BENEFITS OF FLOOD CONTROL ON INDIAN LANDS IN BRITISH COLUMBIA

by

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Abstract

A series of dyking projects on Indian lands on the Similkameen River, B.C. has been recently subjected to an economic evaluation. The objective of this study is to evaluate the procedures of the Agriculture and Rural Development Subsidiary Agreement in assessing the benefits of these projects and to re-evaluate the cost-benefit results.

The original estimation of benefits made use of data for yields and costs of production that are unrealistic. These data are revised and new estimates of benefits are made. A more serious issue however is the imputation of indirect benefits. Farmer response is critical for the achievement of indirect benefits. In this study, direct and indirect benefits are identified and computed based upon the net value of the agricultural production. Different yield scenarios and alternative land uses are incorporated into the analysis consistent with different hypotheses explaining production characteristics and probable farmer response in the area.

Results show that most of the benefits are in the form of indirect benefits and that the cost of the protection exceeds the direct benefits from the point of view of society. If indirect benefits could be obtained from a complete development program to overcome institutional problems, the flood control may be economically feasible.

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CHAPTER 1

INTRODUCTION

This thesis is an evaluation of Agriculture and Rural Development Subsidiary Agreement (ARDSA) procedures of cost-benefit analysis with specific reference to a series of dyking projects on the Similkameen River in South Central B.C. and a re-assessment of the cost-benefit results.

1.1 General Background

The Similkameen Valley with over 17,000 hectares which are arable and irrigable (Talbot 1979) is located in B.C.'s second most important agricultural region: the Okanagan Region. From Keremeos (Figure 1.1) to the Canadian-American border, the Similkameen River Valley lies parallel to the lower part of the Okanagan, the two valleys being separated by a ridge of mountainous land used mainly for grazing. Agricultural production is the main economic activity in the valley. Despite the emphasis in horticulture (the Okanagan Region represents 90 percent of B.C.'s tree fruit acreage according to the B.C. Ministry of Agriculture and Food), farming is extremely diverse: higher land is used for grazing beef cattle, and benches and valley bottoms are used for forage, grains, tree fruits, grapes and vegetables, as determined by climate and other local conditions (Economic Development Commission, Okanagan-Similkameen, Regional District 1978).

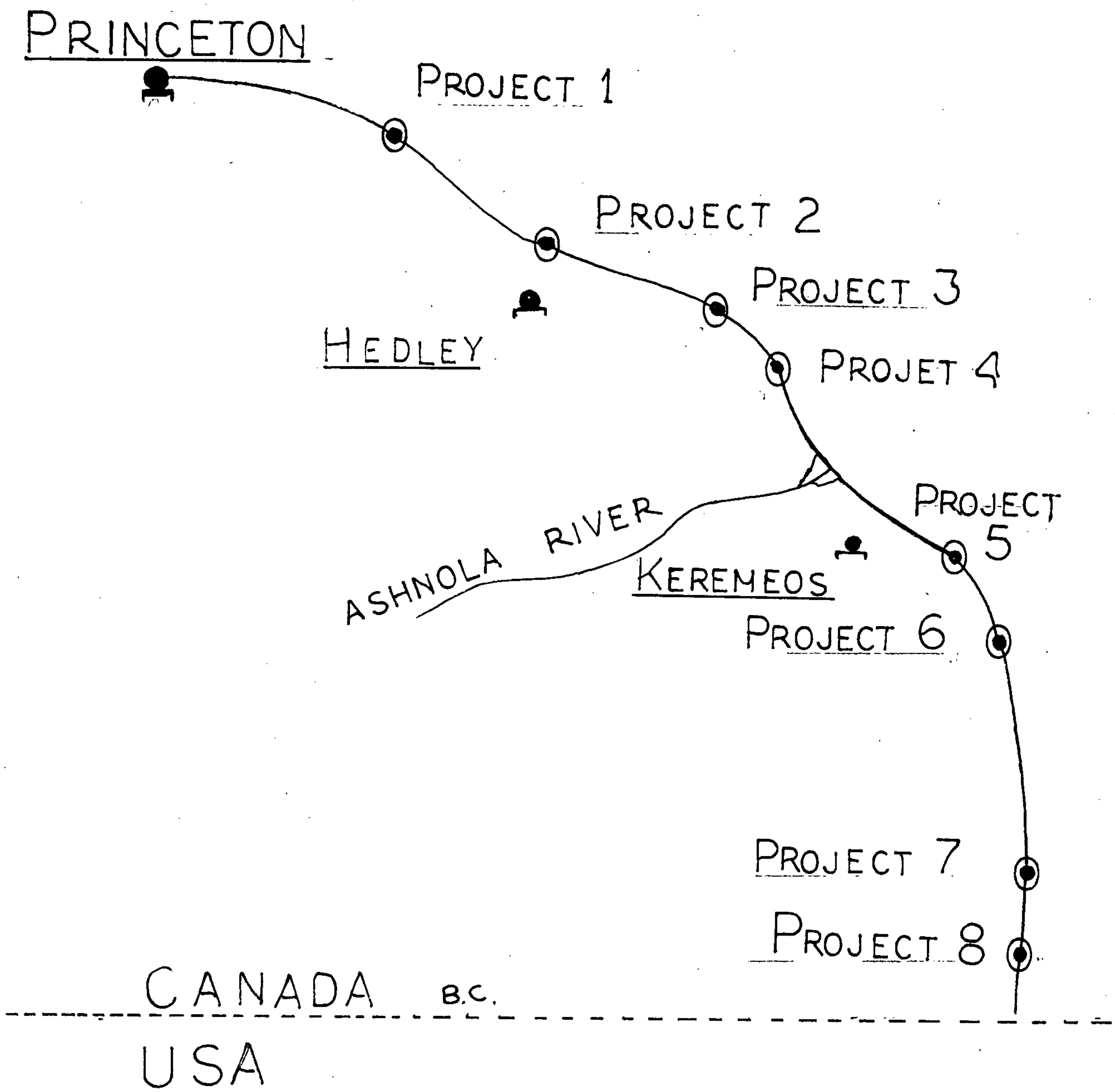

Figure 1.1: Dyking Projects Location on the Similkameen River, B.C.

The Similkameen River (170 km in length in Canada) drains the easterly facing slopes of the Coastal Mountains in and to the north of Manning Park, and flows southeast through a deep steep-side valley emptying into the Okanagan and Columbia River system at Oroville, Washington, just south of the Canadian-American border. The river regime in the area has been classified as unstable. Flooding of the valley floor downstream from Keremeos has been a major problem which occurs to some extent as frequently as once in every four years (Talbot 1979). Major floods occurred in 1948 and 1972. Farmlands and houses were under water for about two weeks along the River between Princeton and Cawston and the village of Keremeos was seriously threatened with being swamped (Department of Indian Affairs 1979; Penticton Herald 1979).

1.1.1 The Project Area

Upon request of Indian communities in the area, nearly 1,620 hectares of agricultural land on Indian Reserves bordering the Similkameen River between Princeton and the Canadian-American border have been considered for protection under a flood-erosion control program. The protection scheme proposed by the B.C. Ministry of Environment consists of a series of dyking projects on various sections of the River (Figure 1.1). Each of them is a separate stucture (separate projects), and cover 70 km in length, when considered all together. Project 1 is to provide protection against river erosion only, and the remaining structures are designed to provide protection against flooding.

The projects directly affect 17 Indian farms -- individual Band operations -- involving over a hundred people of the Indian community in the area and about 50 percent of the Indian agricultural land in the Valley (Western Indian Agricultural Corporation 1981).

1.1.2 Indian Bands in the Area

Two Indian Bands with a total population of 235 people comprise the Indian community in the Valley: the Upper Similkameen Band and the Lower Similkameen Band. The Bands control 16 Indian Reserves which cover an area of 17,877 hectares (Table 1.1.). In the early 19th Century, Indians raised cattle in the valley, however they have played a more passive role in agriculture since migrants moved into the valley and a large portion of the land was leased to non-Indians (Similkameen Indian Band 1980). In the 1972 - 77 period, the Band assumed the administrative functions from the Department of Indian Affairs, and began to play a more active role in the development of its resource base. A Band farm, a 97 hectare cow-calf operation, was initiated and in 1979 - 80 a small orchard was established. A Community Development Plan has been prepared by the Bands and Band members are encouraged to develop their resources further (Department of Indian Affairs 1979; Penticton Herald June 22, 1979). However, most of the lands are still unused.

Table 1.1

Number and Area of Indian Reserves by Band
Similkameen Valley, B.C.

Band & Reserve	Reserve No.	Land (hectares)
Upper Similkameen Band:		
Chuchuwayha	2	2,171
Chuchuwayha	2C	121
Lulu	5	20
Nine Mile Creek	4	80
One Mile	6	4
Vermilion Forks	1	3
Wolf Creek	3	202
	TOTAL	2,601
Lower Similkameen Band:		
Alexis	9	168
Ashnole	10	3,551
Blind Creek	6	162
Blind Creek	6A	4
Keremeos Fork	12-12A	954
Lower Similkameen	2	1,293
Narcisse's Farm	4	750
Range	13	6,768
Skemeoskuankin	7 & 8	1,625
	TOTAL	15,276

Source: Indian and Eskimos Affairs Program, Statistic Division, Canada, 1976, Department of Indian Affairs.

Indian Bands in the Similkameen Valley control land capable of producing high valued crops such as vegetables and fruit (B.C. Ministry of Agriculture and Food). Nevertheless, Indian people in the Valley face constraints no different to other Indians in B.C., which maintain the Indian Community in a disadvantageous socio-economic position when compared with non-Indian communities. For example a low level of education, dependence on welfare, high unemployment rate and low income characterize in part the socio-economic conditions of the Similkameen native community (Similkameen Indian Administration 1981). In addition, Indians throughout B.C. have little or no access to traditional lending institutions (Department of Indian Affairs 1977; B.C. Economic Development Commission 1977).

The Federal Government has developed a number of programs in order to improve the "economic circumstances" of Native People. Special ARDA for instance is a program designed to provide money for resource development for Indians and Indian Bands. ARDSA makes similar funds available to the agricultural industry including individual Indians and Indian Bands. Nevertheless, studies indicate that important objectives of these programmes have not been met (DPA Consulting Ltd., 1980). The result is that basic constraints which maintain the Indian communities in a backward position have not been significantly removed and problems still persist.

1.1.3 ARDSA Funding Role and Evaluation Procedures

ARDSA is a joint federal-provincial program to encourage development of the agricultural sector and food processing industry in rural B.C. The Province has 1 million hectares of under-developed farmland that has the potential for increased production. The program provides funding for (a) identifying and pursuing new or unexploited development opportunities, (b) expanding employment in the agriculture and rural industries, (c) improving the viability of the existing industries and (d) enhancing the ability of rural enterprises to be competitive. By funding a diverse range of projects in a variety of agricultural and geographical areas, ARDSA has attempted to strengthen and develop B.C.'s agricultural sector.

The Similkameen Dyking Project has been considered under the ARDSA program and within its Part III: Primary Resource Development Component. This section concentrates on infrastructure for upgrading land capable of intensive culture as well as activity outside the farm gate and may include community projects. The main objective of this section is to increase the production capability of the under-developed land resource, within the framework of those primary products which show market and production potential (Canada-British Columbia Agriculture and Rural Development Subsidiary Agreement, 1977).

The Western Indian Agricultural Corporation (WIAC) was selected by ARDSA in 1980 to undertake a feasibility study to analyze the benefits of the Similkameen Flood Control project. The analysis was to to be structured around the terms of reference provided by ARDSA (Appendix A). A close contact between WIAC and the ARDSA committee was strongly recommended for the economic feasibility study.

