9.1 INTRODUCTION

In this work, the basic point that we have tried to emphasize is a methodological one. Broadly speaking, we have tried to argue that in order to understand the role of technology in production, it is imperative to examine the broader economic conditions of production within which it is instituted. For, it is these conditions which will ultimately influence not only the adoption of a particular technology but also its effective utilisation and hence the extent to which the technological potential of a given technique is realised in practice. No doubt, the material forces at work in a technology have their objective consequences. However, it is the socio-economic basis of differential response to similar kinds of technological inputs and problems that arise in the course of its operation that we are drawing attention to. We have argued for this viewpoint which we may broadly called 'production relations approach' - in contrast to the technocratic approach implicit in the more usual treatment of this question which considers the technological issues in isolation of their social context. Conceptualised as such technology is considered as an instrument of social change. However, this approach can at best throw some light on the technical potential of a given technology. But as a basis of engineering
social change towards desired goals, it is not sufficient. Not only that, it can be positively misleading when policy recommendations are made with this implicit viewpoint resulting in investment decisions which have limited effectiveness.

Within this overall perspective we have tried to illustrate the critical importance of institutional factors in the use of the major irrigation sources used in Punjab. We have discussed the social and economic factors influencing the creation of irrigation potential, its utilisation in production and the distribution of benefits accruing therefrom among categories of producers. We have viewed these questions in the context of new agricultural technology widely adopted in Punjab after the mid-sixties.

In this chapter, we present a critical overview of the production function approach used for analysing the role of irrigation in production. At the end, we will indicate the policy implications following from such a viewpoint for public and private investment in irrigation.

9.2 PRODUCTION FUNCTION APPROACH

In the literature, the role of irrigation in agricultural production has been typically assessed using an aggregate production function, depicting the technical relations between the various inputs and output. This technical relation is sought to be statistically captured in terms of a specified form of a functional relation fitted to inputs and outputs as observed. The parameters of this function are then
empirically derived and the best fit function is used to derive and/or to test economic propositions such as the relative contribution of different inputs or to test the efficiency of resource allocation with respect to cropping patterns or methods of cultivation.\(^1\) In the process of testing such hypothesis, the statistical production function is attributed properties of the theoretic production function of economic theory.\(^2\) The latter it may be noted is an independent construct requiring to satisfy a special set of assumptions in order to maintain consistency with theory. These requirements may or may not be satisfied by the observed statistical relations between inputs and output. At least there is no a-priori reason that they should do so. This confounding of two totally different notions of 'production functions' therefore raise doubts about the validity of theoretical results and interpretations thereof. In particular, in the course of using this approach to study irrigation, problems arise in relation to handling of complementarities, externalities and specification of inputs, which we shall refer to below.

9.2.1 **Complementarities**

The fact that the productivity of an input is contingent on the adequate level of use of other inputs is not

\(^1\)This is done by testing for the equality of marginal value productivity (MVP) of an input with its price or for equality of MVP of the same input in different uses.

\(^2\)For a detailed discussion of the difference in conceptions, see Bharadwaj (1979).
sufficiently recognised by the production function based analysis. This is evident in the applications of the principle of marginal productivity and the theory of factor substitution. For instance, marginal product of an input is conceived of as a quantitative increase in the output as one input is marginally increased, keeping all other inputs constant. As such, this concept may not have a physical analog since an increase in the magnitude of one input may necessitate a concomitant increase in others, failing which, the output may fail to be positive or the character of output (its physical and chemical composition) may change. Such cases are not too uncommon. However, the concept of marginal product is widely used for a quantitative evaluation of the contribution of a particular input to the output. Alternatively, the output is sought to be explained as a sum of contributions of the various inputs in proportion to their respective marginal products. Policy interferences are then drawn which recommend a higher investment in the input that gives a higher relative marginal product compared to its price. A number of misunderstandings ensue in practice from such exercises: for example of identifying a direct and independent relation between the level of every input to its contribution to output. It is missed out that the level of output depends on a given technique of production, i.e. on a specific combination of inputs and not on the productivities of individual inputs, conceived of in isolation and abstraction.
In the case of irrigational investment this notion of productivity is typically used as follows: Either the marginal product of irrigation is calculated on the basis of existing data\(^3\) to establish its high contribution to output; or a correlation of the level of irrigation with an index of agricultural growth is worked out to emphasise similar conclusions. Given the relative importance of irrigation thus arrived at, it is argued that greater investment in irrigation in areas of low agricultural growth be undertaken to unleash the process of development, thereby attempting to replicate the observed experience of the more productive regions.

