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Productivity Constraints of Cholistani Farmers

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This paper examines the factors behind low crop yield in Cholistan. Both the quantitative and qualitative analysis show how the low levels of agricultural productivity in this area may be linked to material and climatic factors. The quantitative analysis is mainly focused on physical factors. The qualitative analysis, however, emphasises that relative inefficiency of agricultural activity in Cholistan reflects the influence of physical, economic, social and, most importantly, climatic factors. The quantitative findings provide valuable insight into various 'sources of productivity' in terms of acreage effect, capital input effect and irrigation water availability effect. The size of the positive and significant coefficients on these variables suggest the extent to which one or the other variable effect is prominent in improving the crop yield. The qualitative analysis examines multiple interrelated factors which can be blamed on for relative inefficiency of Cholistani farmers. The hot climate of the area turns out to be the most critical variable in this analysis. Many specific technological drought-mitigating measures are proposed. However, for consistent policy formulation, a thorough study and quantitative evaluation of the potential and practicality of these measures in Cholistan is suggested.

INTRODUCTION

This is our second study in the series intended to focus on that part of rural Pakistan which has received little attention not only at the level of policy but also at the level of empirical inquiry.[1] In this paper we attempt to indicate some of our findings on the nature of constraints, along-with the factors underlying them, faced by the Cholistani farmers. The study is divided in four parts. Part I gives the terms of reference and explains the methodology employed for data collection. The data analysis is carried out in Part II and Part III. The former estimates the role of productivity determinants for which the data collected was adaptable to quantifiable measures, while the latter examines some additional, but very important, qualitative factors. Finally, in the concluding Part IV we attempt to suggest some policy measures based on the findings of this study, scientific information available in the literature and our own observations in the field while collecting the data.

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[1]For the first study, see Khan and Anania (1996).

I. TERMS OF REFERENCE AND DATA[2]

Cholistan is the peripheral area of Bahawalpur Division of the Punjab Province. Bahawalpur division lies in the extreme south of Punjab. The southern portion of Bahawalpur comprises of desert area of Cholistan. With a surface area of 45,588 Km, Bahawalpur division is the largest in Punjab, lying south of the Sutlej and Indus river. The Hakra River, once a source for irrigation and ancient settlement, is now only a dry bed, running from the Northeast through the north-central part of the Division. The Hakra roughly divides the Cholistan into the semi-arid Lesser Cholistan in the north, covering an area of nearly 7,561 Km, and the desert of Greater Cholistan, covering an area of 19,278Km, in the south. The Cholistan Desert extends into India in the east and south as the Rajastan Desert, and into Sindh Province of Pakistan in the south west as the Thar desert. The Greater Cholistan, stretching northward from India, is heavily grazed by pastoralists' animals. It is a sandy desert characterised by large, often migrating, sand dunes and interdunal hollows, ridges and depressions. Land is suitable only for grazing. Although, through the pastoral culture and an extended family system, the pastorals of Greater Cholistan are inextricably linked with the inhabitants of Lesser Cholistan, this study's scope of inquiry is limited to the newly settled areas of Lesser Cholistan, where many of the families have farm parcels of land given on lease arrangement by the government.

The Pakistan Census Organisation gives the population of Bahawalpur Division in 1981, the last Census, as 4.7 million. Projecting population based on a uniform, estimated growth rate of 3.1 percent gives an approximate number of 7.4 million by 1996. The population of Cholistan is not easily arrived at. Interpolating from census figures and authors' inquiries, it is likely that population in this particular area is 400,000, at a minimum and possibly as high as 600,000, including pastoralists in the Greater Cholistan. The pastoral population of Cholistan is not known. It is estimated at 100,000, to 150,000, many of whom have families and own or have access to parcels of land in the settled areas of Lesser Cholistan.

Punjab has the greatest number of poor households in Pakistan; and Cotton/wheat Punjab, consisting of mainly Bahawalpur Division, is the poorest [see, Malik (1992), Table 3, p. 989]. The highest concentration of poverty in Pakistan is in southern rural Punjab. Here 30 percent of population is below the poverty line versus 17 percent nation-wide [see, Asian Development Bank (1994)]. The incidence of poverty is most widely visible in the newly settled areas of Lesser Cholistan, the focus of this study.