The terms of reference did not specify what data base (for cost and yields) should be used, but the ARDSA committee recommended the Concensus Data Series (CDS). WIAC undertook a survey to collect data about current socio-economic conditions, land use and yields for Indian farmers but was not able to collect information on production costs. Despite large differences in yields and production practices between Indian farmers and those incorporated in concensus budgets, ARDSA representatives indicated that CDS data must be used in the study. Discussions with the Band were supposed to yield information on the land, farm management experience, and Indian plans, or expectations regarding development of the agricultural resources as related to the flood control project. It was also indicated that the dyking project should be evaluated in terms of the agricultural benefits integrated with the Band's development plans. Additional scenarios for the estimation of land development and use were also to be defined and evaluated by WIAC.

The terms of reference further specified that streams of benefits and costs for each scenario were to be projected over a 25 year life. The net present value with a 10 percent discount rate was to be estimated as well as the internal rate of return in each case. Additional sensitivity analysis was to be undertaken with respect to changes in the values assumed for key economic parameters such as product prices, total level of agricultural benefits and extent of flood damage.

In the economic literature there have been two major conceptions of the role of the economist in preparing benefit-cost evaluations for policy makers. In one description the role of the "analyst" is conceived as that of a technician assisting the decision-maker to make choices that are consistent with the values and objectives of the latter. Consequently, cost-benefit analysis is held to be no more than a technique, or way of organized thought for comparing alternative courses of action. This is the category called the decision-maker approach (Sudgen and Williams 1978). As such -- it is argued -- the virtue of the technique is to be judged by its consistency and explicitness -- irrespective of the policy-maker's values or objectives (Mishan 1981). In any case, by providing the objectives, the policy-maker also provides implicitly the value judgements that the analyst has to accept -- argues Mishan.

A variation of this approach places the role of the economist in a cost-benefit analysis as that of a specialist who is licensed to provide only strictly 'economic' data to the policy-maker; data viewed as information only, with no independent criterion whatever. The policy-maker can attach, again whatever importance he desires to the quantitative estimates. Thus, the discipline of economics is regarded soley as a positive science and, as such, can only offer to policy makers information that is the product of economic analysis and statistics. This position has been proposed by Tinbergen (1966) who sees no role in the decision process for a normative economics. The economist is, in this view, confined to forecast the relevant economic implications of alternative courses of action.

A different conception of cost-benefit analysis as an evaluation procedure is one that regards allocative techniques as embedded in normative foundations. Normative economic judgement resulting from the economist's criterion, are independent of the judgements of policy makers or, more generally, of political judgement (Mishan 1981). Hence, whatever the project debated or implemented by the political process, the economist is entitled, by reference to his criterion, to pronounce the project to be economically efficient or inefficient as the case may be. It should be recognized that it is the political process itself that calls for the implementation of a cost-benefit analysis. Under this latter conception of the cost-benefit analysis such a political demand -- argues Mishan -- implies recognition that an economic ranking is independent of a political ranking. If economic expertise is viewed in this light, the public and the politician will come to regard economic assessment and ranking as a meaningful and independent contribution to the political decision-making process.

Clearly there are elements from both approaches in the terms of reference given to WIAC. The decision-maker defined a particular scenario to be evaluated in terms of land use as described in Band Development Plans, concensus data costs and yields, the discount rate to be used, and key economic variables for sensitivity analysis. As we show below the scenario defined by the decision-maker, ARDSA, was extremely unrealistic. In such a case, the role of the economist should be to point out such a deficiency. WIAC was left with a largé discretionary power to define and justify alternative scenarios and variables for sensitivity analysis. Although WIAC did prepare alternative scenarios, some of the most important deficiencies were not analyzed.

1.2 Objectives of the Study

The research problem of this study involves the identification and application of economic criteria to the flood control project. The overall objective is to evaluate the ARDSA procedures of cost-benefit analysis as implemented by WIAC for the evaluation of the Similkameen River Dyking Project. Based upon a survey conducted by WIAC, the Consensus data on yields and costs of production are not applicable to this project. These data are revised in order to have a more realistic base upon which benefits can be estimated. Implicit farmer response to the flood control project is a particularly important aspect of the estimation of benefits by WIAC. The effect of farmer response is in terms of indirect benefits of the project. No attempt is made to develop a formal model to predict farmer response. However, farmer response and resultant indirect benefits are estimated for a number of alternative and the most likely alternative specified. No attempt is made to evaluate the design of flood control structures. Dyking costs are taken as given and the design is assumed to be the best to provide flood protection to the area.

In summary, project objectives are:

a) to examine the Similkameen Project and describe the evaluation made,

b) to re-specify costs and yields that are realistic for Indian farmers,

c) to develop a methodology for estimation of indirect and direct benefits,

d) to estimate direct and indirect benefits for a number of alternatives, and

e) to specify most likely alternatives.

1.3 Methodology

The basic procedure of evaluation of flood/erosion control benefits in the context of cost-benefit analysis is a comparison between without-project condition and with-project condition. The difference between the two is considered as benefits.

The physical separability of the flood protection structures and the different location of these structures allow each dyke to be evaluated as a separate project. Consequently, eight evaluation units (EU) have been developed. Each evaluation unit corresponds to one of the projects. The concept of the EU is represented in Figure 1.2. The EU is a unit of analysis which comprises floodplain areas as well as flood-free areas because it considers all the land that the particular farmer owns or controls. The EU is an analytical device to identify what areas will be affected and what kind of impact they will receive because of the project. Nevertheless, only the area 'within the project' (the area to be protected) has been incorporated in the quantitative analysis.

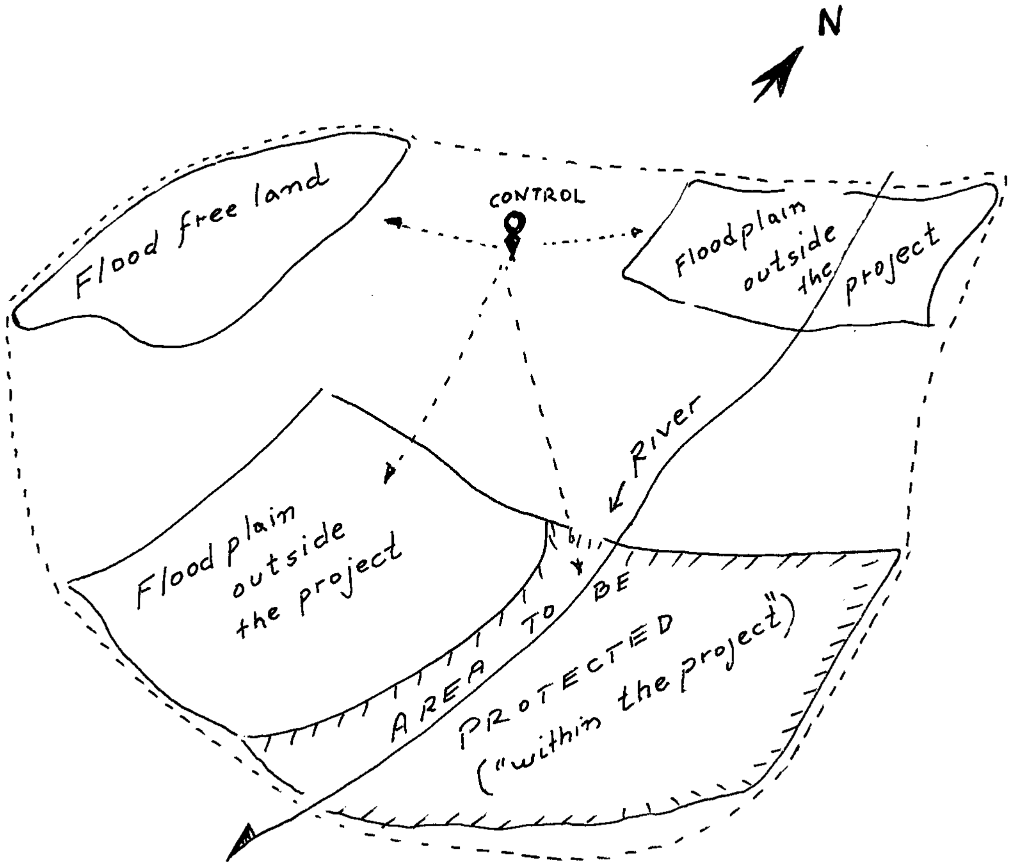

Figure 1.2 The Evaluation Unit.

To analyze flood/erosion damages in the different areas a mixed crop hectare was constructed as an analog of the 'area within the project', for each EU. This hectare maintains all of the natural characteristics as well as the activities of the particular EU; i.e., it is a smaller replica (exactly 1 hectare) of the area 'within the project' of the given EU. Consequently, the damage per hectare for a particular activity in a particular EU will differ from the damage per hectare for the same activity in a different EU depending on how floodplains proportion will differ. Also, the damage to a given activity will differ within the same EU depending upon the crop combination adopted which will depend upon the soil capability for agriculture and how the different soil capability conforms to the floodplain proportion.

Under flood conditions, the expected yields for the several crops are determined by the relationship.

$$[Ey]_{EU_i} = \sum_i \lambda F \left[y^f(p) + y^{nf}(1-p) \right] \qquad (1.1)$$

where

$[Ey]$ is expected yield for i^{th} hectare of i^{th} Evaluation Unit

y^f is yields when floods occur

y^{nf} is average yield for Indian farmers when floods do not occur

λ is proportion of crops in given floodplain

P is cummulative probability for or given floodplain F be flooded

EU_i is Evaluation Unit i^{th}

The net present value of production over a period of 25 years provides the basis for estimating the benefits from the flood control project in this study.

1.4 Thesis Guide

This thesis is organized into four chapters. Chapter 2 deals with the methodological aspects. Relevant theory is reviewed and some issues of cost-benefit analysis when applied to social studies are discussed to provide a framework for the analysis. Chapter 3 presents the analysis. The project is examined, and the most important deficiencies in the evaluation procedure are identified. Chapter 4 presents the conclusions.

CHAPTER 2

EVALUATION CRITERIA: A THEORETICAL FRAMEWORK

This chapter attempts to identify an appropriate criterion to evaluate flood control projects on agricultural lands. It examines the nature of flood control benefits and the economics of flood protection.

The chapter begins by giving a brief review of some approaches used in the evaluation of flood control programs, and then relevant economic theory is reviewed to examine some issues of benefit-cost analysis when this technique is applied to flood control projects.

2.1 Some Approaches to Evaluate Flood Control Programs

A number of methodologies have been proposed to evaluate flood control projects. James (1964) developed a methodology for evaluating flood control programs and determining the optimum combination of structural and non-structural measures in accordance with the criterion of economic efficiency. His approach is based upon minimization of "nature's flood tax" on the sum of the cost of the alternative means used for paying it. The problem is formulated as a sequence of single-stage problems, where the optimum state at each stage is independent of the effect of that state on subsequent stages. A linear programming procedure is used to obtain the optimum single stage solution as a reasonable approximation and to avoid complications of using dynamic programming.

Lind (1966) developed a general land-use model based upon location theory and analyzed the different kinds of benefits from structural and non-structural flood protection measures within a dynamic programming framework. The general equilibrium model developed by Lind makes use only of rental values obtained in the initial equilibrium, eliminating the need to evaluate future rents. Both Lind and James formulated their models on a certainty equivalent basis.

Brown (1972) suggested simulation procedures based on dynamic programming to investigate and evaluate under uncertainty the benefits from different flood protection measures. He developed a maximizing model which 'shows' the rationale of a single investor in the floodplain illustrating how he would evaluate the different alternatives. Brown based his theory on expected utility maximization to explain how individuals will respond to a variety of government policies, which either change the probibility of floods or change the cost of replacement of activities, including "doing nothing".