Although, prima facie, there is nothing wrong in recommending a higher investment in irrigation which may well be needed, and critically so, the basic flaw with the above mode of reasoning lies in its attempt to extrapolate the limited\(^4\) experience with regard to irrigation to other areas (and to future) in a purely mechanistic way. That is, the functional dependence of the productivity of irrigation on the overall technique of production is ignored.\(^5\) In fact, it

\(^3\)Typically, the data are either highly aggregated, e.g. irrigation through different sources is all considered under one category. Or the data pertain to a particular region and are not suitable for analysing the general situation.

\(^4\)That is, with respect to the time period and region.

\(^5\)For instance, the productivity of irrigation in combination with HYV and chemical fertilizers, is much higher, than in the case of traditional technology. Existing evidence points to the prevalence of a multiplicity of techniques of production, even within the category of irrigated agriculture - leading to a wide variation in the output indices (e.g. cropping intensity, yield per acre etc.) associated with irrigation.
would be necessary to investigate the specific production conditions pertaining to the region which influence the adoption of more productive technology (see Bhaduri 1981) with irrigation as one of the inputs. Recommending higher doses of irrigational investment in the absence of this may lead to a situation whence irrigation will fail to call forth the expected response. Besides, it will remain under-utilised, a problem which has afflicted a significant chunk of irrigation investment in India (see Chapter V).

Another significant complementarity of irrigation i.e. with natural and environmental factors, is also ignored while using the production function approach. Irrigation is assumed to have a unique relation with output whereas it is a well known fact that productivity of irrigation is critically dependent on such climatic factors as rainfall and temperature which are inherently variable. No doubt better control over irrigation can ameliorate the variation in its productivity but it cannot overcome it due to the unpredictability of the variation of natural factors. Further, certain ecological consequences associated with the development of irrigation sources constitute an additional factor which limits the

---

6 This conclusion is supported by the findings of the present study wherein we have tried to show that in the case of Punjab, the differences in agricultural productivity of the districts is explained not so much by the availability of irrigation per se but by the more or less favourable land distribution (reflecting the productive potential of the producers in the area). This enabled a more productive use of the available sources of irrigation.

7 For instance waterlogging in case of canals and decline of water table with tubewell development.
productivity of irrigation. Investment decisions regarding irrigations which follow from production function analyses which ignore this complementarity of irrigation with natural factors may result in wastage of resources.

Finally, similar problems arise from the use of production function in the theory of factor substitution where the underlying premise is that factor proportions adjust in response to changes in relative prices of inputs. The schedule of constant product (isoquant) is required to be strictly concave to the origin with a negative slope. That is, it is assumed that increasing amounts of one factor is required to be substituted for another, as we move along the isoquant.\(^8\) The implicit assumption regarding the technical process is that factors are mutually substitutable thus denying their complementarity and qualitative specificity. For instance, using more of irrigation for less of chemical fertilizer cannot make up for the loss of yield while using more of chemical fertilizer for less of irrigation, can positively reduce the yield by burning up the soil and the plants.

9.2.2 Externalities

Production function analysis, as is in vogue, fails to capture the externalities associated with the use of certain inputs which can have undesirable consequences. For instance, although tubewell irrigation may be found to be a

\(^8\)This is expressed as the condition of increasing rate of technical substitution.
very efficient and productive source of irrigation, its unregulated development results in a secular decline of water table. This can adversely affect the viability of the dug wells in the area which are the only source of irrigation available to the small farmers. Further, if the case study discussed in Chapter VIII (where we discuss the externalities of tubewell development) was analysed using the production function, the conclusions regarding efficiency (or lack of it, if so discovered) remain quite irrelevant and of little value for understanding the nature of change taking place and thereby attempts at rectifying it.\textsuperscript{9}

9.2.3 Specification

The problem of specification in production function analysis arises at two levels. First, there is the problem of the specification of the function itself.