The Cholistan Development Authority (CDA) was established about 10 years ago to provide land allotments to Cholistani people of the desert. Various land

[2]The data used in this study were collected by the first and the third author in December 1995 for assessing the socio-economic impact of "Design of the Bahawalpur Division Area Development Project" of the Asian Development Bank.

settlement schemes were established with allotments ranging from 5 hectares to 10 hectares per household, depending on the potential productivity of land.[3] Allotment criteria should have resulted in an equitable distribution of potentially irrigable land. Our survey, however, indicated that some large extended families were able to acquire or at least exercise effective control over considerable number of allotments and lands in the area are also being allotted to non-Cholistanis.

The authors developed Rapid Rural Appraisal Survey instruments to gather information on Cholistani farmers. A village survey instrument was employed for group interviews, and farmer survey instrument was employed to record discussions with individuals. The survey was conducted in three Tehsils, Liaqatpur, Yazman and Fort Abbas—one each in the three Districts, Rahim Yar Khan, Bahawalpur and Bahawalnagar respectively, of Bahawalpur Division. A total of five communities[4] were selected in each District and a total of 30 farmers were interviewed in each community. There were three major constraints in conducting this survey, time, resources and accessibility to the communities. Many of the communities selected were within a three kilometer radius of a metalled, or hard surface, road. Many are isolated and difficult to get to because of poor or no roads. Survey was conducted in some communities after walking several kilometers.

The village survey indicated that people in the surveyed communities are mostly Siraiki speaking with a small minority speaking Punjabi. The ethnic make up of the communities surveyed is 80 percent Siraiki and 20 percent Punjabi. With 2 percent of Hindus, the population is predominantly Muslim but the social and political life of the people is governed largely by the traditional extended family and clan system. The total land area of the fifteen surveyed communities is estimated at 6,441 hectares and their total population is estimated at 19, 500. In official estimates the population density of the rural areas of Bahawalpur Division is estimated at 137 per square kilometer. Our findings show that population density in the fifteen communities surveyed is 302 persons per sq. km: 194, 246 and 513 person per sq. km in Liaquatpur, Yazman and Fort Abbas Tehsils respectively.

[3]CDA has a set of established criteria for the allocation of land to each Cholistani. These include: the land to be irrigated is initially leased to individual families for a period of 20 years, after which ownership rights are bestowed. The name of the head of the family appears on the lease. For the lease, the family pays a nominal fee, the amount determined by the specific scheme under which the land was allotted. At the end of the lease period, the family pays a larger fee per acre. The land cannot be sold or exchanged until the full title is received. The major criterion for releasing the land to the family is that 75 percent of the land must be under cultivation at the end of the lease period. If the family cannot meet the criteria, the lease arrangement is extended to allow the family to make necessary adjustments. In 1997 and 1998, many of the lease period will be completed and full title should be conveyed to the farmers.

[4]The term "Community" is used here instead of term "village", because the focus area of this study does not always fit easily into single cluster of houses implied in the commonly accepted use of "village". Households in the most recently settled areas of Lesser Cholistan are often found scattered over a wide area. In many cases, the only way to get from one set of households to the other is to walk a long way in the fields, since no roads or pavements exist presently to link them together.

II. PRODUCTIVITY CONSTRAINTS: QUANTITATIVE ANALYSIS

The impact of capital, human capital, land, labour, education, credit and water availability on wheat and cotton yield is measured quantitatively. We also wanted to estimate the impact of Agricultural Research and Extension Services, but hardly any farmer appeared to have access to them. Uniform data was available for 348 observations of the 450 farmers interviewed. The equation in functional form is written as:

$$Y = f\ (K, H, N, D_e, D_c, D_w)$$

The left hand variable represents cotton and wheat yield. The right hand variables are capital (K) taken as expenditure on seed, fertiliser and pesticides; human capital (H) taken as family's expenditures on food and health; labour (N) employed in numbers; land (L) in acres; dummy variable for education (D_e) taken as zero and one for less than five and five or more years of education respectively; dummy variable for credit (D_c) taken as zero and one for informal and formal sources respectively and dummy variable for water (D_w) zero, one and two for Liaquatpur, Yazman and Fort Abbas Tehsil respectively, corresponding to the relative levels of irrigation water availability in the three areas.