The major advantage of these approaches is that the evaluation incorporates the relative economic efficiency of structural and non-structural measures as well as the optimum mix of measures, the optimum installation schedule, and the required cost of implementation. Undoubtedly these procedures can be of great value when planning comprehensive development of floodplains. However, the costs of these evaluation procedures can be prohibitive because of data requirements and highly skilled manpower needed to construct these models. For small projects, the relative simplicity of cost-benefit analysis often warrants its use instead of the various operation research methodologies described above.

For these reasons cost-benefit analysis has been widely used as a technique of formal quantitative analysis of flood control (Mishan 1976, McKean 1967, and Eckstein 1958). Basically this approach consists of the enumeration and evaluation of a set of consequences of a particular change. The basic criteria is whether benefits exceed costs where benefits encompass the consequences of flood control that increase welfare, and costs emcompass those consequences that reduce welfare (Winch 1973). However, benefit-cost analysis does not formally include an optimization procedure so it does not insure that the best project design will be undertaken. However, cost-benefit analysis does alert decision makers to projects which will decrease social welfare. The optimization approaches illustrate the importance of investigating alternative responses to the danger of flooding. Brown's approach, in particular, illustrates the importance of assumptions about how individuals will respond. All of the optimization procedures illustrate the fact that a particular project such as dyking is only one means of responding to the threat of floods. There have been a number of refinements in cost-benefit methodology which in part correct for the problems illustrated by a comparison of the cost-benefit approach with the optimization approaches. In the following sections, cost-benefit analysis is reviewed including some of the refinements which relate to improving project evaluation.

2.2 Welfare Economics Basis of Benefit Cost Analysis

When it was stated that flood control projects should be deemed desirable if "the benefit to whomsoever they may accrue, are in excess of the estimated costs" (United States Flood Control Act 1936), the discipline of welfare economics was introduced into the practical world of public decision-making. This section briefly examines some of the basic elements of welfare economics -- the foundation of Benefit-Cost Analysis -- and the more relevant issues of this technique when applied to social studies.

Pure welfare economics, as a scientific means for explaining and predicting the behaviour of a society through the political mechanism of policy-making, has met with little success, but applied welfare economics is fruitful. Positive economics enables us to predict the outcomes resulting from alternate policies, and the use of this in welfare economics enables us to derive the appropriate policy to achieve a particular objective (Winch 1973). Consequently, as Mishan (1976) suggested, welfare economics is to be regarded as a study of the contribution economics can make to advancing the social welfare.

The basic requirement to judge projects in accordance with the individual preferences of consumers is a measure of the strength of consumer's preferences for the benefits of the particular project relative to the benefits that those resources could have yielded in their next best use (Pearce and Nash 1981).

Economic theory tells us that in an economy with identical consumers,[1] where they can freely allocate their money incomes between all goods and services, they will maximize the following expression (subject to the usual assumptions of reationality and perfect knowledge):

(2.1) $$Z = U(x_1 \ldots\ldots x_n) - \lambda [y - \sum P_i x_i]$$

First order conditions for a maximum are:

(2.2) $$\frac{\delta Z}{\delta x_i} = \frac{\delta U_i}{\delta x_i} - \lambda P_i = 0 \qquad \text{for all } i$$

or

(2.3) $$\frac{\delta U_i}{\delta x_i} \Big/ \frac{\delta U_J}{\delta x_J} = \frac{P_i}{P_J} \qquad \text{for all } i, j$$

This is the well known conditon that the consumer equates his marginal rate of substitution between each pair of goods with the price ratio.

Now, if as a result of implementing a particular project, production of certain goods (say i to k) increases at the expense of diverting resources from production of other goods (1 to n), it may be possible to test if this change in output has improved the situation

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[1]Consumers have identical tastes given by the ordinal utility function $U = U (X_1 \ldots\ldots X_n)$, identical incomes (Y), and face identical fixed prices for goods $(P_1 \ldots\ldots P_n)$.

of consumers in terms of the utility maximization hypothesis by examining the sign of $\sum_i P_i dx_i$ (assuming fixed prices and that the output generated by the project is distributed equally among consumers).

From the first order conditins and by substituting in

$$(2.4) \qquad \sum_i P_i dx_i = \frac{1}{\lambda} \sum_i \frac{\partial U_i}{\partial x_i} \delta x_i$$

The value of U is increased if $\sum_i P_i dx_i > 0$. It follows that under stated assumptions, relative prices provide a perfect measure of the relative benefit of output changes in terms of consumer preferences. To compute this measure we need to know the additional amounts of goods (i to k) produced and the amounts of goods (1 to n) forgone by the diversion of resources.

The implication of this analysis is that in a perfectly competitive market economy, with all the usual assumptions relating to perfect competition, market prices reflect social value for both inputs and outputs. Market prices therefore are appropriate to measure the value of the products produced by a particular project such as flood control and the costs of building dykes. With the introduction of intermediate products the analysis is considerablly more complex. However, if the intermediate products are produced in a market economy, then their prices reflect the social value of the inputs used in producing them. More difficult problems arise when the assumption of "identical consumers" is relaxed; it is quite possible for a project to lead to the following

$$\sum_i P_i dx_i > 0 \qquad \text{for some consumers}$$

and $$\sum_i P_i dx_i < 0 \qquad \text{for others}$$

The adoption of a Benthamite[1] objective function maximizing the sum of individual utilities and the assumption of identical marginal utility of money income for all individuals has often been suggested. The social worth of a project may be obtained by simple summing equation (2.4) above across all individuals.

(2.5) $$dSW = \sum_h \sum_i \frac{\delta U_{ih}}{\delta x_{ih}} dx_{ih} = \lambda \sum_h \sum_i P_i dx_{ih} = \lambda \sum_i P_i dx_i$$

where λ is the marginal utility of money income. Again, the procedure of valuing changes in output at market prices would be justified. However, it is not possible to base the choice of an objective function on individual preferences alone unless all individuals are in agreement on the welfare function to be used. Moreover, the assumption of identical marginal utility of money income is untenable.

Attempts have been made to estimate the elasticity of the marginal utility of income with respect to money income to measure the change in social welfare, however this approach to the treatment of

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1 $SW = \sum_h U_h$, h denoting the individual to whom the utility function applies.

distributive effects appears inoperable (Pearce and Nash 1981). Another approach to social appraisal of projects which restored the Pareto principle is based on the Hicks-Kaldor (1939) compensation test which basically says that a project (or policy) is to be judged socially beneficial if the gainers secure sufficient benefits such that they can compensate the losers and still have some net gain left over. If the compensation is actually paid, implementation of the project brings about a Pareto improvement; if compensation is not paid, the situation is to be referred as a 'potential' Pareto improvement.

Nevertheless, this approach does not avoid the need to make distributional judgements in the social appraisal of projects. In addition, circumstances may exist where the Scitovsky 'paradox' may arise[2].

Distributive weighting systems to be applied to costs and benefits when the existing distribution of income is 'non-optimal' implies converting money measures of costs and benefits into a measure of the social utility of the effects. The procedure remains controversial,

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[1]If one person is better off, and no one is worse off, welfare is increased, implying that welfare is an increasing function of individuals' utilities; i.e. $W = w\ (U_1 \ldots\ldots U_n),\ \frac{dw}{\partial U_i} > 0 \quad \forall i$

[2]Implementing the project may satisfy compensation test at the initial income distribution, however, the project implementation can change the income distribution in such a way that a move to abandon the project will it itself satisfy the compensation test at that income distribution.

and has been severely criticized in the literature (Harberger 1971, Mishan 1974).

The accepted practice in cost-benefit analysis today is just to deal with the assurance of the 'potential' Pareto improvement and leave the distributional matter to be treated by different mechanisms such as taxation or other political criteria. The cost-benefit procedure basically focuses on the economic efficiency issue.

When the impact of a project is such that market prices are affected, the assumption of constant prices is no longer valid (Figure 2.1), then by using the concept of consumer surplus the market demand curve can be regarded as the marginal valuation curve for society. Thus the area under the entire ceteris paribus demand curve corresponds to society's maximum valuation for a particular good. The

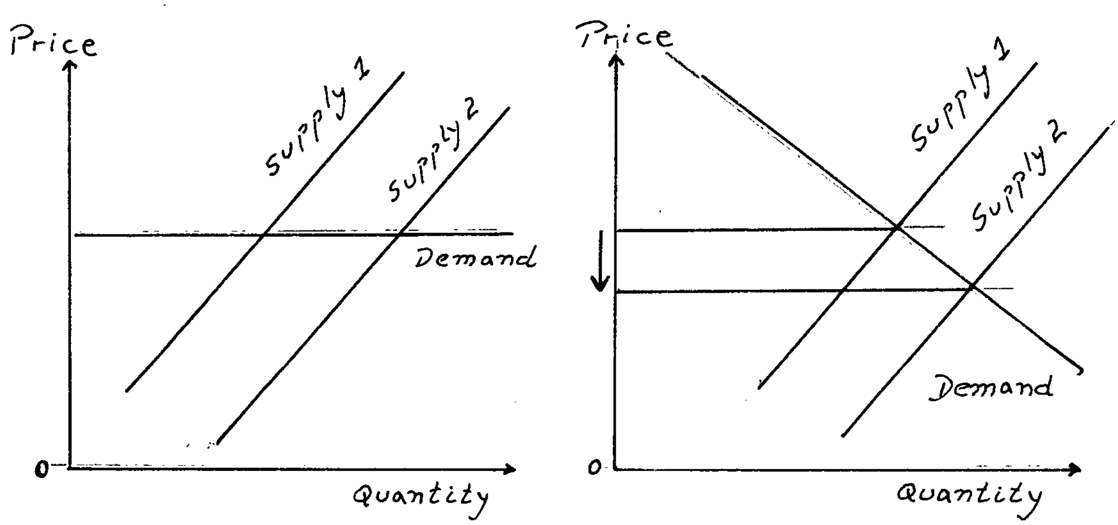

Figure 2.1 Measurement of benefits with a small project (left) and a large project (right) contrast.

consumer surplus area is to be regarded as the social benefits (Mishan 1976).

In a project such as Similkameen flood control, the additional production of agriculture commodities is small relative to the size of the market. Consequently, commodity prices will not change whether the project is funded or not and the evaluation can assume fixed prices.

The consideration of the social opportunity cost of the specific investment requires the evaluation of the alternative social benefits forgone by the private and public sector in choosing to adopt the particular project (Mishan 1976). Determining the project's admissibility thus requires comparing its annual benefit time-stream with the time-stream of consumption that would have occurred if funds had not been used in the particular project. When selecting among 'admissible projects' it is necessary to choose between time-streams with different durations and profiles. This involves assigning a single-value measure to each time-stream except in cases of dominance.[1] (Feldstein 1964). The most common single valued measure of a time-stream of benefits or costs is its discounted net present value defined as:

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[1] One project having greater net benefit in each year than that of every other project.

(2.6) $$NPV = \sum_{t=0}^{n} \frac{B_t}{(1 + r_t)^t}$$

where

B_t is the benefit or cost in period t

n is the time profile of the projects, and

r_t is the social rate of disount in period t.