\textsuperscript{9}For example, in the area under consideration where tubewell and canal irrigation coexist, the production function could take the following form:

\[ Y = A X_C + B X_t + \ldots \]

where \( Y \) is the output, \( X_C \) and \( X_t \) are indices for canal and tubewell irrigation respectively. This function would no where indicate the direct dependence of the reduced productivity of canals (as indicated by coefficient \( A \)) on the spread of tubewell irrigation (or \( X_t \)). Therefore the function would merely reflect at best, the final relation between output and the two kinds of irrigation and rationalise it, without any consideration of the dynamics of the situation.
As mentioned earlier, the production function analysis involves fitting a statistical function on to the available cross-sectional or time-series data which is then used for testing of efficiency of resource allocation and calculation of productivities of inputs. The conclusions thus derived are dependent partly on the form of the hypothesized functional relation between inputs and outputs. Therefore these conclusions will vary with the choice of alternate production functions. In fact there are no hard and fast rules regarding the choice of a particular function (i.e., whether it is linear, exponential, etc.). A well known text in the field, while discussing the basis of selection of the function, notes that the analyst "seldom can let the choice rest alone on objective empirical selection of the one 'best-fitting' form . . . . He must reject some types or modifications of equations because it is too costly to compute regression coefficients or estimate the parameters for the entire range of possible functions. Some equations may be rejected simply because their algebraic form makes computations and solutions of economic or other optima too difficult." (Heady and Dillon: 1961, p. 104). Further, it goes on to point out that "Different individuals may be able to give equally valid reasons for selecting alternative types of functions" (Heady and Dillon: 1961, p. 104). That is, considerations other than those pertaining to the objective technical conditions of production can be decisive in the choice of the function and ultimately in formulating the recommendations following from
it. This, therefore, undermines their reliability for the purpose.

Secondly, there is the problem of the specification of inputs, particularly when it is the quality of the input that is crucial for productivity as in the case of irrigation. For instance, irrigation is mostly specified in terms of either the area irrigated or a volumetric unit (i.e. cusecs or acre-inches of water), which is found to be unsuitable for analysing its productivity for the following reasons. First, the reliability of the available data leaves much to be desired (see, Report, G.O.I.:1973, p. 110), and to that extent, any conclusions based on their use are also rendered unreliable. Secondly, very often there is no uniformity in these concepts. For instance, area irrigated by canals and deep tubewells as published in the official statistics in Punjab has a different meaning in both the cases. Finally, and by far the most important limitation of these indices is their inability to reflect the quality of irrigation, in terms of the control over the time and quantity of irrigation exercised

---

10 In case of canals it refers to the net area irrigated irrespective of the number of irrigations, i.e. it includes land irrigated at least once as well as that which receives multiple waterings. In case of deep tubewells however, every watering of an acre counts as an additional acre of land irrigated, irrespective of whether it constitutes an additional watering to an already irrigated area or irrigates an additional unit of land. Hence the final figure is an index of the gross area irrigated, without any indication of its distribution over land.
The quality of irrigation which has radically different effects on output. However, it is precisely the quality of irrigation which has radically different effects on output.11

One possible way to overcome the above problem would be to treat the qualitatively different techniques of irrigation as separate inputs to check on their respective productivities (see, Chopra, 1981). However, these differences in quality, as we have demonstrated earlier, are related not merely to the technical differences between the alternative sources or irrigation but also to their 'mode of utilisation'. This, in turn, is a function of the socio-economic position of the producer. Therefore, one can have either of the following situations: either the same technique of irrigation can show a wide variation of its productivity under different conditions of utilisation faced by different categories of producers or a technically superior source of irrigation may be associated with lower productivity due to poor conditions of utilisation while a relatively inferior source may not reflect a correspondingly low productivity due to more favourable conditions of utilisation. It follows therefore, that the mere separation of different types of irrigation on technical basis may not solve the problem of capturing the qualitative specificity of a particular mode of

---

11 For instance identical irrigated acreage (or cusecs) with the use of canals and tubewells will be found to be associated with different cropping patterns and their yields, due to the differential quality of these sources.
irrigation. This points to the need of a much more careful specification. Possibly, the study of irrigational productivity could be organised according to modes of irrigation, and for stratified groups of users.

9.2.4 Efficiency Tests

Finally one may question the validity of the conclusions following from the efficiency tests, as done in the production function analysis. For instance, when efficiency of resource allocation is tested by equating the marginal value product of an input with its cost, it is assumed that all categories of producers face identical production function and factor and produce prices, as markets are assumed to be perfectly competitive. This creates difficulties for the application of this methodology in a situation which is characterised by non-competitive markets and which are not yet capitalistically developed - as in the case of production conditions in the Indian agriculture. For instance, in the case of irrigation, as we have illustrated, there exists a wide variation in the cost of irrigation and its productivity across different socio-economic groups of producers.

