 1979-81 Pak-Upland and Desi
COTTON3.WK1	Area and Production, 1981-83 by Pak-upland/Desi varieties
GRAM.WK1	Area and Production, 1969-77 irrigated and unirrigated
GRAMA.WK1	Area and Production, 1977-81 irrigated and unirrigated
GRAMB.WK1	Area and Production, 1981-83 irrigated and unirrigated
GUAR3.WK1	Area and Production, 1981-83
JOWAR2A.WK1	Area and Production, 1979-81 irrigated and unirrigated
JOWAR3.WK1	Area and Production, 1981-83 irrigated and unirrigated
LANDUSE.WK1	Land use data by district, for years 1954-55 and 1959-60
MAIZE2A.WK1	Area and Production, 1979-81 irrigated and unirrigated
MAIZE3.WK1	Area and Production, 1981-83 irrigated and unirrigated
MAJMIN.WK1	Provincial-level data for production of "major-minor" crops, 1955-69
MANGO3.WK1	Area and Production, 1981-83
MASH1.WK1	Area and Production, 1969-75
MASH2.WK1	Area and Production, 1975-77
MASH2A.WK1	Area and Production, 1977-79 and 1980-81 ('79-80 n.a.)
MASH3.WK1	Area and Production, 1981-83
MASH3.WK1	Area and Production, 1981-83

MASOOR3.WK1	Area and Production, 1981-83
MATTAR3.WK1	Area and Production, 1981-83
MINORS1.WK1	Provincial-level area and production data for minor crops, 1975-86
MINORS2.WK1	Provincial-level area and production data for minor crops, 1955-75
MUNG2.WK1	Area and Production, 1969-77
MUNG2A.WK1	Area and Production, 1977-79 and 1980-81 ('79-80 n.a.)
MUNG3.WK1	Area and Production, 1981-83
OILSEED.WK1	Area and Production, 1969-75
OILSEEDA.WK1	Area and Production, 1975-77
OILSEED2.WK1	Area and Production, 1977-81
OILSEED3.WK1	Area and Production, 1981-83
ONION3.WK1	Area and Production, 1981-83
PEANUT3.WK1	Area and Production, 1981-83
POTATO3.WK1	Area and Production, 1981-83
RICE2A.WK1	Area and Production, 1979-81 by Basmati, IRRI, other
RICE3.WK1	Area and Production, 1981-83 by Basmati, IRRI, Other
SUGAR2A.WK1	Area and Production, 1979-81 irrigated and unirrigated
SUGAR3.WK1	Area and Production, 1981-83 irrigated and unirrigated
TOBACCO1.WK1	Area and Production, 1969-77
TOBACCO2.WK1	Area and Production, 1977-81
TOBACCO3.WK1	Area and Production, 1981-83
VEGGIE3.WK1	Area and Production, 1981-83
WHEAT2A.WK1	Area and Production, 1979-81 irrigated and unirrigated, Mexi-Pak and other varieties
WHEAT3.WK1	Area and Production, 1981-83 irrigated and unirrigated, Mexi-Pak and other varieties

Schedule of Activities

July 7	Left Monrovia, Liberia, 2200 hrs.
July 9	Arrived Islamabad, 070 hrs.
July 10-23	In Islamabad; worked with Qazi Tauqir Azam, Shahid Iqbal and others to collect and assemble data.
July 23	Arrival of Dr. Robert E. Evenson
July 24-Aug.1	Left Islamabad; travelled to Faisalabad with Dr. Evenson, Dr. Bill C. Wright and Qazi Tauqir Azam.
Aug. 02	In Faisalabad; met as a group with Dr. Agha Sajjad Haider, newly appointed Member for Social Sciences, PARC
	Met subsequently with Vice Chancellor, University of Agriculture, Faisalabad.
	Met with Mr. Muhammad Sharif, Senior Scientific Officer, Agricultural Economics Research Unit, Ayub Agricultural Research Institute.
	Met with Dr. M. A. Bajwa, Director General Agricultural Research, Ayub Agricultural Research Institute. Also present at meeting: Dr. Mohammad Hussain Chaudhry, wheat breeder, AARI
	Met with Dr. S. H. Mujtaba Naqvi, Chief Scientific Officer and Director, Nuclear Institute for Agriculture and Biology, Faisalabad.
	Travelled to Lahore by road
August 3	Met with Dr. Zafar Altaf, Secretary of Agriculture Government of the Punjab; Mr. Zake Ulleh, Chief Planning; Dr. Abdul Majid, Director General, Rice Research Institute, Kala Shah Kaku; and Mr. Sadiq Cheema, Director General, On-Farm Water Management Project, Punjab.
	Met with Khalid Rashid, Statistical Officer, Crop Report Service (Punjab).
	Met with Mr. Alchley Ahmed, Deputy Director (Coordination) Bureau of Statistics (Punjab).
	Visited Rice Research Institite, Kala Shah Kaku; met with Dr. Abdul Majid, Director General.