The social rate of discount makes benefits and costs at different points in time commensurable with each other by assigning to them equivalent present values. Any new public investment having a net present value above zero when discounted at that rate of interest will add to social welfare.[1]

The choice of an investment option will depend upon the rate of interest (discount) used. The selection of a social discount rate has been a controversial issue and it remains as such. In a mixed economy with external effects, capital rationing and other market imperfections, there are multiple interest rates and no single rate can be taken as a measure of both time preference and the productivity of capital (Marglin 1963). Harbeger (1969) suggested that a social rate of discount could operationally be estimated as a weighted average of

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[1]This decision criteria will be equivalent in most situations to the criteria which requires an internal rate of return greater than the social rate of discount. The internal rate of return is defined as

$$\sum_{t=0}^{n} \frac{B_t}{(1 + r_t)^t} = 0$$

the marginal rate of productivity of capital in the various sectors from which investment is displaced. The central concept here is that funds provided by government must be raised in domestic and foreign capital markets resulting in less domestic investment in each sector with returns foregone as indicated by the marginal rate of return appropriately adjusted for transfers (taxes). Although several authors have disagreed with Harberger's approach (Feldstein 1973, Marglin 1963, Campbell 1975 and 1981), Jenkins (1980) used the methodology to estimate the social rate of discount for Canada. Jenkins found the social rate of discount over the period of analysis to be 10.02 percent and suggested that 10 percent would therefore be appropriate.

ARDSA specified a rate of 10 percent for the evaluation of the Similkameen dyking project which is in accord with the work of Jenkins. This discount rate is therefore also used here.

2.3 Measurement of Benefits and Costs of Flood Control

The costs of flood control by specific engineering projects are easily estimated using techniques developed by builders and engineers. The estimate of the benefits of flood protection assuming a specific project design is considerably more difficult. This in effect is the type of evaluation that was undertaken for the Similkameen dyking project. The evaluation of benefits is particularly difficult because benefits of flood protection are not the same as the costs of floods. In general, there can be considerable indirect benefits as the existence of flood protection may induce a different intensity in land use giving rise to a larger level of benefits. The analysis of indirect benefits for Indian lands in the Similkameen have been used far less intensively than non-Indian lands. If the cause of this less-intensive level of use can be assigned to the flood hazard, then considerable indirect benefits will result. On the other hand, if the cause is based on other factors then the level of indirect benefits may be negligible.

2.3.1 Rental Rates, Capital Costs and Flood Protection Benefits

Flood control benefits and flood damages (or losses) are not necessarily equal. In fact, actual or expected losses may lead to overestimating benefits if there is overinvestment in the floodplain, or underestimating these benefits if significant enhancement benefits can be obtained from additional investment in the area. Renshaw's "tax analogy" (1961) illustrates the case: flooding may be thought of as a positive tax exacted by nature on the occupants of floodplains; *i.e.*, reducing the net income streams of the inhabitants of floodplains below those that would prevail in the absence of floods. These nature's taxes are not offset by the provision of goods and services and therefore, they are real losses to the community.

The marginal productivity of a parcel of land will decrease as additional units of non-land inputs are used with it as shown in

Figure 2.2 below.

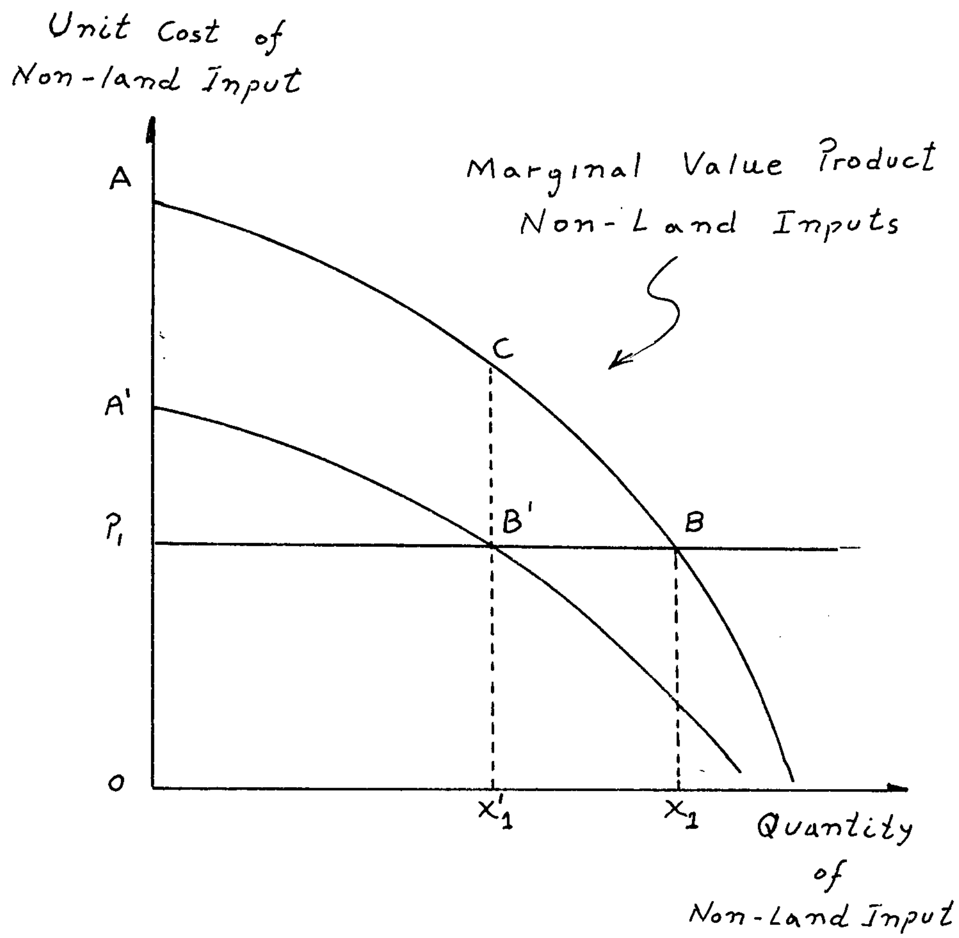

Figure 2.2 Marginal Value Product of Non-Land Input per Unit of Land.

In equilibrium the optimum amount of non-land input used is X_1 for a price of P_1. The expenditure on non-land inputs is P_1X_1 (the rectangle $OP_1\ BX_1$) and the returns to land (its rental value) is the triangle A B P_1.

If Renshaw's flood tax[1] is seen as an excise tax or unit tax on output, then the Marginal Value Product Curve -- from the point of view of the farmer -- shifts downward to A' B'. This has several effects. The optimal amount of non-land inputs is reduced from X_1 to X_1' and consequently expenditure on non-land inputs is reduced to OP_1 B' X_1'. The amount of rent is reduced to A' B' P_1. The total reduction in rent is A B B' A'. The reduction is composed of two components: A C B' A' is a direct loss caused by the flood, and C B B' is an indirect loss caused by the reduction in use of the non-land inputs because of the threat of flood.

If non-land input costs are equal or greater than A, then it would not pay to develop the land when flood potential exists. In this situation all the benefits are indirect benefits that result from putting the land to use. In fact as the unit cost of non-land input increases from P_1 to A the importance of the indirect benefits from flood control increases relative to the direct benefits of flood control.

The most important type of indirect benefits that can be derived from providing flood protection to Indian lands in the Similkameen valley are change in land use and yield increases through additional

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[1]Renshaw described this "nature's tax effect" by varying non-land input prices and maintaining the same marginal efficiency of capital (marginal value product curve) of non-flood conditions. The author of this thesis, however, feels that a better description of the "tax effect" is shifting the marginal value product curve as in Figure 2.2 and maintaining prices unchanged. After all, input prices are determined by the market and are independent of the floods in the context of our illustration.

inputs.

The fact that the degree of flood hazard is incidental to land has important implications. The difference between rental values of flood free lands and land comparable in all other respects except for flood hazard provides a direct measure of the net annual benefits of flood control. There are a fairly significant number of conditions for these rents to be a measure of the net social benefits of flood protection. These conditions are that the project does not affect prices at the margin, the absence of externalities, and that market prices are a measure of value. In the absence of a direct measure of rents, it is necessary to estimate the returns to land by estimating costs and returns from production as was done by WIAC for the Similkameen project.

With the annual value of flood protection measured directly by market observations on rental rates or estimates from budget data, the conversion to a single value by discounting is required. But the market also can provide an alternative measure of the net present value of flood protection. This alternative measure is the difference between the capital cost of flood free land and land subject to flooding (both with the same production potential). The advantage of this alternative measure is that it is not necessary to select the rate of discount or some of the more subtle theories about factors which determine asset values in an uncertain world (Melichar 1979, Feldstein 1973). However, as described above, the market rate of discount is not likely to be the same as the social rate of discount and an adjustment of market values is necessary to account for this difference.

2.3.2 Causes of Lack of Development and the Measure of Indirect Benefits

Market data on rents or capital values may be difficult to obtain for a number of reasons. Both rent and capital values are very local phenomena dependent upon such things as transportation, distance from market centres and infrastructure. It is frequently the case that land subject to flooding is somewhat unique in the area so that data are not available on comparable land without flood hazard. This is particularly the case for Reserve lands as the land is generally not traded in a well defined market. In these situations it is necessary to estimate the benefits of flood protection in terms of the increased production that can be obtained as a result of flood protection. The measurement of indirect benefits become a particularly critical issue in this approach.

The possible benefits associated with the erosion and dyking protection system for the Similkameen case include:

a) net value of production on land saved from being eroded;

b) production saved because of flood control, or alternatively direct crop losses;

c) production saved from decreasing productivity levels in a given period as a result of flooding in the previous period;

d) production costs saved because of flood control;

e) additional net value of production obtained because of induced changes in land use:

f) additional net value of production obtained because of more intensive management in existing uses;

g) intangible benefits

Items (a) and (d) capture the direct benefits; these are the additional value of production that would result if there were no changes in production practices and land use. But some intensification of management practices and a change to higher valued uses may be expected if flood protection occurs. The sources of these additional benefits are identified in items (e) and (f). Also, other benefits should accrue to the flood protection such as the enhancement of the sense of security of the people. This type of benefit falls in the category of intangible benefits and is extremely difficult to measure in economic terms.

The U.S. Water Resource Council suggests a procedure to estimate flood control benefits as illustrated in Figure 2.3. Direct benefits are estimated fairly easily as the difference between the value of production in a flood-free situation and the value of production in a flood situation. The estimation of indirect benefits is more complex because the procedure implies some sort of prediction concerning changes in the pattern of agricultural land use and changes in production technology.