One possible way to partially overcome such a difficulty is to use separate irrigation prices (costs) for

---

12 For a discussion of a similar problem faced in the context of another input i.e. labour, see, Bharadwaj (1979), wherein she points out the difficulties of treating labour as a homogeneous quantum, given its heterogeneity and time spread in actuality.

13 That is, the derived average based on cross-sectional or time series data.
different groups of users, when equating it with marginal value product (MVP) of irrigation while testing for efficiency of resource allocation. However, given a situation as illustrated in the present study, where the small scale farmers\(^{14}\) often face higher irrigation cost, such an exercise will tend to make the MVP of irrigation lower than its price for this category. This will lead to the inference of over-investment in irrigation by this - the most precarious category of farmers: Such an inference is reinforced, if one takes into account the lower productivities of irrigation\(^ {15}\) faced by precisely the same socio-economic group as well as the lower product prices that they typically realise. In other words, the problem arising due to the involuntary dependence of the poor farmers on low quality/high cost modes of irrigation is interpreted merely as a case of inefficient allocation of resources to irrigation. That is, it does not attempt to explain or question the basis of the constraints\(^ {16}\) but takes for granted and only comments on the inadequate adjustment to them, as perceived on efficiency considerations. Following

\(^{14}\) For example, small scale users of electric tube-wells, and those who purchase water in both, canal and tube-well irrigated areas.

\(^{15}\) As reflected by the lower efficiency of the mode of irrigation they use and its implications for production, which (if we assume) are reflected by a lower marginal product.

\(^{16}\) That is those leading to the discrimination faced by small farmers in relation to the quality and cost of irrigation accessible to them.
which, it may even recommend a more efficient combination of inputs with a further reduced dependence on irrigation. Thus it serves to rationalise the existing inequalities rather than direct itself to the question of redressing this imbalance.

Similar conclusions would follow if we had used the production function approach to analyse the cross-sectional data relating to the combined use of public and private sources of irrigation as discussed in Chapter VIII. That is, considering canal and tubewell irrigated area as separate inputs a higher productivity would be found to be associated with tubewell irrigation compared to canal irrigation. However, the cost of tubewell irrigation (i.e. price of irrigation) is also higher than that of canals irrigation. Therefore, it is likely that both the identities i.e. \((MVP)_c + P_c\) and \((MVP)_t = P_t,^{17}\) would be found to hold good simultaneously. This would imply that small farmers using only canals and large farmers using only tubewells both operate efficiently. Hence, the conclusion of efficient allocation of resources between canal and tubewell irrigation. However, using the production relations approach - we have tried to illustrate precisely the opposite - i.e. a highly irrational allocation of resources.

\(^{17}\) Where MVP stands for marginal value product of irrigation, \(P\) for the price of irrigation, and subscripts \(C\) and \(T\), indicate canal and tubewell irrigation respectively.
Examples such as these cast a shadow of doubt on the meaningfulness of the entire exercise regarding efficiency tests and the conclusions following therefrom.

9.3 POLICY IMPLICATIONS OF DIFFERENT VIEWPOINTS

The major policy issues with reference to irrigation typically relate to investment decisions regarding choice between public and private sources of irrigation, or major/medium and minor works; or decisions pertaining to technological improvement of the existing systems; or attempts to improve the utilisation of the same by appropriate infrastructural development.

However, the fundamental problem with the set of policies thus prescribed is not so much with the nature of a particular recommendations as the basic rationale underlying such policy formulation. That is, it is the basis of arriving at such recommendations that, to begin with, limits the probability of their successful implementation.

The basic logic underlying most thinking regarding irrigation issues essentially follows the ideas propounded by economists like Theodore Schultz (1964). In an attempt to explain the low productivity of agriculture in traditional societies he argues that the farmers in these societies use whatever resources available to them in an efficient manner (as defined according to the production function approach), irrespective of the scale of production. The problem therefore, lies not in the unequal land distribution that typically
characterises such societies but in the poor returns to the inputs they use in production. That is, it is the low productivity of the technology that they use and not the resource-ownership structure that is responsible for their economic backwardness. The logical extension of this viewpoint is to recommend a more productive technology as a means of modernising agriculture while, at the same time, playing down the need for any kind of institutional measures - the most pertinent being those relating to land reforms and collective irrigation management. Recommendations for promoting irrigational investment per se perceived as a part of more productive technology, as an answer to the stagnant agricultural growth therefore, take their cue from the above viewpoint.