In its estimable form, the function may be written as:

$$Y = \beta_o + \beta_1 Ki + \beta_2 H_i + \beta_3 N_i + \beta_4 L_{i+} \beta_5 D_e + \beta_6 D_c + \beta_7 D_w + \mu$$

The model is estimated by employing Ordinary Least-square estimation Method and the results are listed in Table 1.

Table 1

Estimated Regression Coefficients

No. of Observations=348 *Y=Dependent Variable*

Regressor	Coefficient	t-Statistics
Intercept	–36227.2	–7.76
K	1.11	8.84
L	3303	17.13
D_w	6719	2.09
Adj–R^2= 0.667	*DW Stat*.= 1.76	*F. Stat*.= 230

All but three explanatory variables are dropped from the final estimated form of the production function formulated for Cholistani farmers. Only capital, land and irrigation water have turned out significant constraints on production with positive coefficients. The variables for land and capital are significant at 99 percent level, while the dummy variable for water is significant at 97 percent level. The size of Adj-R^2 is about 68 percent, showing strong relationship of the explanatory variables with the crop yield. All the indicators show that the results are statistically valid and that the model in its final estimated form is well specified.

However, we do find some theoretical problems with the final estimated equation which must be taken into account for a meaningful analysis. While the lessons on the theory of production, along with the corresponding evidence, conclude that investment in human capital, nutrition, health and education, equips all groups of producers to carry out efficient investment programmes, the dummy variables for education and variable for human capital have been dropped in our final estimated model because they turned out insignificant. Such a distortion, in our opinion, has resulted due to the unavailability of the consistent data required to measure the true impact of these important productivity determinants. The only measure available for estimating the impact of human capital was farmers' families' expenditures on food and health. Since there existed wide variations in farmers' family sizes and composition with regard to age, the data appears inadequate to conform to the theoretical disposition. The inadequacy of data, along with the incompatibility of supplementary requirements, might also has caused the dummy variable for education to weigh insignificant. The literacy threshold is taken very low, 5 years and above of schooling, and only 76 of the 348 observations meet the standard. But almost all of them have education between 5 and 8 years of schooling. Given the poor availability of the communication and transportation[5] services in Cholistan, primary education of some farmers cannot be expected to make a difference in productivity. The insignificant coefficient on the dummy for credit can also be explained in terms of data problems: only 15 of the 348 observation ever could have access to formal credit market. Finally, the insignificant coefficient on the variable for labour does not, however, pose any theoretical problem. On the contrary it endorses the widely accepted view of the existence of surplus labour in the traditional sector [see, Lewis (1954)].

There is also some conceptual problem with the large and significant coefficient, with a positive sign, on the land variable. Given the empirical evidence in literature, we can expect the crop yield to vary inversely with farm size because, as Griffin (1974) says, the implicit rental price of land will be higher for the small

[5]Even if they can afford to buy and read it, because of poor road conditions, farmers mostly cannot get hold on a newspaper. There is no electricity in any of the fifteen communities surveyed. Only in one village a farmer had a television which was operated with tractor's battery. Very few farmers indicated that they have a transistor.

cultivator (who has less of it, and less financial potential to get more of it) as compared to the larger (who has more of it, and also the financial resources to get more of it). So the subsistence farmers have to become more efficient in order to survive, and this efficiency in 1960 was visibly nearer its limits in Pakistan than the larger farm size categories. However, this is exactly one of the main points we want to emphasise in this study. As mentioned earlier, the allotment criteria should have resulted in an equitable distribution of potentially irrigable land, but some large extended families were able to acquire considerable number of allotments. These families are mainly non-Cholistanis and almost all of them belong to Fort Abbas Tehsil which has better social and economic provisions compared to other two Tehsils of the surveyed area. Our survey indicated that in the Fort Abbas Tehsil some of the non-Cholistanis are cultivating holdings of up to 40 hectares. Since the heavy requirements for the adoption of the new technology necessitates considerable investment on fertiliser, pesticides, tubewells and agricultural equipment, small cultivators cannot afford it. This is exactly the point of the 'bias' in favour of large holdings.