The aggregate of decisions taken over time by decision makers responsible for organizing and operating individual land holdings are

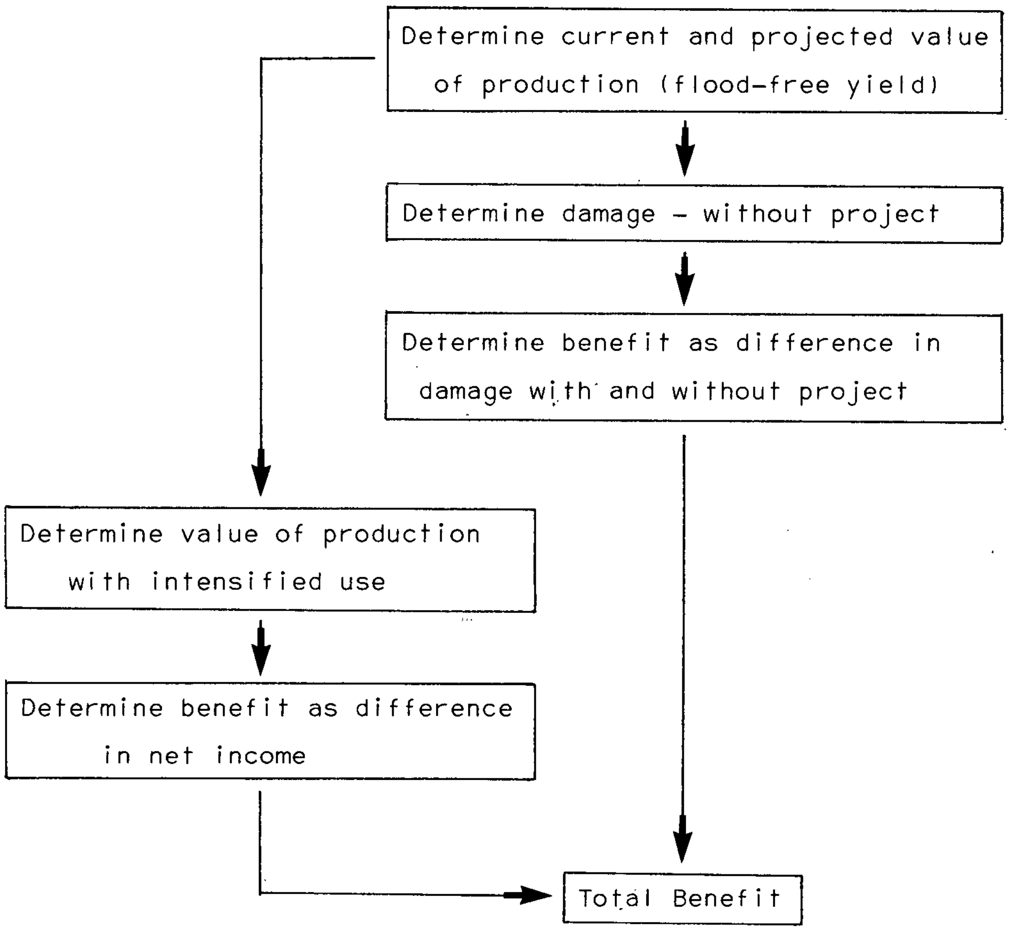

Figure 2.3: Flowchart of Agricultural Floodwater Resources

Source: Water Resource Council, Federal REgister, Part IX, December 14, 1979, Washington, D.C. U.S.A.

reflected in the pattern of agricultural land use. Change in this pattern depends upon decisions being made to adopt new practices. Ideas, products and practices perceived as new by individuals have been defined as "innovations", while the process by which they spread to members of a social system has been defined as "diffusion" (Rogers and Shoemaker 1971).

Decision makers are usually classified in terms of the stage at which they adopt an innovation, and this has been related to personal characteristics and communication networks. Those who invest, develop or are first in one area to adopt an innovation are classified as "innovators". Others are classified as "early adoptors", "early majority", "later majority" and "laggards".

The main factors involved in the one-farm decision making process can be summarized in Figure 2.4. The relationships between economic constraints, available knowledge and personal attributes of the decision maker should be noted. The decision maker, when deciding alternative forms of land use, does not necessarily choose ventures which are optimum in terms of economic return. It is possible that his choice may be random, but it is more likely to be in terms of land use strategy which is satisfactory rather than optimum. In fact, it has been suggested that the decision maker rarely has the capability or desire to examine all the possibilities involved in seeking to optimize the outcomes of his decisions, and thus is willing to seek merely a satisfactory solution. Difference of this kind can be accounted for in terms of differing rates of communication,

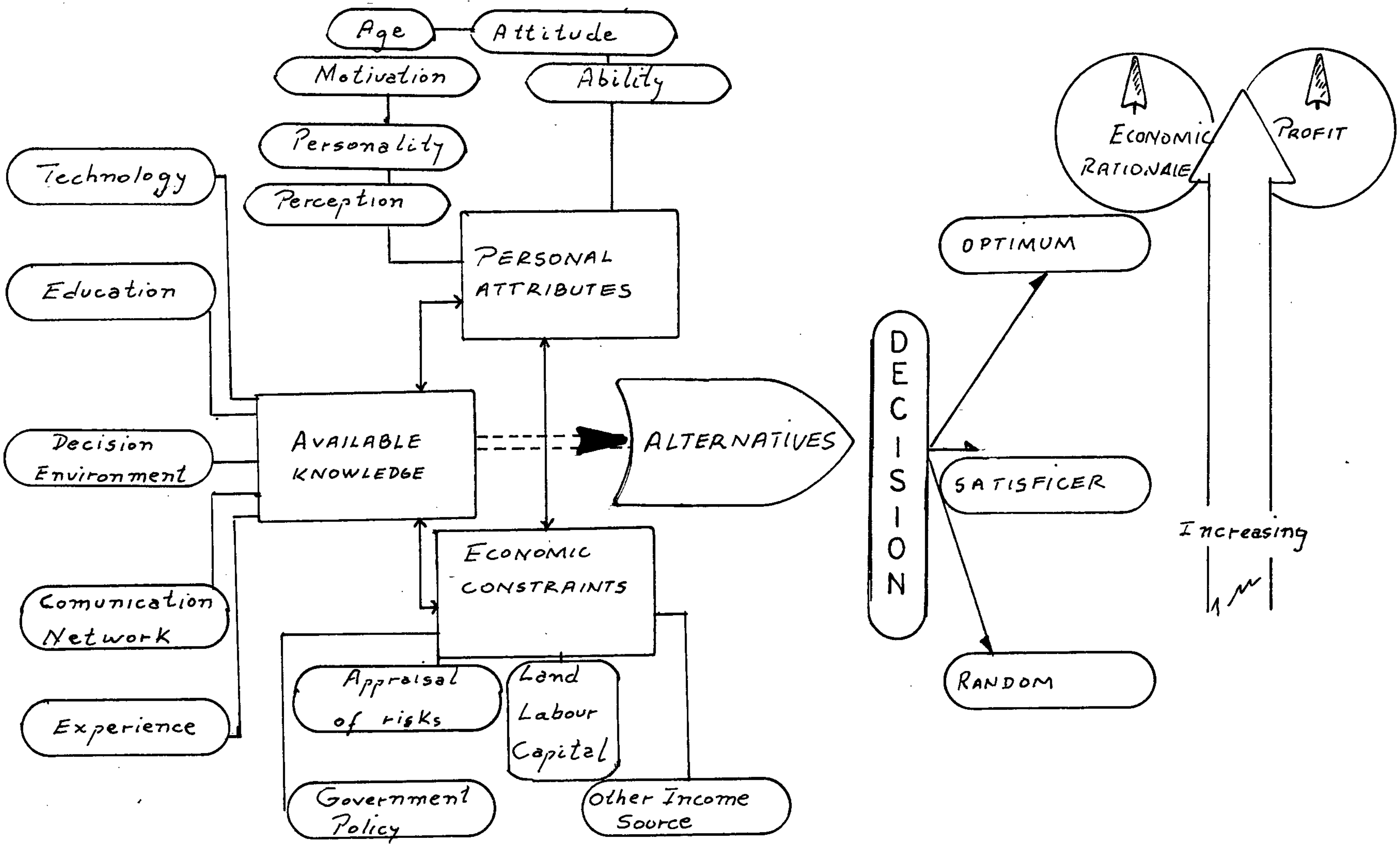

Figure 2.4 The Farm Decision Making Process Source: derived from Cooke & Johnson (1969)

variations in knowledge and levels of aspirations, attitudes to risk, and uncertainty about the environment within which decisions are made. The decision environment refers to the set of knowledge available to the decision maker and is fundamentally determined by the nature of the decision maker. The extended or real environment (i.e., the set of complete knowledge assumed in most normative economic models) is unlikely to coincide with the former. It has been hypothesized that innovations perceived by decision makers as having greater utility tend to be adopted first. Nevertheless, it has been pointed out that increase in farm income and rate of return on investment does not always correlate positively with the rate of adoption (Fliegel and Kilvin 1962). Consequently, farmers' expected utilities are subjectively determined and are not necessarily based on strictly economic criteria.

Considering all of the above and that a prediction model has not been used in the analysis, the response from local farmers to the provision of flood protection in the Similkameen is not easy to determine. Thus, the indirect benefits associated with changes in land use and changes in production technology are difficult to measure. The causes of the current pattern in the use of the land and the low level of productivity are not well known for the Similkameen Indian Bands.

Although the land potential offers opportunities to the Similkameen Band to develop its agricultural resources, the pattern of land use on the Reserve suggests that Indians have faced serious difficulties in this regard. The crop pattern on reserve land outside the project area is roughly 30 percent non-irrigated grass and the remaining 70 percent under native pasture and shrubs (Western Indian Agricultural Corp. 1980). The current and potential land use on the Skemeoskuakin Reserve illustrates the typical lack of development throughout the project area (Table 2.1).

The yields obtained by Indian farmers in the Similkameen area (Table 2.3) also suggest the existence of problems when compared to the yields obtained by non-Indian farmers in the same area.

The literature on Indian poverty basically offers three different types of explanations that may account for the differences between Indian and non-Indian agriculture. The first is that Indians have different constraints on their participation in the market than do non-Indians (Becker 1971); another explanation is that Indians lack managerial and technical knowledge (Sorkin and Johnston 1971). A third explanation is that Indians have different goals than non-Indians (Bennet 1969) which is equivalent to that of the "inert peasant" or "satisficing peasant" in the economic development theory literature (see Reynolds 1975). Dorner (1959) has attributed some effects to all three in explaining Indian poverty implying that the three types of explanations are not mutually exclusive. Work done by Trosper (1978) suggests that land tenure or other institutional problems may underline Indian difficulties in attaining the operating levels of non-Indian agricultural production.

Table 2.1

Land Use in Agricultural Areas of Skemeoskuakin Indian Reserve
Similkameen Valley, B.C.

(hectares)

Crops	Current Situation	Land Potential
Vegetables	0	405
Orchard	0	662
Alfalfa (irrig.)	0	658
Grass (irrig.)	0	662
Grass (non-irrig.)	297	728
Native Pasture	431	728

Source: WIAC Survey, 1980

This might be compared to non-reserve land use in the Valley where about 40 percent of the land is in orchards, 8 percent in vegetables and the remaining in hay, grains and other crops Table 2.2. The Reserve land is considered to be among the best land in the Valley (B.C. Ministry of Agriculture and Food).

Table 2.2

Land Use Pattern in the Okanagan-Similkameen

Crop	Year 1971	1976	1981
Haycrop	42.6	45.3	48
Orchard	46.1	40.3	38
Vegetable & Small Fruits	5.9	8.3	8
Grains	1.5	1.7	3
Others	3.7	3.9	4

Note: Figures in percent on a basis of 13,838 hectares.

Table 2.3

Average Yields in Floodfree Areas of the Similkameen Valley, B.C.

Crop	Units	Indian Farmers[a] (unit/ha)	Average in the Valley[b] (unit/ha)
Irrigated Crop			
Alfalfa	tons	8.5	13.0
Grass	tons	6.7	10.0
Non-Irrigated			
Alfalfa	tons	3.2	6.4
Grass	tons	2.9	5.2
Native Pasture	AUM[c]	0.25	NA

ha = hectare

Source: [a]WIAC Field Survey, 1980

[b]B.C. Ministry of Agriculture - Consensus Data Series

[c]Aninal Unit Month - defined as one mature cow with/without unweaned calf at side McLean, A., Range Management - Agriculture Canada).

If one accepts Bennet's "inert peasant" thesis, then one may expect very little impact of the dykes in changing land use and production practices. However, we feel this thesis is probably not tenable. The argument has also been used in the development literature to describe underdevelopment in many third world countries but has been convincingly refuted by Schultz (1961). At the same time problems with tenure, access to finance, lack of training and educational opportunities, discrimination and social problems are important barriers to development of Indian agriculture.