9.3.1 Relative Costs and Productivity Based Studies

This notion is implicit for instance, in the policy prescriptions based on an aggregative approach (see, Hanumanta Rao, 1974, 1975; Swaminathan, 1977; Lakdawala, 1977; S.K. Rao, 1971) which attributes the stagnation in agricultural growth rates during the sixties to declining public investment in irrigation (see Rao, 1975). Alternatively, high growth prior to the Green Revolution is attributed to corresponding growth in public irrigation (see Rao, 1971), either way propagating the cause of public investment in irrigation. While this result may broadly be true, it does not provide a sufficient basis for effective policy formulations.
On the other hand, various studies based on the production function approach would rather recommend privately owned shallow tubewells as more productive than public canals or tubewells (see Mellor and Moorti:1973). Similar technocratic perception of the problem of under-utilisation of canal works underlies the entire Command Area Development (CAD) approach. This viewpoint locates the problem of poor canal utilisation primarily below the outlet in terms of incomplete infrastructural and technological development which hinder fuller realisation of irrigation potential which CAD seeks to rectify.

Another set of studies, based on a variant of this one-sided concept of irrigation make their recommendations purely on relative cost consideration of different sources of irrigation (see Dhawan:1973; Bhatia:1976). These costs however, are calculated on purely independent market considerations and do not reflect the costs actually faced by the users - as refracted through the conditions of utilisation of the source that they face.

The basic weakness of the approach on which the above policy prescriptions are based lies in their gross neglect of the social and institutional factors which influence the productivity of irrigation in a given situation. For example, while recommending increased investment in public irrigation - as a solution to agricultural under development - it ignores the following: First, to account for the poor performance of the various public irrigation projects already existing in
the country, and secondly, to identify the social circumstances on which the relative success of others was contingent and which would be required to be established in order to replicate the experience. 18

The limitations of a technological interpretation of agricultural performance, implicit in such thinking, have also been pointed out elsewhere (see Sen and Amjab:1977; Bhaduri:1981). 19

---

18 This insensitivity to the variation in social environment in which irrigation is sought to be introduced, has also been characteristic of most irrigation policies of the World Bank (see Wade:1982). For example, Wade points out that the obsession of the Bank with superimposing rotational irrigation, water users organisations, lining of channels, in fact the entire CAD approach all over, ignores the regional specificities - both physical and social. Lining of channels for example, makes sense only in the sandy soil areas of Punjab, Haryana and Rajasthan; rotational irrigation below the outlet is a waste except under certain soil conditions and when there is relative water scarcity; success of warabandi is contingent on smooth topography and reliable water supply from the main system besides an effective communication system of the Irrigation Department (see Sekher:1981, p. 27).

19 In a study of comparative performance of agricultural growth of Eastern and Western Punjabs after the mid-sixties, Sen and Amjab have tried to show how the differential response (i.e. more dynamic in case of East Punjab) cannot be explained in terms of differential availability of technological inputs. On the contrary it was the different structure of property (i.e. land) relations which conditioned the use of available inputs. Therefore, it was observed that in spite of a higher level of total irrigation in West Punjab at the beginning of the Green Revolution period, the agricultural growth lagged behind that in the Eastern Punjab. The geo-physical terrain of the two regions was fairly similar and there were no systematic differences in supply of HYV technology.
9.3.2 Policy Prescriptions

The point of the foregoing discussion is not to argue against public investment in irrigation or even to play down its critical importance. What is being argued is that blindly persisting in allocating huge amounts of scarce financial resources in public irrigation projects or, for that matter, in private irrigation through indirect finance and subsidies etc. may not ensure the realization of the full potential benefits if the social conditions effecting its productivity are not reckoned with.

In fact, it has been argued that considerable increase in irrigation productivity can be realised by streamlining the performance of existing public works, by improving their managerial and organisational aspects as well as technical revamping. Equal if not more emphasis in irrigation policy should be received by these than by further development of sophisticated and high cost structures. 20

---

20 Wade cites a number of examples of irrigation systems with sophisticated controls and simple ones where the efficiency of latter (i.e. percentage of water reaching the fields) is higher or no worse than the former (see Wade: 1982), following these he rightly recommends as a feasible solution, altering the procedures of operation of water allocation and monitoring the outputs.