Finally, the authors believe that there are so many imperfections regarding the economic conditions in Cholistan that a quantitative model alone cannot adequately explain all the factors which directly and indirectly affect the agricultural activity in the area.

III. PRODUCTIVITY CONSTRAINTS: QUALITATIVE ANALYSIS

There are two dominant production systems in the surveyed communities: (1) an agro-pastoral system representing about 75 percent of the population, composed of irrigated agriculture undertaken in association with the raising of livestock that are either stall-fed or grazed in the desert; and (2) a pastoral system which comprises chiefly of a trans-humant element, involving the seasonal movement of people and livestock in the desert made up of herders tending goats and camels permanently located in the desert, together representing about 25 percent of the population. The development of agriculture within these communities is recent and concurrent allotment of land to the male heads of families is responsible for present settlement patterns. Most of the families in the surveyed communities who have an irrigated allotment follow an agro-pastoral lifestyle, combine their farming with annual migration to their traditional grazing areas (tobas) in the Greater Cholistan. Only in two or three of the communities, a shopkeeper, technician, teacher or driver was found. Pastoralism is a major component of the production system. Although Cholistanis have reduced herds in the communities of Lesser Cholistan, the other members of the extended family have larger herds in the Greater Cholistan. There are no animal health facilities available in these communities. Many of those involved in livestock management were very concerned about the distance they have

to travel to gain access to a vet. The average distance they must travel is 10.5Km. Of the 15 communities surveyed, not one community had a health care facility. In the Liaqatpur Tehsil, the nearest health clinic was in Firoza, a town at a minimum distance of 12km and maximum distance of 25km from the surveyed communities. In the Yazman area the distance range for the five communities surveyed was 8-35 km. In Fort Abbas Tehsil the health clinic was located in village no. 286, at an average distance of 4 to 5km from the surveyed communities.[6]

Literacy rates are very low in Cholistan. Nearly hundred percent of adult women are illiterate in surveyed communities. Majority of the adult men are illiterate too. Hardly any adult man of surveyed households went to a secondary school. There are a total of 18 schools. They include 12 primary schools (five years of schooling) for boys, 5 girls primary schools and one middle school (eight years of schooling) for boys. Most of these schools are of recent origin, built by the government under Social Action Programme (SAP). Unfortunately, many of these schools are not working because there are no teachers even though the government assigned them to various communities. The major problem appeared to be the lack of amenities for teachers to stay in the communities e.g. housing, water, etc., and the lack of transportation to reach the communities. Secondary schools are situated at quite a distance from these communities. Eight communities have a distance range of 3-12km and the rest have a range of 20- 32km.

Most of the Cholistani farmers are poor, isolated, subsistence-oriented, desert people. They care most about what is going on in their fields and their villages, and their communities reflect this inward looking orientation.[7] Most of the farming units in Cholistan conform to Chayanov's definition of "Pure family farms" [see, Chayanoy(1966)]. According to his definition, such farms never hire labour to supplement that of family members. They carry on agriculture as a means of livelihood, not a business for a profit. The number of family members that work on agricultural land full-time is about 2.4 persons per farm. The number of family members that are engaged in farming, in a variety of ways is 3.7 persons per individual farm. The agricultural methods used by Cholistani farmers are mostly labour intensive, as in hand transplanting from seedbed to field, manuring, mulching and mounding, and terracing. They, however, use technological inputs purchased in

[6]These distances must be adjusted for poor transport facilities and roads condition. The respondents told the authors that very often they have to take the serious patients to the health clinic by animal driven carts.

[7]Here it is useful to remember the difference between closed and open farmer communities that Eric Wolf made more than 40 years ago. The closed communities are more inward looking than the open communities. They tend to produce mostly basic grains and food rather than commercial crops and often have cultural, historical or political differences with the larger society. Open communities usually have many more economic, political and cultural connections to the larger city. The influence of the outside world is a more direct and more important part of everyday life in open communities [see Wolf (1955)].

the market, such as farm implements, fertiliser and some pesticides, and they sell part of their production, mainly cotton, in the market.