Basically two forms of tenure arrangements are found on band lands in British Columbia. Most of the land is common property and subject to band management. The administration of band land has in the past been undertaken by the Department of Northern and Indian Affairs. As pointed out above, the administrative function in the Similkameen has been returned to the individual Bands. However, the Bands are in the process of developing the institutions to make use of the land. If the land is to remain as common property then some form of co-operative institutions need to be developed before the land can be effectively used and, of course, there is the difficult problem of forming these institutions.

Some land is also held under Certificates of Possession which in many respects is equivalent to private ownership. Certificates of Possession can be transferred between band members but not to non-band members. Transfers are difficult to effect however because the market is very narrow and therefore few other band members can afford to purchase. Also, mortgages on the land to facilitate transfers are not feasible because land cannot be used as security with non-band financial institutions such as banks. Of course, the seller could in theory "take back" a mortgage but this is rarely done. Certificates of Possession tend to be held by older Indians who were once farmers as a legacy for their grandchildren. Transfers also require band permission which will frequently create political problems and therefore are frequently not perfected when initiated.

Education levels are low in the band population as is practical experience in farm and business management. This makes the formation of effective co-operatives difficult as well as reducing the potential of individual farmers. As Barichello (1978) points out, education levels are an important factor in explaining farmer management abilities, but low education levels lead to high payoff from extension and adult education programs. However, low levels of education are also correlated with low levels of response to new production opportunities such as those created by dyking programs.

Indians in general have a very limited access to traditional lending sources. A major factor is the inability to use their major asset, land, as collateral. This in part has led to a "vicious circle" where Indians have not been able to build up other assets (cattle, machinery, etc.) because of the inability to use land as collateral. Even personal property is difficult to enforce as the property is on reserve land. Indians can apply to three federal government sources for grants: the First Citizen Fund, Special ARDA, and the Economic

Development Fund. All of these funds generally require an important financial committment from Indians borrowing the money for any investment to be undertaken. This is if an Indian farmer wanted to spend \$ 60,000 to develop an irrigated orchard, then he would have to have \$ 30,000 of his own money to be able to borrow an additional \$ 30,000 from one of these sources. In addition, the application procedure is involved and there are maximum limits of \$ 30,000 for individuals and \$ 100,000 for bands. These are large amounts of money for most Indians or bands to raise but generally small in terms of the money needed for viable commercial farming today.

In the particular case of the Similkameen Indian Bands and in connection with the estimation of flood control benefits, two hypotheses can be suggested, one which attributes the lack of development (in terms of land use and in terms of yields) entirely to the flood hazard. The second hypothesis is that the lack of development is due to factors other than floods; i.e.,

Hypothesis	Causes of Lack of Development
H_o :	Floods
H_1 :	Finance, Management, Abilities, Tenure, Education

Four possible combinations in regard to the type of benefits from flood protection can be consequently established as in Table 2.4. Combination I was implicitly assumed in the WIAC study. Based upon the above, we feel that Combination II, III or especially IV is likely in view of the financial demand required to implement changes in management and land use.

Table 2.4

Yield/Land Use Hypothesis

Combination	Current Situation of Low Yields	Current Situation of Land Use
I	H_o	H_o
II	H_o	H_1
III	H_1	H_o
IV	H_1	H_1

Under combination I, flood events are indicated as the primary reason for the low yields and current land use in the area. In this situation, benefits from flood protection are captured in the following expression:

$$(2.7) \qquad B = \left(CS_{LY}^{w} - CS_{LY}^{w/o} \right) + \left(A_{HY}^{w} - CS_{LY}^{w} \right)$$

where

B = Total Benefits (measurable in net present value)

CS_{LY}^{W} = Net Present Value of Current Production Situation with Protection and Low Yield Scenario

$CS^{W/O}_{LY}$ = Net Present Vaue of Current Production Situation without Protection and Low Yield Scenario

A^{W}_{HY} = Net Present Value of Alternative Production Situation with Protection and High Yield Scenario. This represents a situation with more intensive use of land.

The first term of the right hand side represents the direct benefits from flood control and the second term represents the indirect benefits. Combination IV represents a situation where low yields and land use are attributed exclusively to factors other than flood hazard. Consequently, only direct benefits are to be derived from flood protection. This is represented by:

$$B = (CS^{w}_{LY} - CS^{w/o}_{LY}) \qquad (2.8)$$

Combination II and III represent a type of situation where the combined effect of flood hazard and institutional constraints play a role in preventing agriculture development in the area. In the first case((combination II) only the low yields are attributed to the presence of floods (drainage problems). Factors other than floods are indicated to determine the land use pattern. Consequently, benefits in the form of yield increases in the current land use are the direct benefits:

$$B = (CS^{w}_{LY} - CS^{w/o}_{LY}) + (CS^{w}_{HY} - CS^{w}_{LY}) \qquad (2.9)$$

For combination III, yields relate to factors other than floods (such as lack of management, level of investment, information, etc.) but land use is considered to be affected by the flood situation. Therefore direct benefit and indirect benefit are to be accounted. This is represented by:

$$(2.10) \qquad B = (CS^{w}_{LY} - CS^{w/o}_{LY}) + (A^{w}_{LY} - CS^{w}_{LY})$$

where the first term is the direct benefit and the second term captures the indirect benefit. This is summarized in Table 2.5. Note that direct benefits are the same in all cases, but indirect benefits change with each combination. Under H_1 a separate development program consisting of a package of tenure improvement, provision of a source of external credit, access to educational and extension services would be needed to obtain the indirect benefits. These types of benefits are a result of training and/or information which enables farmers not only to identify their best production opportunities, but often to implement their activities successfully. In combination I, benefits from yield increases and from a change in cropping pattern are entirely assigned to the flood protection and therefore benefits from a development program are nil. In situation II, cropping pattern changes may be associated with a development program. In situation III, only yield increases are to associate with a development and in situation IV, crop pattern changes as well as yield increases can be linked to this sort of benefit.

Table 2.5

Flood Control Benefits
(measurable in NPV dollars)

Combination	Direct Benefits	Indirect Benefits
I	$CS^{w}_{LY} - CS^{w/o}_{LY}$	$A^{w}_{HY} - CS^{w}_{LY}$
II	$CS^{w}_{LY} - CS^{w/o}_{LY}$	$CS^{w}_{HY} - CS^{w}_{LY}$
III	$CS^{w}_{LY} - CS^{w/o}_{LY}$	$A^{w}_{LY} - CS^{w}_{LY}$
IV	$CS^{w}_{LY} - CS^{w/o}_{LY}$	0

Total flood control benefits are given in Table 2.6. Total flood control benefits are highest under combination I and lowest under combination IV. The total level of benefits will be at an intermediate level for combination II and III. Note that if a successful development program were undertaken, there would be a considerable impact on flood protection benefits for all hypothesis combinations except I. In this situation, land use and/or yields would be changed and the "current situation" would no longer be the base from which benefits are estimated.

If land use and/or yields can be modified with a development program, then the benefits of such a program can be estimated as shown in Table 2.7 under each of the hypothesis combinations. These benefits are the inverse of those in Table 2.6 in terms of relative magnitude with the largest benefits for combination IV and no benefits for combination I.

As a final point, it is necessary to stress that all of the hypothesis combinations are somewhat extreme. It may be the case that both flood protection and a development program are inseparable components of a single project to increase both the level of management and move to higher valued uses. In this case, flood protection would be part of a total development package with benefits equal to:

$$B = A_{HY}^{w} - CS_{LY}^{w/o}$$

Table 2.6

Total Flood Control Benefits

Hypothesis Combination	Benefits
Without development program:	
I	$A^{w}_{HY} - CS^{w/o}_{LY}$
II	$CS^{w}_{HY} - CS^{w/o}_{LY}$
III	$A^{w}_{LY} - CS^{w/o}_{LY}$
IV	$CS^{w}_{LY} - CS^{w/o}_{LY}$
With Development program:	
I	$A^{w}_{HY} - CS^{w/o}_{LY}$
II	$A^{w}_{HY} - A^{w/o}_{LY}$
III	$A^{w}_{HY} - CS^{w/o}_{HY}$
IV	$A^{w}_{HY} - A^{w/o}_{HY}$

Table 2.7

Development Program Benefits

Hypothesis Combination	Benefits Without Flood Control
I	0
II	$A^{w/o}_{LY} - CS^{w/o}_{LY}$
III	$CS^{w/o}_{HY} - CS^{w/o}_{LY}$
IV	$A^{w/o}_{HY} - CS^{w/o}_{LY}$

CHAPTER 3

ANALYSIS OF ARDSA PROCEDURES TO EVALUATE FLOOD CONTROL BENEFITS

In this chapter the estimates of costs as specified in the WIAC study are reviewed. As stated above in the objectives, the structures are assumed to be the best design to obtain flood protection in the area and no modification of these costs or evaluation of the scale is undertaken. Next, an estimation of benefits based upon land values is made. Because of the lack of data these results have to be seen as tentative, but do provide a verification of the calculation of benefits based upon an analysis of crop production activities. In the following secion, benefits under Hypothesis Combination I from Table 2.5 are respecified based upon a modification of costs and yields from the Consensus data used by WIAC. These are compared with the WIAC results to show the effect of data used on estimation of benefits. This is followed by an estimation of direct and indirect benefits under Hypothesis Combinations II, III, and IV. The final section contains an estimation of maximum possible benefits of a development program as an alternative to increase welfare.

3.1 Flood Hazard and Costs of Protection

Flood and erosion hazard has been independently analyzed for each evaluation unit (EU) considering the relevant flood plains, flood characteristics, and the level of economic activity in each of them.

The B.C. Ministry of Environment (1973) has reported that floods in the area usually exceed a period of 15 days in the two floodplains relevant to the project. This flood in both cases has a duration of 15 days; for flood plain A the flood probability is 16 percent, for flood plain B the flood probability is 8 percent. The damage in terms of lower yields and higher costs is the same for both types of flood for a hectare that is flooded. This is illustrated in Figure 3.1. The project areas and costs of protection are shown in Table 3.1.

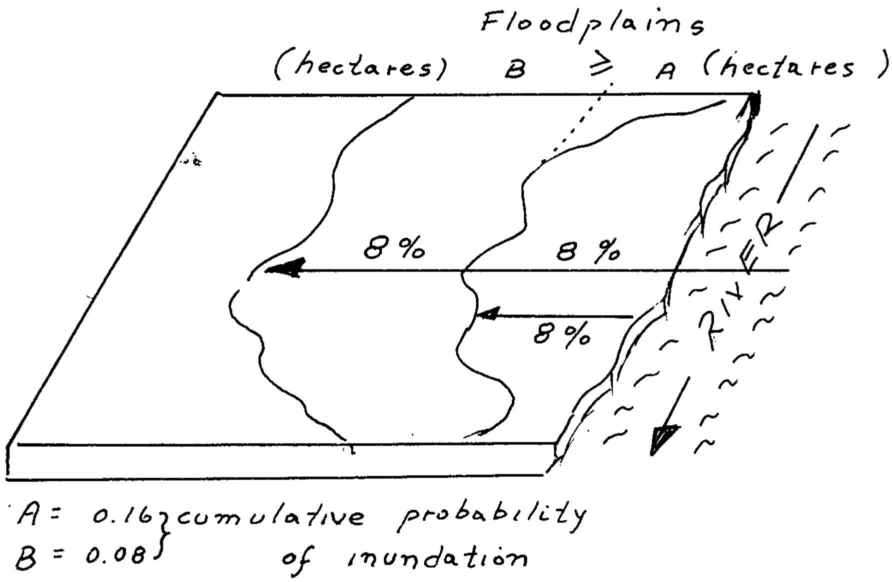

Figure 3.1 Relevant Floodplain and Probability of Inundation

Table 3.1

Summary of Construction Costs of
Similkameen Flood and Erosion Control Projects

(1981 dollars)

Evaluation Unit	Area Protected[a] (hectares) 8 %	16 %	Cost of Project	Cost per Hectare
1	12[b]		40,000	3,333
2	10	-	240,000	24,000
3	50	44	455,000	4,840
4	24	36	465,000	7,750
5	-	400	2,045,000	5,112
6	-	100	440,000	4,400
7	-	187	720,000	3,850
8	-	728	1,572,000	2,159

[a]Area protected from a flood with an 8 % and 16 % cummulative probability of occurrence. The area protected from the less severe flood (16 %) would also be protected from the 8 % probability flood.