Further, Wade points out in case of canals that if water losses are reduced by 10%, the saving would be roughly 20 million acre feet, i.e. equivalent to three Bhakra Dams (see Wade: 1980, p. 217); lining of channels in Punjab can lead to an increase in irrigated acreage of 1.75 million acres which is higher than that planned to be irrigated by installing deep tubewells (1975). See Vohra (1975) for a further discussion of such alternatives.
Following the findings of our present study wherein we have tried to locate the poorer efficiency of public canals as compared to the private tubewells in the mode of operation and utilisation of canal's water, our recommendation need not be a necessary shift to private investment. We have already drawn attention to the far greater inequitous effects of the latter. Instead the direction would be to explore the possibilities of co-operative use of land and/or irrigation assets, specially by the small landowners to overcome the scale effect and to attempts at improving utilisation of canals by mobilising the users from below for a greater participation in the functioning and management of these public works. All such efforts will necessarily entail political conflicts in so far as it may challenge the existing pattern of privileges enjoyed by the economically dominant sections of the village community. However, these are issues which are beyond our purview.
APPENDIX A.9.1

REVIEW OF IRRIGATION STUDIES

The studies regarding the role of irrigational development in the production process can broadly be classified under the following categories:

(1) Those pertaining to the creation of irrigation potential.

(2) Those relating to the utilisational aspects.

(3) Those dealing directly with the relationship of irrigation with the economic variables such as productivity, income, and employment.

1. Irrigation Potential - Its Creation: The central issue addressed by the studies in this category is investigation of the conditions of investment of public and private irrigation works. In the case of public works for instance, they deal with a critical evaluation of the criteria of investment officially recommended as a basis of selecting irrigation (and multipurpose) projects in the country i.e. the benefit cost ratio (see Report, Irrigation Commission:1972, Vol. 1, p. 215) and point out certain limitations of its use\(^1\) (see,  

\(^1\) For example, the inability of B-C ratio to yield a unique selection. In so far as from the point of economic efficiency or productivity, competing projects can have similar B-C ratios, alternative basis of selection would be needed which needs to be well defined and articulated to avoid arbitrary decision making. Further, the criterion is
for instance, Sovani:1975, Rath:1973). A closely related group of studies pertains to the problems encountered in formulation, appraisal and evaluation of irrigation projects. (For a critical review of these, see Vaidyanathan:1978).

Another set deals with a discussion of relative costs (both capital and variable) of irrigation through different sources which forms the basis for recommending investment in a particular source. However, the basic weakness of these studies lies in their failure to consider irrigation in its institutional setting and the implications of this for the calculation of related costs and benefits in project evaluation.

A further set of studies dealing with the creation of irrigation assets² attempt to account for the differences in pattern of observed growth of irrigation sources in certain regions in terms of differences in the socio-economic variables such as, average size of holding, its fragmentation, credit availability etc. In terms of throwing some light on

unsuitable for objectives other than those of pure economic efficiency while goals of most development policies are diverse. This involves identification and quantification of costs and benefits which may be qualitative. In fact, the calculation of B-C ratio (i.e. a comparison of net benefits, before and after irrigation, with costs) totally ignores the qualitative and structural changes that take place as a result of introducing irrigation. This failure to account for the indirect effects is the single largest weakness of the B-C approach, as also noted by a standard text on the subject (see U.N. Guidelines:1972).

the factors affecting the decisions of the farmers to go in for private irrigational investment (e.g. in shallow tubewells in the recent years) - and of the State (in the case of public investment), these studies are by far the most interesting as they attempt to investigate the social conditions influencing adoption of a particular technology.

2. **Irrigation Potential - Its Utilisation:** We have already discussed the significant underutilisation of irrigation potential created particularly through the means of public works in India. A separate set of studies can be identified which basically report the extent of underutilisation of various irrigation projects and try to account for the same.\(^3\) However, most of these studies perceive the problem of utilisation in rather narrow technocratic terms\(^4\) and the solutions that follow are necessarily purely technological.