Yields of the main Kharif crops (cotton, fodder, sugarcane and rice) and Rabi crops (wheat, mustard greens, and fodder) are lower than the averages for the Bahawalpur District for two reasons: (1) farmers in the surveyed area receive less water than other irrigated areas and therefore use less of other inputs, and (2) they have not received the assistance they need to farm efficiently. The prevailing standard of weed control, land preparation, land levelling, onfarm water management, and timing of inputs is low. The principal fodder crop grown during the Kharif season is sorghum, or more commonly known as jowar, has a good yield but the farmers only get one cutting. The principal fodder crop grown during the Rabi season is mustard greens mixed with lucerene/berseem. The mustard greens are used for both human and animal consumption. Very little of the mustard crop is used to produce oil seeds. The fodder crop yields during the Rabi season are very low because of the uncertainty of irrigation water. Also, with the uncertainty and inadequate water supplies, fewer inputs are used with brackish water, thus, subsequent crop yields are lower than those achieved in the rest of the Punjab.

The Bureau of Statistics for all of the Cholistan area estimated that there is 29, 811 hectares under cultivation of which 60.5 percent is under wheat production and 57.3 percent is in cotton production. In the surveyed area, where the climatic conditions are much dryer, the land is more saline, many of the farmers on the tail end of the watercourse indicated that 40 percent of the cultivable land is under cotton production and 48 percent of the cultivable land is under wheat production. Also, 94 percent of the farmers indicated that they plant and harvest crops in both the Kharif and Rabi crop season. Table 2 provides a comparison of the yield of main crops in the surveyed area with that of the Bahawalpur District and Pakistan. Despite the harsh conditions, the yield in the surveyed area, given in column three, fares quite favourably with the two comparable sets of figures listed in column two of the table. In the Bahawalpur District, wheat yield averages around 2,133 kgs per hectare, cotton about 2,122 kgs per hectare, and sugarcane about 40, 872 kgs per hectare. The village Survey indicated that the average wheat, cotton and sugarcane yields in the surveyed area fall below by 28 percent, 41 percent and 38 percent respectively. The yield in the surveyed area compares, however, much better with the corresponding averages for Pakistan. The wheat and sugarcane yields fall below the average for Pakistan by 9 percent and 33 percent respectively. The cotton yield, on the other hand, is 84 percent higher in the surveyed area than that of the average for the country as a whole. The farmer survey indicated that the major income earner crop was cotton.

The estimated annual net income per farm family in the surveyed area is Rs 25,205. This is considered below the national poverty line. The gross income information we were able to obtain from the sale of crops and livestock and incomes

Table 2

Comparison of Crop Yields per Hectare

Crop	Bahawalpur Pakistan (District) Yield (kgs)		Surveyed Area Yield (kgs)	Difference in Yield (kgs)		Difference in Yield (%)	
				BWP	Pak.	BWP	Pak.
Wheat	2,133	1,703	1,547	–586	–156	–28 %	–9 %
Cotton	2,122	683	1,261	–861	+578	–41 %	+84 %
Sugarcane	40,872	37,660	25,334	–15,538	–12,326	–38 %	–33 %

Source: Agricultural Statistics of Pakistan. Figures for Bahawalpur District and Pakistan give the output in year 1995-96 and 1992-93 respectively.

received from any other source show that most of the farmers in the surveyed area are subsistence producers and that they are below the national poverty line. The indicators also show that most of the farmers in the surveyed area are not generating sufficient resources to move out of the poverty situation.

The surveyed area is commanded by canals fed from three barrages on the Sutlej and Chenab rivers and from a link canal originating at the Ravi River. According to the Cholistan Development Authority, the total area commanded by the irrigation system amounts to about 100,000 hectares in the three surveyed Tehsils. Because of water shortages, the actual area cultivated for each cropping season (Kharif and Rabi) is about 55,000 hectares. The canals providing water to the surveyed Tehsils were designed for non perennial irrigation or, more specifically, to provide irrigation water supplies for about ten weeks, during and immediately after the monsoon. During this period, high river flows permit surplus water to be diverted to these areas. Most farmers who depend on gravity water supplies receive only enough water to irrigate 20 to 30 percent of their 5 hectares holdings. As the distance from the head of the canal increases, so the amount of water available to each farm decreases. The networks are loosely controlled and farmers near the head canal take the opportunity to help themselves to additional water. As the largest supply of water is received at the end of the Kharif season, farmers use it to finish the Kharif crop planted under rain fed conditions. Following crop harvest, they sow their Rabi crops into already moist soils and irrigate as long as water supplies last. In the surveyed area, 99 percent of the farmers said that they had access to irrigation canal water.[8] But 84 percent of the farmers indicated that the canal irrigation water supply was not available year round and 94 percent of the farmers said the water supply was inadequate to meet their crop needs. They also said that the average length of the watercourse providing water to their farms was about 2.7km and all the