[b]Erosion protection rather than flood protection. Land being lost at 1/4 hectare per year.

For EU1 where the river erosion process is estimated to progress at a rate of about 1/4 of a hectare of land loss per year, only erosion control has been proposed by the B.C. Ministry of Environment despite the fact that flooding is also a problem. In the remaining areas erosion protection is only to protect the dyke structure and consequently benefits cannot be separated into erosion control benefits and flood control benefits.

3.2 Benefits Based Upon Land Values

Good data on the difference between rental values or capital costs for land with and without flood hazard is required to estimate flood protection benefits based on land values. An accurate measure would have to take into account the degree of flood hazard. Rental rates for Indian lands show a great variability varying from 42 to 346 dollars per hectare in the Similkameen Valley (Western Indian Agricultural Corporation 1983). These rates represent rental rates for C.L.I. class 2 land subject to flooding. Because of the 'thinness' of the market, there is considerable uncertainty about what equitable rents should be. The $ 42 and $ 346 per hectare are rates paid by the Band to individual Band members. Another instance has been recorded of similar land rented to a band at $ 123 per hectare.

Data are not available on land sales of reserve land between Indians or between Indians and non-Indians. Information on sales of non-Indian land can only give an approximation of the value of flood protection because of the different characteristics of ownership. However, these data may provide an upper bound on the probable level of benefits from flood protection.

Land values vary greatly in the Okanagan-Similkameen region with existing land use (Table 3.2). Forage land averages 5,167 and 7,710 dollars per hectare across all sales in 1980 and 1981 respectively. According to McRoy (1983) hay land in the Similkameen valley would sell for $ 6,170 - $ 7,413 per hectare in 1983. Data are not available on the difference in market value of land subject to flooding and the assessment authority does not have a means for estimating the impact of flood hazard on land value. But Larry Shannon (1983) estimated that land subject to flooding every 5 - 10 years would have a reduced value of around 10 percent. Assuming that land values would be enhanced by 10 percent of $ 7,413 or $ 741 per hectare, this value is far less than the costs of flood protection in all Evaluation Units. Even if we assume land is in the most valuable use, benefits from flood protection for private non-Indian lands would at most be $ 3,824 per hectare[1]. This value is higher than the cost of flood protection for EUs except EU 8.

It might be argued that the private market distorts values of flood protection. Speculative forces, capital appreciation over time as discussed by Melichar (1979), and the social rate of discount will

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[1]This is ten percent of land value for "small fruit" land.

Table 3.2

Land Values in the Okanagan-Similkameen, B.C.

Use	Land Value (dollar/hectare)	
	1980	1981
Grain and Forage	5,167	7,710
Vegetable	8,552	22,709
Tree Fruit	37,407	30,789
Small Fruits	38,244	22,511
Beef	1,707	2,520
Dairy	3,805	8,006
Poultry	5,491	11,416
Mixed	8,745	5,856
Other	7,885	8,426
Weighted Average	5,782	3,954

Source: B.C. Assessment Authority

make the social value of flood protection to appear higher than it should be.

3.3 Direct Benefits Based Upon Net Value of Agricultural Production

3.3.1. WIAC Estimation of Benefits

Data used by WIAC including costs of production, yields, existing land use, normalized prices are all given in Appendix B. These data are used to derive the net benefits of dyking in Table 3.3.

Forage production has been identified as the basic activity in the current Indian agriculture in the Similkameen: alfalfa and grass (irrigated and non-irrigated). Although cow-calf operations were reported, they are not considered in the analysis for two reasons: one, data were not available and second, the main losses from floods and erosion basically affect the forage production. It is however, recognized that floods may have a direct impact on cattle operations increasing the costs of the operation because of the need to move cattle from the flood plain. Moreover, floods may cause cattle losses.

Flood damage for each crop was arrived at through consultation with specialists of the B.C. Ministry of Agriculture. It was indicated that a period of 15 days of flood conditions, as in the Similkameen

Table 3.3

Estimation of Net Benefits of Flood Protection
as made by WIAC

(NPV: thousand dollars 1981)

	Indians			Society[d]		
Evaluation Units	Current Situation[a]	Farmer Plans[b]	Alternative Plans[c]	Current Situation	Farmer Plans	Alternative Plans
1	2	9	37	- 43	- 36	- 8
2	15	17	13	- 256	- 254	- 258
3	34	144	285	- 479	- 369	- 228
4	25	89	133	- 499	- 435	- 391
5	255	917	2,189	- 2,049	- 1,387	- 115
6	80	222	552	- 416	- 274	56
7	106	361	983	- 705	- 450	172
8	266	1,387	2,901	- 1,505	- 384	1,130

[a] Estimated as $CS^{w}_{LY} - CS^{w/o}_{LY}$

[b] Estimated as $F^{w}_{HY} - F^{w/o}_{HY}$

[c] Estimated as $A^{w}_{HY} - A^{w/o}_{HY}$

[d] Estimated in a, b and c minus dykes costs.

area, kills forage crops[1] (100 percent direct crop damage). No damage was indicated for native pasture. Secondary damage for alfalfa and grass are considered in the analysis as well, i.e. reduction of yields in the years following the flood[2].

The economic impact of floods and erosion on the production activities has been measured by computing changes in costs and returns for the various activities. Flood damage has been estimated throughout the analysis using these estimation of impacts on yields and costs.

WIAC evaluated benefits for three scenarios as follows:

a) A "Current Situation" Scenario with change in land use and yields corresponding to hypothesis combination II in Table 2.5. In this alternative, current situation yields were used with concensus data costs.

b) "Farmers Plan" Scenario where Concensus yields and costs were assumed, but land use was assumed to change to patterns reflecting Indian intentions. This implicitly assumes that land use will suddenly change just before dykes are built but independent of dykes being built.

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[1]Alfalfa and cultivated grass

[2]The crop rotation cycle is affected and full production is reached at least one year later.

c) An "Alternative Plan" Scenario[1] where consensus yields and costs were assumed but like (b) above, land use changes suddenly and independently of dykes being built. The change in land use is more extensive than the farmers' plans and includes orchard and vegetable crops. For both the second and third scenarios, the change in land use and the concensus yields are seen to derive from outside forces and are not rationalized. The benefits of the dykes in these situations are estimated as

$$(3.1) \qquad B = A_{HY}^{w} - A_{HY}^{w/o}$$

These benefits correspond then to benefits of flood protection assuming an effective development program has been established as given in Table 2.6 (Combination IV, with development program). As discussed in Chapter 2, problems of tenure, finance, levels of education and management ability, make it unlikely that these developments will occur without substantial development programs.

WIAC also calculated benefits from a "risk averter" scenario for "Alternative" and "Farmer Plan" where both yields and land use were assumed to change, but they were assumed to change from a no use base. Implicitly all production completely was assumed to cease unless dykes were built. Because this assumption seems so false, no attempt is made here to reproduce these results.

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[1]Actually two "Alternative Plans" were evaluated with two different changes in land use.

3.3.2 Modification of Data

Some of the data used by WIAC are not realistic. This in large part is probably due to ARDSA terms of reference. In this section, the modifications that should be made are described. The effect of these modifications on calculations of the benefits of dyking are shown.

The 17 Indian farmers involved in the project were obtaining on the average 8.5 tons/hectare from irrigated alfalfa (Western Indian Agricultural Corporation 1980). Because of no available information regarding irrigated grass yield obtained by the Indians, the 10 tons/hectare average reported for the valley by the Ministry of Agriculture was adjusted consistent with the alfalfa yield differential between the Indian farmers and the figures reported by the Ministry. Therefore, the average yield for irrigated grass among the Indians was established at 6.7 tons/hectare in this study. For non-irrigated alfalfa, the average yield among Band members was estimated at 3.2 tons/hectare (Western Indian Agricultural Corporation 1980). Because data were not regarding irrigated grass yield obtained by the Indians, the 10 tons/hectare average reported for the Valley by the Ministry of Agriculture was adjusted consistent with the alfalfa yield differential between the Indian farmers and the figures reported by the Ministry. Therefore, the average yield for irrigated grass among the Indians was established at 6.7 tons/hectare in this study. For non-irrigated alfalfa, the average yield among Band members was estimated at 3.2 tons/hectare (Western

Indian Agricultural Corporation 1980). Because data were not obtained for the average farmer in the Valley, the 6.4 tons/hectare of the Consensus Data (CDS) Model for Armstrong-Enderby area was used. For non-irrigated grass, the average in the Valley was derived by WIAC from alfalfa production, Armstrong-Enderby area as the base and the figure was adjusted consistent with a grass-alfalfa production relation. The average figure for the Valley was established at 5.2 tons/hectare. For Indian farmers, the average yield for non-irrigated grass was reported at 2.9 tons/hectare.

Production from native pasture was established in terms of the carrying capacity estimated by B.C. Ministry of Agriculture range specialists for the particular area. These yield estimates (summarized in Table 2.2, Chapter 2), represent long term average yields obtained by the producers in flood free conditions.

In flood plain areas, expected average yields will vary in accordance with the probability of being flooded and the crop mix on the various flood plains of the different evaluation units (Table 3.4).

There are a number of reasons that suggest that cost of production data provided by the Ministry of Agriculture (consensus Data Series - CDS) do not reflect the current Indian situation in the Similkameen Valley. Consensus Data are only a guide to producers and it is recognized that because substantial differences exist in production conditions among farmers, these data should be used with caution, especially if applied to those farmers who did not participate

Table 3.4

Expected Average Yield from Indian Farmers in Flood/Erosion Areas

Current Situation

Crop Units: ton / hectare / year

Evaluation Units	Alfalfa		Grass	
	Irrig	Non-Irrig	Irrig	Non-Irrig
1	8.13	-	-	-
2	7.73	-	-	-
3	-	-	-	2.2
4	-	2.42	-	2.3
5 to 8	-	2.03	-	2.2

in the process of producing the data as is the case with the Indian farmers.

If CDS cost-based figures are applied to the Indian farmers in the Similkameen - under flood conditions - production activities exhibit negative returns per hectare for all but two evaluation units. For these two units (with irrigated alfalfa crops) the profitability of the operation is extremely low. (Table 3.5) If normalized product prices represent an average value over a period of time, expected yields are considered fair estimates (given the long record of information on the probabilities of floods for the area), and non-irrigated crops have been grown by the Indians for a long time, then the farm operations must have ceased before if negative returns are expected. The implication of this is that a model of the current crop production situation - which incorporates CDS cost data figures - does not represent reality reasonably well unless one accepts the hypothesis that Indian farmers in the Similkameen are irrational.