August 4	Visited Directorate of Agricultural Extension (Punjab). Met with Mr. Bashir Sabir, Director of Adaptive Research; Ch. Muhammad Afal, Director of Crop Report Service; others.
	Met with Mr. Sadiq Cheema, DG On-Farm Water Management Training Institute.
	Dr. R.E. Evenson departed for New Delhi.
	Met with Mr. Imtiaz Siddiqi, Additional Census Commissioner, Agricultural Census Organization.
August 6	Met with Mr. Sadiq Cheema, DG On-farm Water Management Proect.
	Met with Ch. Muhammad Afzal, Director, Crop Reporting Service.
	Met with Mr. Malik Afzal, Director General, Agricultural Extension.
	Met with Mr. Malik Ghulam Farid, Director Agricultural Marketing.
August 7	Met with Dr. Zafar Altaf, Secretary of Agriculture, Government of the Punjab.
	Met with Dr. Mohammad Rafiq, Director Basic Soil Investigation, Soil Survey of Pakistan.
August 8-20	In Islamabad. Continued collection of data; prepared; final report.

Acknowledgement

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At Winrock headquarters, Joe Dale, Debbie Smith and others deciphered my handwritten scrawls, braved the perils of the Liberian telecommunications system, and somehow contrived to get me from to Monrovia to Islamabad with a mimimum of difficulty. (I am hoping the same will hol . true for the return trip).

And finally, thanks to the consultants and crew at the USAID Staff House in Islamabad for making life pleasant, interesting and comfortable for the six weeks of my stay.

Partial Bibliography of Sources

The following is a partial list of the most important publications, articles and books which have been used in constructing the data base. It does not include some materials which have been prepared specifically for the project from office records; nor does it include all the items which were referred to at various times.

Statistical Publications

Government of Pakistan, Agricultural Census Organisation. Village Statistics, 1972. Released as part of 1972 Census of Agriculture. Lahore: Agricultural Census Organisation, 1973.

Government of Pakistan, Federal Bureau of Statistics. 10 Years of Pakistan in Statistics, 1972-82. Karachi: Statistics Division, 1983.

Government of Pakistan, Federal Bureau of Statistics. Pakistan Statistical Yearbook 1986. Karachi: Statistics Division, 1986.

Government of Pakistan, Federal Bureau of Statistics. Pakistan Statistical Yearbook 1988. Karachi: Statistics Division, 1988.

Government of Pakistan, Finance Division. Economic Survey, 1985-86. Islamabad: Economic Adviser's Wing, 1986.

Government of Pakistan, Finance Division. Economic Survey, 1987-88. Islamabad: Economic Advisor's Wing, 1988.

Government of Pakistan, Ministry of Agriculture and Works. 1960 Pakistan Census of Agriculture. Volume II: West Pakistan. Karachi: Agricultural Census Organization, October 1963.

Government of Pakistan, Ministry of Agriculture and Works. Land and Crop Statistics of Pakistan. Fact Series III. Rawalpindi: Department of Agricultural Economics and Statistics, June 1962.

Government of Pakistan, Ministry of Agriculture and Works. Survey Report on Farm Power, Machinery and Equipment in Pakistan. Rawalpindi: Agriculture Wing (Planning Unit), 1967.