[8]In addition, about one percent of the farmers use tubewells as a mean to irrigate their crops. All of these respondents were in the Fort Abbas area which could be using a combination of sweet and brackish water.

farmers agreed that the watercourses need to be improved. Given the sandy soil conditions in parts of the surveyed area, a large percentage of the irrigation water could be lost to seepage.

Most of the surveyed area is underlain by moderately to highly saline groundwater. There are no permanent natural bodies of surface water in Cholistan. Low rainfall, high rate of water infiltration into the sands, and high evaporation rate preclude the natural accumulation of surface water. A hydrological survey carried out by the Water and Power Development Authority (WAPDA) in 1963 indicated that most of the area is underlain by moderately to highly saline groundwater at depths ranging from 30 to 90 meters (95 to 395 feet)[9] and the salinity ranges from 368 to 34, 000 mg/1 of total dissolved salts. There are two belts of sweet water in Cholistan. One extends for 80 km from Fort Abbas toward Mojgarh Fort and varies from 10 to 15 km in width. It lies between 40 and 100 meters below the surface and has an estimated volume of 10 billion litters. The second is centred just north west of Derawar Fort, and occupies an area of 50 sq. km, yielding about 25 m below the surface with a maximum thickness of 100 m. Both sweet water lenses are surrounded and underlain by bodies of brackish and saline waters. While the present depth of the groundwater in the irrigated parts of the area does not interfere with agriculture, its high salinity is potential threat to the root zone.

Nobel-Laureate Gunner Myrdal's assertion that "climate exerts everywhere a powerful influence on all forms of life, vegetables, microbial, animal and human, and on inanimate matter as well" [see, Myrdal (1968), Vol. III, pp. 2121–38] is particularly true for Cholistan's agriculture. Indeed, agriculture is one of the riskiest professions in the world, natural hazards affecting farm output include uncertainties of weather, such as deficiency of moistures or droughts; excessive moisture, including flooding; excessive cold; hailstorms; tornadoes, cyclones, typhoons, or windstorms; and natural fire and lighting. Of all these phenomena, widespread drought has historically had the most detrimental effect. There have been many definitions of drought. A simple definition of agricultural drought given by Rosenberg (1980) is that drought is a climatic excursion involving a shortage of precipitation sufficient to adversely affect crop production or grassland or horticultural productivity. Drought is a recurrent phenomenon in Cholistan, as it is in all of the semi-arid and sub-humid areas of the world. Therefore, it would be useful to discuss the drought as a productivity constraint for Cholistani farmers in some detail.

The climate in Cholistan is characterised by low rainfall, varying from less than 100 mm in the west to 200 mm in the east, with periodic droughts. Rain usually falls between July and September, which is the monsoon period, and between January and March, as the Winter-Spring rains. Temperatures are extremely high in

[9]The Village survey indicated that the depth of the water table was within the WAPDA range.

summer and mostly mild in the day and cold at night in the winter with an occasional frost. It is one of the hottest regions in Pakistan. The mean summer temperature is 34 degrees Centigrade with highs reaching nearly 50 degrees. Monsoon rains fall in heavy showers, partly infiltrating into the sandy ground to be conserved for plant utilisation without recharging the ground water. In clayey layers a portion of the rainfall sods does not infiltrate and accumulates as run-offs in tobas and kunds (reservoirs for human and stock use respectively); the remaining evaporates. Aridity is the most striking feature of Cholistan, with wet and dry years occurring in clusters. The annual rainfall may occur during as few as 10 day. The spatial variation among rainfall zones may be greater than the year to year variation of the entire area.