A second set of studies partially overcomes the narrow technocratic viewpoint of those mentioned above and thereby form a more interesting and meaningful set.\(^5\) With


\(^4\)That is, as one of technically inadequate supply of irrigation services and lack of conjunctive availability of other technical requirements - e.g. land levelling, soil reclamation etc.

reference to the use of tubewells, for instance, Dhawan's studies focus on the external diseconomies of using privately owned shallow tubewells; particularly on the implications of this for the small scale farmers. Following this, he recommends the use of public tubewells. Although such studies do bring out certain pertinent and crucial points regarding the use of private tubewells, the policy inferences for the installation of public tubewells suffers from an implicit neglect of the utilisational problems encountered in their use.6

The studies with reference to the use of canals form a useful set in so far as they focus on the institutional and organisational aspects of water use. For instance, in a series of studies Wade (1975b & c) tries to focus on the need to study the relations between the irrigation bureaucracy and the farmers in order to analyse the discrimination in the distribution of benefits from irrigation accruing to different socio-economic groups of users.7 Another excellent study by Reidinger (1974) locates the utilisational problems of canal water in the rotational system of water distribution as practiced in North Indian canals.8

6 For example, those relating to water distribution and its reliability, which influence the control of the users over the irrigation they receive.

7 Evidence for which, is not lacking (see Thorner: 1962; Van Der Velde: 1971; Reidinger: 1975; Praasad: 1972).

8 See also, Narayana, Ratnam and Nair: 1982; Sengupta: 1980.
However, the above studies remain as yet confined to partial aspects and are fragmented in scope. That limits their use as a basis for formulating a comprehensive irrigation policy. The direction and approach to the problem however remain a desirable and welcome departure from the more narrow technocratic perception of the problem which typically characterise most official thinking on the subject.

3. Irrigation and Production: Basically, studies in this category address themselves to the relationship of irrigation with productivity and other economic variables such as income, employment etc. They can be further subdivided into the following three sections:

(i) Those based on production function approach
(ii) Those based on correlational approach
(iii) Those based on institutional approach.

3.1. The studies in the first section investigate the impact of irrigation on production employment, income etc. Using the production function technique of analysis, 9 basically, production functions are calculated under different conditions of irrigation and marginal value products of various inputs and allocational efficiency of resource use between them are compared. The comparisons typically relate to irrigated and unirrigated areas or areas irrigated through

---

different sources of irrigation. Such comparisons are then used as a basis for recommending the superior situation - as perceived by the higher efficiency or marginal value product of various inputs including irrigation where the output is taken as agricultural production. We have tried above to point out some of the weaknesses of such conclusions and inferences based on analytical techniques whose theoretical basis remains questionable.

3.2. The basic approach of the correlational studies is to draw policy inferences based on the observed correlations of variables such as output, cropping intensity, per acre yields, employment, income with irrigation. Although these studies do bring out a lot of interesting information on the association of different types of irrigation (both with respect to quality and quantity), with different economic variables, their weak point lies in their failure to explain these observed correlations. They provide a possible starting point for deeper studies.

3.3. By far the most interesting set of irrigation studies are the ones that attempt to investigate the impact of irrigation on the relations of production, in totality. That is, 10

how investment in irrigation sources, both public and private, influences the total production structure, the economic interests of the different classes and their interrelationships. For example, Whitecombe in her study of the agricultural development of United Provinces under the British (see Whitecombe:1971) tries to show how the development of canal irrigation led to changes in the cropping pattern (from coarse food-grains to commercial crops) which rendered the position of the small cultivator more vulnerable by increasing his dependence on the zamindars and money-lenders. Epstein, in a study of the effects of introduction of canal irrigation in Southern India also notes a similar dislocation of the economically weaker sections as a result of the commercialisation of agriculture which followed the said irrigational investment (see Epstein:1953). Yet another study by Clay (1974) relating to the Kosi region in Bihar notes the reversal in the relation of dependence between the large and small cultivators, following from increased tractorisation as a result of extensive tubewell development in the region.

The approach implicit in studies such as these remains most useful and meaningful for understanding the role of irrigation in production as it attempts to go beyond the narrow confines of a more technocratic or economic viewpoint.
CHAPTER X

CONCLUSION

During the course of our study regarding the productive influences of public (canals) and private (tubewells) sources of irrigation in Punjab we have come to the following broad conclusions:

10.1 SOCIAL BASIS OF TECHNOLOGICAL PROBLEMS

The various problems faced in the operation and maintenance of public and private sources of irrigation which have a bearing on the quality of irrigation provided — are rooted in the social basis. That is, in so far as they are related more to the conditions of creation of irrigation potential and its utilisation rather than to the nature of these techniques of irrigation per se.