Government of Pakistan, Ministry of Agriculture and Works. Yearbook of Agricultural Statistics, 1968. Fact Series No. VII. Rawalpindi: Food and Agriculture Division, Agriculture Wing (Planning Unit), January 1969.

Government of Pakistan, Ministry of Agriculture and Works. Yearbook of Agricultural Statistics, 1969. Fact Series No. VIII. Rawalpindi: Food and Agriculture Division, Agriculture Wing (Planning Unit), February 1970.

Government of Pakistan, Ministry of Finance, Planning and Development. 25 Years of Pakistan in Statistics: 1947-1972. Karachi: Central Statistical Office, Economic Affairs Division, 1972.

Government of Pakistan, Ministry of Food and Agriculture. Livestock Statistics of West Pakistan. Fact Series No. 3. Karachi: Directorate of Agricultural Economics and Statistics, 1960.

Government of Pakistan, Ministry of Food and Agriculture. Report of the National Commission on Agriculture. Islamabad: National Commission on Agriculture, 1988.

Government of Pakistan, Ministry of Food and Agriculture,

Agricultural Census Organization. Pakistan Census of Agricultural Machinery, 1975: Final Report -- Data by Districts. Lahore: Agricultural Census Organization, 1977.

Government of Pakistan, Ministry of Food and Agriculture, Agricultural Census Organization. Pakistan Census of Agriculture, 1972. Volume V. Special Report: Selected Data by Sub-Divisions. Lahore: Agricultural Census Organization, 1976.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1977. Volumes I and II. Islamabad: Food and Agriculture Division (Planning Unit), 1978.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1979. Volumes I and II. Islamabad: Food and Agriculture Division (Planning Unit), 1980.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1981. Volumes I and II. Islamabad: Food and Agriculture Division (Planning Unit), 1982.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1982. Islamabad: Food and Agriculture Division (Planning Unit), 1983.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1983. Islamabad: Food and Agriculture Division (Planning Unit), 1984.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1985. Islamabad: Food and Agriculture Division (Planning Unit),

1986.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Agricultural Statistics of Pakistan, 1986. Volumes I and II. Islamabad: Food and Agriculture Division (Planning Unit), 1988.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. Assessment of Performance of Commercial Banks in Distribution of Loans to Agriculturalists, 1980-81. Publication E.S.-68. Islamabad: Food and Agriculture Division (Planning Unit), Economic Studies Branch, September 1983.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. A Study on Cost of Production of Crops: Maize, 1983-84. Publication E.S.-79. Islamabad: Food and Agriculture Division (Planning Unit), Economic Studies Branch, January 1985.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. A Study on Cost of Production of Crops: Paddy, 1983-84. Publication E.S.-82. Islamabad: Food and Agriculture Division (Planning Unit), Economic Studies Branch, January 1985.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. A Study on Cost of Production of Crops: Sugarcane, 1983-84. Publication E.S.-80. Islamabad: Food and Agriculture Division (Planning Unit), Economic Studies Branch, January 1985.

Government of Pakistan, Ministry of Food, Agriculture and Co-Operatives. A Study on Cost of Production of Crops: Wheat, 1983-84. Publication E.S.-83. Islamabad: Food and Agriculture Division (Planning Unit), Economic Studies Branch, January 1985.

Government of Pakistan, Ministry of Food, Agriculture, Cooperatives and Land Reforms. Pakistan Census of Livestock, 1976. Final Report: Data by Districts. Lahore: Agricultural Census Organization, 1977.

Government of Pakistan, Ministry of Food, Agriculture, Cooperatives and Land Reforms. Pakistan Census of Livestock, 1976. Special Report: Data on Milk Yield, Animals Slaughtered for Meat, Breed-Wise Distribution of Cows and Buffaloes and Livestock Population by Size and Tenure of Farms. Lahore: Agricultural Census Organization, 1977.

Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Underdeveloped Areas and Land Reforms. Agricultural Statistics of Pakistan, 1975. Volumes I and II. Islamabad: Agriculture Wing (Planning Unit), 1976.