Thus, agricultural drought occur in Cholistan because of erratic rainfall unrelated to crop needs. If the total rainfall in Cholistan was evenly distributed in space and time, the water needs for the entire cultivated area will be satisfied. The fundamental requirement for drought management in Cholistan is the collection and storage of water for utilisation in protective irrigation during dry spells (water harvesting). Further, refined predictions of rainfall are needed to match crops with expected weather, particularly now that so many hybrid varieties of crops are available. Most importantly, better communications and exchange of information in Cholistan should be set up. Finally, an integrated strategy to minimise the adverse impact of drought on crops, farm, animals, and human population with short and long term action plans will have to be developed at the national level. In the long term strategy, the development of irrigation sources and scientific land and water use planning will have to receive attention. Also, the capability of making fairly accurate long term weather forecasts will have to be developed.

The soil in Cholistan is classified as either saline or saline-sodic with a pH value ranging from 8.2 to 8.4. The pH level of the saline-sodic soil ranges from 8.8 to 9.6. Cholistani soil has poor moisture retention capacity, which is primarily due to the organic content of soil. Generally, organic content of soil comprises several compounds of the humic and fulvic acid types, which are formed by microorganisms in the breaking down of cellulose [see, Schnitzer (1976), p. 426].

These compounds are important for soil because of their ability to retain water and mineral salt and resistance to leaching. Ormerod (1978) points out that high temperature, long periods of drought, intense ultraviolet radiation and particularly high kinetic energy rainfall, which destroys the granular structure of the soil, decrease the activity of soil microorganism so that there is little possibility in open land for the stable organic content of the soil to build up; indeed there is tendency for it to be destroyed. During the long dry season, there is some loss of topsoil due to wind erosion. However, far more damage is done during the onset of the rainy season. The vegetative cover, at the end of the dry season, is already reduced and often at an absolute minimum. Thus when a heavy thunder shower occurs, the water

does not infiltrate into the soil as it might in light steady rain, and year after year soil erosion takes place due to surface runoff. Tempany and Grist (1958) have suggested that if the heavy rains double the water flow, "scouring capacity is increased four times, carrying capacity thirty-two times and the size of particles carried sixty-four times." Fisher (1961) estimates that these processes have contributed to the erosion of nearly 150 million acres in India. There are, however, no estimates available for Pakistan.

The above discussion does not mean to imply that Cholistani soil cannot be protected from severe erosion. By appropriate land use patterns and management techniques, it should be possible to reduce and control the erosion problem significantly. The overriding fact, however, remains; we still do not know enough about soil taxonomy in Cholistan. Substitution of present crop pattern with a more desirable variety is one solution. But lack of infrastructure to give appropriate advice and limited availability of investment capital, credit and necessary agricultural inputs severely restrict the options available.

Further, there are other problems with Cholistani soil as well. Preparation of the land for planting is generally carried out prior to the onset of the rains. This means that this arduous task has to be carried out very often in what turns out to be the hottest and driest season of the year by labour-intensive means with people who are mostly undernourished.[10]

Many specific technological drought mitigating and soil improvement measures have been proposed. Some of the components of this technology are: improved soil management practices; use of improved and appropriate seeds; use of fertilisers; intercropping/double cropping; proportionate cropping; watershed management; and supplementary life saving irrigation. There is an urgent need to undertake for Cholistan a thorough study and quantitative evaluation of the potential and practicality of these measures in regular and emergency use. Most important of all is the watershed-based management system which brings together several components of improved technology and recognises that the improvement of any one may have small effect on crop yields. The combination of all components that can produce the most significant synergistic effects are:

— land management practices that reduce runoff and erosion and that give improved surface drainage with better aeration and workability of the soils;
— cropping systems and crop management practices that establish crop at the very beginning of the rainy season, that make efficient use of moisture throughout both the rainy and post-rainy season, and that give high sustained levels of yields; and
— implements for cultivation, seeding, and fertilising that enable the required land and crop management practices to be efficiently carried out.

[10]For information on the food intake of Cholistani families, see Khan and Anania, opt. cit.