10.2 IMPORTANCE OF QUALITY OF IRRIGATION

Examining the role of irrigation in the production process we find that what is important is not the mere availability of a quantum of irrigation — but its quality i.e. its efficiency. This we have defined as an index of the control of the user over the time and quantity of available irrigation. This is critical in influencing the producers' decisions and their eventual outcomes. The efficiency of irrigation is however, not merely a function of the technique of irrigation
but also of its particular mode of utilisation. This mode of utilisation in turn depends on the economic and social status of the user and the nature of extant arrangements.

10.3 **SCALE EFFECT IN THE UTILISATION OF GIVEN IRRIGATION**

We have tried to show that, given the source of irrigation in an area, the access of the farmers to the same depends on the prevailing mode of its utilisation which was found to depend on the socio-economic position of the users. Taking land owned as a rough index of the socio-economic status of a cultivator, it was found that the efficiency (or quality) of the mode of irrigation accessible to the farmers was dependent upon their economic status. There was a distinct discrimination in the quality of irrigation against the small as compared to large land owners, given the same technical sources of irrigation. And, this applied both to public and private sources of irrigation — i.e. to canals and shallow tubewells in Punjab.

10.4 **SUPERIORITY OF SHALLOW TUBEWELLS OVER CANALS IN TERMS OF THE EFFICIENCY OF IRRIGATION**

It was found that privately owned shallow tubewells provided irrigation with a better efficiency than the canals, largely due to better control of the user owner over irrigation. The canal users, on the other hand, have to adjust all their agricultural operations to the rigid schedule of water supply.
10.5 AGRICULTURAL PRODUCTIVITY OF DISTRICTS WAS FOUND TO BE DIRECTLY PROPORTIONAL TO PRE-PONDERANCE OF LARGE HOLDINGS AND QUALITY OF IRRIGATION

Conducting an inter-district survey of agricultural growth rates (in terms of total output, cropping intensity, and physical yields), it was found that the highest growth was observed in districts like Ludhiana where there was a combination of a higher proportion of larger holdings and larger proportion of area irrigated by shallow tubewells i.e. the more efficient source of irrigation compared to canals.

This was explained as follows: taking land owned by the farmers as an index of their capacity for productive investment in both irrigation and non-irrigation inputs, the land distribution of a district gives the resource-status and hence the productive potential of different farmers. It is this feature of social structure, we have argued, that critically influences the aggregate productivity of an area. Areas with a preponderance of small holdings will tend to show lower productivity\(^1\) than those with a larger proportion of large holdings. As regards irrigation it was found that, first, given technical feasibility, higher agricultural productivity was found when a larger proportion of area was irrigated by better quality of irrigation (i.e. tubewells) and secondly when quality of irrigation was utilised in a more productive manner by large holdings who were dominant in the district. Certain large holding districts (e.g. Bhatinda, Ferozpur etc.) showed

\(^1\)Both in terms of growth and absolute levels, given other things identical.
lower productivities than, for instance, Ludhiana due to the technical constraint they faced with regard to the installation of tubewells for which reason they had to depend on canal irrigation. This imposed limits on the use of non-irrigation inputs as well, thereby restricting output inspite of the high productive potential of the farmers. Certain small holding districts, on the other hand, (e.g. Amritsar, Gurdaspur, Kapurthala) exhibited lower productivity inspite of having ideal conditions of tubewell installation and also having in fact a high proportion of tubewells irrigated area. The utilisation of this better quality of irrigation was poorer, and secondly, their use of non-irrigation inputs was constrained.

The hypothesis, therefore, is as follows: It is not merely the availability of irrigation, even when of superior quality, that guarantees high productivity in a region. This depends more on the effective utilisation of irrigation in conjunction with other inputs. These are factors which, we have argued, depend on the production conditions (e.g. land distribution in our case) faced by the producers.

10.6 USE OF PUBLIC CANALS AND PRIVATE TUBEWELLS, IN THE SAME AREA WAS FOUND TO BE COMPETITIVE AND NOT COMPLEMENTARY

Using the data from Amritsar district where extensive development of tubewell irrigation has taken place in an area having already a high level of canal irrigation, we found that the emergence of private tubewells after the mid-sixties led to the deterioration of efficiency of canal irrigation, forcing the small farmers to either purchase water from other tubewell
owners or instal their own tubewells. This has implied an over investment for them, given their small scale of cultivation and also has led to a situation where underutilised tubewells and canals coexist, while some farmers do not have access to either source. Thus the combined use of public and private sources for the area has meant an increased underutilisation of both the sources accompanied by a deterioration in the economic position of the small scale cultivators.