Government of Pakistan, Ministry of Food, Agriculture and Under Developed Areas. Survey Report on Agricultural Credit Situation in West Pakistan. Publication S.S. XV. Islamabad: Food and Agriculture Division (Planning Unit -- Agriculture Wing), April 1972.

Government of Pakistan, Ministry of Food, Agriculture and Under Developed Areas. Survey Report on Economics of Tubewells' Irrigation in the Selected Districts of the Punjab. Publication S.S. XIV. Islamabad: Food and Agriculture Division, Planning Unit (Agriculture Wing), 1972.

Government of Pakistan, Planning Division. Cost of Production of Major Crops, Under Irrigated and Un-irrigated (Barani) Conditions, Average Leading Farmer, Punjab in 1979-80. Publication AGR-139. Islamabad: Agriculture and Food Section, November 1980.

Government of Pakistan, Planning and Development Division. Pakistan Fertilizer Statistics. National Fertilizer Development Centre Statistical Bulletin No. 3. Islamabad: National Fertilizer Development Centre, February 1984.

Government of Pakistan, Planning and Development Division. Pakistan Fertilizer Statistics. National Fertilizer Development Centre Publication No. 3/86. Islamabad: National Fertilizer Development Centre, April 1986.

Government of Pakistan, Planning and Development Division. Pakistan Fertilizer Statistics. National Fertilizer Development Centre Statistical Bulletin No. 4. Islamabad: National Fertilizer Development Centre, January 1988.

Government of Pakistan, Planning and Development Division, National Transport Research Centre. Transport Statistics, 1984. Volume I. Publication NTRC-83. Islamabad: National Transport Research Centre, April 1985.

Government of Pakistan, Statistics Division. Handbook of Population Census Data. For Census of 1981. Province Reports for Punjab, Baluchistan and NWFP. Islamabad: Population Census Organization, 1987-88.

Government of Pakistan, Statistics Division. Pakistan Census of Agriculture, 1980: Special Report -- Mouza Statistics. Lahore: Agricultural Census Organization, 1982.

Government of Pakistan, Statistics Division. Mouza Statistics, 1983: Settled Areas Only. Lahore: Agricultural Census Organization, 1987.

Government of Pakistan, Statistics Division, Agricultural Census Organization. Pakistan Census of Agricultural Machinery, 1984. Volume 1. All-Pakistan Report. Lahore: Agricultural Census Organization, 1987.

Government of Pakistan, Statistics Division, Agricultural Census Organization. Pakistan Census of Agriculture, 1980. Volume III. Special Report: Selected Data by Sub-Divisions. Lahore: Agricultural Census Organization, 1983.

Government of West Pakistan, Agriculture Department. West Pakistan Agricultural Statistics: Series No. 1 -- Crops. Includes years 1954-55 to 1964-65. Paperbound book; location and date of publication no longer legible.

Government of West Pakistan, Department of Agriculture. Season and Crop Report of West Pakistan, 1965-66. Lahore: Evergreen Press, 1966.

Government of West Pakistan, Department of Agriculture. Season and Crop Report of West Pakistan, 1966 67. Lahore: Evergreen Press, 1967.

Government of West Pakistan, Department of Agriculture. Season and Crop Report of West Pakistan, 1967-68. Lahore: Evergreen Press, 1968.

Government of West Pakistan, Directorate of Livestock Farms. Eighth Annual (Research) Report: 1969-70. Lahore: Directorate of Livestock Farms, 1970.

Government of North-West Frontier Province, Barani Agriculture Development Project. Agriculture Statistics in N.-W.F.P. for the Years 1970-71 to 1976-77. Peshawar: Barani Agriculture Development Project, April 1978.

Government of North-West Frontier Province, Bureau of Statistics. Development Statistics, 1985. Peshawar: 1985.

Government of North-West Frontier Province, Bureau of Statistics. Important Socio-Economic Statistics for North-West Frontier Province, 1986. Peshawar: Planning and Development Department, 1986.

Government of North-West Frontier Province, Directorate of Agriculture. Agricultural Statistics of N.W.F. Province: 1974-75 to 1976-77. Peshawar: Agricultural Information Wing, 1978.