IV. CONCLUSIONS AND RECOMMENDATIONS

What significance do our findings hold for policy-making to improve the conditions of Cholistani farmers. First and foremost, the lesson is that the assumptions that such systems are capable of only marginal improvements at best are fraught with danger. The implication is that any policy-making for these communities will require a high degree of collaboration among economists, meteorologists, agricultural scientists and anthropologists, and that this collaboration should start at the very beginning of the planning cycle. Thirdly, For any cost effective developmental programme, each Cholistani community should not be considered as an entity itself. If community planners can cluster and link the communities together to provide the basic social and physical infrastructure, education and health facilities, electricity, roads and other development opportunities, the cost to the society and to the communities would be minimised.

An adequate supply of irrigation water appears to be a major constraint in increasing agricultural production in the surveyed area. Policy interventions can be made by demonstrating improved water management practices, land levelling, improved seed, fertiliser and the use of pesticides. However, it does not appear that policy measures can readily increase the supply of irrigation water beyond the present level. It would be more appropriate if a more pragmatic approach was used to increase agricultural output. The authors recommend that, for policy formulation, a complete survey of agricultural activity be carried out to determine the Kharif and Rabi crops yields of the Cholistan. It would help find out whether the relatively low yields are attributed to the lack of irrigation water, soil conditions, or whether a change in cropping patterns is required to maximise the availability of agricultural water, soils, and the plentiful supply of underground brackish water. The village survey as well as the farmer survey indicated that the present flows of irrigation water is insufficient for crop production. If this is the case after the recommended crop survey in Cholistan is completed, it should be suggested that the farmers change their cropping patterns to maximise the use of present supply of water. This can be done by switching to more drought resistant crops such as sorghum or to salt tolerant crops such as fodder and trees to take advantage of the brackish water. This could help the farmer to maximise the use of the land and water, and over the long term increase farm incomes. The present situation would not allow the farmers in the surveyed area to rise above the subsistence level.

Climate is clearly a factor that has to be considered explicitly in any economic development plan for Cholistan: otherwise the plan is unlikely to be viable on a long-term basis. Furthermore, the physical, social, economic and cultural conditions and institutional infrastructure are very different in Cholistan compared to the rest of Punjab. Thus, a development plan that has proved to be a success elsewhere in Punjab may not necessarily be successful in Cholistan. Particularly, for an important

human activity such as agriculture there are fundamental differences in conditions which must be taken into account.

So far, the government has not taken any corrective action to reduce poverty in Cholistan. In fact, governments in Pakistan are themselves often formed by people who have close psychological, social, economic and political links with the beneficiaries of the process of concentrated growth. Basic human amenities are very much lacking in Cholistan. As things stand at the moment, the surveyed communities are being denied all the civic provisions. It is apparent that local government services are not reaching these communities. The role of the Cholistan Development Authority (CDA) needs to be reassessed.

There are many myths about the Cholistan region, majority of which are pessimistic. It is often believed that Cholistani soil is low in fertility, climatic conditions are extreme, plant and animal pest problems are insurmountable, human health problems are serious, etc. While there is an element of truth to many of these issues, which presumably is the reason why these myths grew, it is neither possible nor scientific to make such generalised statements for a vast area containing 600,000 inhabitants. It must be recognised that for the formulation of a consistent policy framework our knowledge of conditions and potential in Cholistan is limited. We still do not know enough about desert plants, many of which can be successfully exploited as sources of food, fibre, forage and fuel. We need more information on Cholistani soil, and ways by which sustainable agricultural yields can be obtained. Ways and means of carrying out scientific research have improved tremendously during the past three or four decades, and thus it should be a matter of years rather than centuries to ascertain sustainable development process for Cholistan. The most fundamental challenge for the planners and decision-makers ought to be how to devise and implement appropriate development strategies for Cholistan which will satisfy short-term requirements of immediate economic development with the virtue of maintaining long-term consistency within the national policy framework. When it is further considered that the right policies have to be devised in spite of inadequate scientific knowledge, the problem is going to be a most difficult one to resolve. Given the political will at both regional and national level, the problem can be solved. If not, the future for the inhabitants of Cholistan will be bleak indeed.

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