Government of the Punjab, Agriculture Department. Ayub Agricultural Research Institute: Annual Report, 1985-86. Faisalabad: Ayub Agricultural Research Institute, Research Information Section, 1986.

Government of the Punjab, Agriculture Department. Punjab Agricultural Statistics: 1980-81 to 1984-85. Volume I. Lahore: Directorate of Agricultural Information, February 1987.

Government of the Punjab, Agriculture Department. Rice Research Institute: Annual Report, 1986-87. Kala Shah Kaku: Rice Research Institute, 1987.

Government of the Punjab, Bureau of Statistics. Crop Acreage

Statistics of the Punjab: Rabi 1983-84. Lahore: Bureau of Statistics, 1985.

Government of the Punjab, Bureau of Statistics. Crop Acreage Statistics of the Punjab: Rabi 1984-85. Lahore: Bureau of Statistics, 1986.

Government of the Punjab, Bureau of Statistics. Crop Acreage Statistics of the Punjab: Kharif 1985. Lahore: Bureau of Statistics, 1986.

Government of the Punjab, Bureau of Statistics. Crop Acreage Statistics of the Punjab: Kharif 1986. Lahore: Bureau of Statistics, 1987.

Government of the Punjab, Bureau of Statistics. Crop Acreage Statistics of the Punjab: Rabi 1986-87. Lahore: Bureau of Statistics, 1987.

Government of the Punjab, Bureau of Statistics. Punjab Development Statistics: 1983. Lahore: Bureau of Statistics, 1983.

Government of Sind, Bureau of Statistics. Agricultural Statistics of Sind 1987. Karachi: Planning and Development Department, 1987.

Government of Sind, Bureau of Statistics. Development Statistics of Sind: December, 1973. Karachi: Planning and Development Department, 1973.

Government of Sind, Bureau of Statistics. Development Statistics of Sind, 1975. Karachi: Planning and Development Department, December 1975.

Government of Sind. Development Statistics of Sind, 1986. Karachi: Bureau of Statistics Planning and Development Department, 1986.

Articles

Sharif, Muhammad, Muhammad Shafique, Zulfiqar Ahmad, M. Asim Maqbool, and Jim Longmire. Monitoring Rice Varieties Grown in the Rice Zone of the Punjab: Results from 1985-87. AERU Faisalabad Staff Paper No. 88-6. Faisalabad: Agricultural Economics Research Unit (PARC), Ayub Agricultural Research Institute, PARC/CIMMYT Collaborative Program, 1988.

Sharif, Muhammad, Zulfiqar Ahmad, Muhammad Shafique, M. Asim Maqbool and Jim Longmire. Monitoring Wheat Varietal Diffusion in the Irrigated Punjab: Results from 1987-88. AERU Faisalabad Staff Paper No. 88-5. Faisalabad: Agricultural Economics Research Unit (PARC), Ayub Agricultural Research Institute, PARC/CIMMYT Collaborative Program, 1988.

Books and Other Publications

International Labour Organization. Pakistan Country Report. Mimeographed Report. Islamabad: ILO Office, December 1978.

Khan, Muhammad Aqil. Wheat Variety Development and Longevity of Rust Resistance. Lahore: Government of the Punjab Agriculture Department, 1987.

Pakistan Water and Power Development Authority. Pakistan Development Statistics. Statistical Bulletin No. 40. Lahore: WAPDA Planning and Investigation Organization, June 1983.

Rock, Carroll and Kerry Gee. An Appraisal of Agricultural Price

Statistics in Pakistan. A study supported by the Pakistan Food Security Management (FSM) Project in cooperation with the Ministry oof Food, Agriculture, and Cooperatives (Economic Analysis Component), the Federal Bureau of Statistics (Agricultural Data Collection Component), and the U.S. Agency for International Development. Pakistan Economic Analysis Network Project Special Reports Series No. 2. Islamabad: EAN Project, December 1987.

Wheat Research Institute, Ayub Agricultural Research Institute. Annual Report for 1985-86. Faisalabad: Wheat Research Institute, 1987.