Consequently, a direct survey was done in the area in September of 1982 to obtain more economic data related to cost of production among Indian farmers. Main findings were that Indian farmers have usually used less seed and less fertilizer than non-Indian farmers in the Valley. Reseeding has not been a common practice and fertilizer has not been applied to the crops every year. Because no cost data have been kept by Indian farmers, the finding was used in conjunction with the CDS derived data to produce a set of cost data which better reflect the Indian production situation. Based on the

Table 3.5

Profitability of Current Production Activities for Indian Farmers - Without Flood Protection

Evaluation Unit	IRR[a] (%)	Net Present Value (thousand dollars 1981)
1	3.4	- 13.7
2	2.65	- 10.5
3	0.0	- 36.3
4	0.0	- 15,9
5	0.0	- 345.0
6	0.0	- 121.8
7	0.0	- 154.5
8	0.0	- 395.2

Notes: [a]Internal Rate of Return

[b]NPV discounted @ 10 % (private financial analysis)
CDS cost-based figures
25 year period

fact that Indian farmers in the area do not fertilize every year, this item has been adjusted accordingly.[1] The amount of seed mix used (oats and alfalfa) has been estimated proportionally to the yield. Machinery operating costs have been adjusted in terms of

[1]Fertilizer application in alternate years

time saving (hours of machinery) because of less fertilizer being applied, no reseeding, and harvesting and handling of a lower crop yield.[1] Two adjustments have been made to labour: one to reflect time saving[2] (man-hours) because of less cultural practice and less crop harvest and second, an adjustment to the value of man-hours to reflect a "shadow price" for Indian labour in accordance with unemployment rates prevailing on the reserve; the average rate was reduced to the statutory minimum wage rate. Similar adjustments have been made to the input costs for the remaining production activities. (Appendix B)

Capital investment costs based on CDS data have been basically maintained. However, the capital cost figures were not incorporated into the cost stream as lump sums starting year one and then adding capital replacement, as originally done. This procedure is unrealistic for an "existing situation" and also is a potential source of upward bias in costs when this "existing production situation" is introduced as opportunity cost in the analysis of other alternative production situations.

Because the existing situation basically comprises on-going operations, investment costs have been incorporated into the stream of costs (on an annual basis) as a constant figure formed by a combination of replacement capital costs weighted in accordance

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[1]Time reduction in machinery operation: 20 to 25 %

[2]Time saving estimate @ 30 %

with the depreciation schedule for the different items. Thus, the investment costs have been yearly spread over the period of analysis. A summary of the production cost estimates is shown in Table 3.6. (For details see Appendix B).

Net economic value of current production activities of Indian farmers in the Similkameen using CDS cost-based figures and cost-adjusted figures are compared in Table 3.7.

The costs adjustments were incorporated into the cost-benefit analysis to estimate the direct benefits from flood control as described in Table 3.8. These benefits are those applicable under combination IV in Table 2.4. If this situation holds, then clearly flood protection should not be undertaken on any EU. The results in Table 3.8 might be compared with those reported as "Current Situation" by WIAC (Table 3.3). Direct benefits of flood control after cost adjustments appear lower than those reported by WIAC.

3.4 Estimation of Indirect Benefits

Alternative production situations based on different crop patterns and production levels have been investigated and incorporated into the analysis of benefits. This recognized the possibility that these situations might be induced by the provision of flood protection to the area.

Table 3.6

Summary of Average Production Cost Estimated for the Similkameen Area - Current Situation (1981 dollar per hectare)

Crops	Operating Costs		Investment Costs	
	Indians[a]	Non-Indians[b]	Indians[c]	Non-Indians[d]
Irrigated				
Alfalfa	248.6	378.1	215.9	3,136
Grass	212.2	318.8	215.9	3,136
Non-Irrigated				
Alfalfa	93.8	143.3	92.4	1,431
Grass	92.5	135.9	92.4	1,431

[a]Adjusted as described (cost per year)

[b]CDS figures (cost per year)

[c]Yearly amount over the 25 year period

[d]Lump sum start up costs

Note: 10 percent contingency originally included in the figure has been removed.

Table 3.7

Net Economic VAlue of Current Production of Indian Farmers in the Similkameen Area Without Flood Protection

(thousand dollars 1981)

Evaluation Unit	Net Present Value (CDS figures)	Net Present Value (cost adjusted)
1	- 13.7	26.53
2	- 10.5	18.36
3	- 36.3	7.12
4	- 15.9	5.40
5	- 345.0	18.16
6	- 121.8	6.0
7	- 154.5	8.74
8	- 395.2	29.19

Discount rate of 10 percent.

Table 3.8

Estimation of Net Benefit of Flood Protection
(NPV: thousand dollars 1981)

Evaluation Units	To Indians	To Society
1	5.1	- 40
2	5.6	- 265
3	18.8	- 494
4	8.5	- 515
5	188.9	- 2,115
6	66.5	- 429
7	83.4	- 728
8	218.1	- 1,553

3.4.1 Induced Changes in Land Use

The crop pattern associated with what has been named 'Farmer Plans' has been primarily based on information obtained from a survey done among the farmers in August of 1980. In personal interviews, Indian farmers were asked to answer questions such as: Have you considered expanding your present 'farming area'? Are you going to grow the same crop next year? Have you considered growing different crops in the near future? What would be the main obstacle for you in going from what you grow now to a different kind of crop? What is the main problem you have with the present crop, if any? All these questions aimed at depicting an alternative production situation whose possibility will be discussed later.

Although on a small scale, new production activities emerge with the Indian farmer plans -- tree fruit and vegetable production. The Band have already planted 5 hectares of various fruit trees in flood free land in an attempt to diversify production among their members. For farmers involved in the project, however, orchard and vegetable production are new activities.

The "Alternative Plans" represent hypothetical situations in which Indian farmers are assumed to achieve higher levels of diversification and intensification given the production potential of the land base in the area. These Alternative plans related to hypothesis combinations I and III (Table 2.4) where floods are assumed to be the main constraints related to the use of land in the area.

Production of apples is incorporated in the analysis as a proxy for orchard production. The figures are based on a case where producers are constrained to 4 hectares of land, faced with establishing and maintaining an orchard system over a twenty-five year time period. The model is described in the Appendix B.

For vegetable production, tomatoes are used as a proxy. Data from Producer Consensus Costs and Returns - Field Tomato, South Okanagan and Similkameen areas, BCMA - CDS 238 1980. Production figures are based on long term average yields obtained by the producers. It has been reported that the produce is marketed in four different markets. The economics of tomato production is summarized in Table 3.9 A 100 percent flood damage was assumed for vegetable production (total crop losses). For orchard, no loss of production is assumed, but labour costs are considered to receive the main impact of the flood (Swales, 1980). After consultation with the specialist from the B.C. Ministry of Agriculture and Food, a 20 percent increase in labour costs was estimated to reflect the basic impact of flood on orchard production.

Land use associated with the various alternatives are described in Appendix D.

3.4.2 Induced Changes in Management: Yields and Costs

Estimated production from Farmer Plans was based on the average expected yields for non-Indians despite the survey having revealed lower yields for current production of Indian farmers in the area. To recognize this fact and make a more plausible analysis, Farmer Plans have been considered under two different scenarios: a low yield scenario and an average yield scenario.

For the low yield scenario, data are based on what is reported as average for the Indians in the area. For the other scenario, the average estimates applicable to non-Indian farmers are applied to the Indians as well. Adjustments have been made to the investment costs to make allowances because of the introduction of higher yields in the current situation. This has been based on the assumption that current yields among Indians will increase up to the average yield in the Valley, proportional to an investment addition. Consequently, the investment costs have been introducted in the combined form composed by the yearly fixed amount resultant of spreading the investment over the period of analysis (as in current situations) plus about one third of the corresponding lump sum form of capital investment (or replacement) when applicable. Table 3.9 summarizes the data base for both scenarios and for the several production activities.

For both vegetable and orchard production, estimates have been also adjusted for the Low Yield Scenario with criteria similar to the one applied to the traditional forage crops.

Table 3.9

Expected Yield and Cost Scenarios
Data Base Flood Free Condition

(per hectare)

Activity or Crop	Low Yield Scenario	Average Yield Scenario
Irrigated		
Alfalfa Yield	8.6 tons	13 tons
Alfalfa Prod. Cost	$ 251	$ 382
Alfalfa Inv. Cost	$ 218	$ 218 yearly + 1/3 Lump Sum Inv. Cost[a]
Grass Yield	6.7 tons	10.2 tons
Grass Prod. Cost	$ 215	$ 322
Grass Inv. Cost	$ 218	$ 218 yearly + 1/3 Lump Sum Inv. Cost[a]
Veg. Yield	(x yields) 0.7cwt	(x yields) table
Veg. Prod. Cost	$ 5,922	$ 8,462
Veg. Inv. Cost	$ 4,762	$ 6,805
Orchard Yields	(yields x 0.7) tons	yields tons
Orchard Costs	(costs x 0.7)	costs table
Non-Irrigated		
Alfalfa Yield	3.2 tons	6.5 tons
Alfalfa Prod. Cost	$ 95	$ 145
Alfalfa Inv. Cost	$ 93.5	$ 93.5 yearly + 1/3 Lump Sum Inv. Cost[a]
Grass Yield	3 tons	5.2 tons
Grass Prod. Cost	$ 215	$ 138
Grass Inv. Cost	$ 93.5	$ 93.5 yearly + 1/3 Lump Sum Inv. Cost[a]

[a] or replacement

Notes: dollars of 1981

The value of production obtained from Farmer Plans under both scenarios are presented in Table 3.10.

Table 3.10

Economic Value of Production from Farmer Plan

Different Production Scenarios

(NPV thousand dollars 1981)

EU	Low Yields Scenario: Without Protection	Low Yields Scenario: With Protection	Low Yields Scenario: Benefits to Indians	Average Yields Scenario: Without Protection	Average Yields Scenario: With Protection	Average Yields Scenario: Benefits to Indians
1	26.5	31.6	5.1	36.7	46.15	9.45
2	18.4	24.0	5.6	26.9	35.5	8.6
3	4.3	87.5	83.2	173.3	299.76	126.5
4	-13.5	34.3	47.9	76.5	149.29	72.8
5	-394.4	166.45	560.4	313.04	1,159.78	846.7
6	-14.4	120.8	135.2	160.91	366.57	205.7
7	-131.25	94.2	225.5	265.14	602.87	337.7
8	-300.15	571.5	871.6	830.17	2,155.91	1,325.8
	-804.1	1,130.3	1,934.5	1,882.66	4,815.8	2,933.1

Alternative Plans have also been adjusted in the same manner to produce two different scenarios. The model is run again and results are shown in Table 3.11.

Table 3.11

Economic Value of Alternative Plans Under Different Production Scenarios (NPV: Thousand dollars 1981)

	Low Yields Scenario			Average Yields Scenario		
EU	Without Protection	With Protection	Benefits to Indians	Without Protection	With Protection	Benefits to Indians
1	102.3	133.2	30.9	170.4	218.9	48.6
2	-117.4	-113.4	4.0	109.4	113.3	3.9
3	-29.3	165.2	194.3	730.2	1,006.2	276.1
4	-6.7	80.12	86.8	479.3	602.7	123.4
5	529.5	2,068.5	1,539.0	3,484.4	5,684.7	2,200.4
6	73.2	461.9	388.7	834.5	1,391.1	556.5
7	268.9	960.7	692.0	1,457.4	2,451.4	994.0
8	-62.2	1,970.8	2,033.0	3,958.7	6,891.8	2,933.0
	758.3	5,727.0	4,968.7	11,224.6	18.360.0	7,136.0

Note: CS not taken as opportunity cost.

3.4.3 Evaluation of Benefits

Benefits that may result from providing flood protection on the area are estimated for the various hypothesis combinations as explained in Chapter 2. Indirect benefits to the Indians are shown in Table 3.12.

Table 3.12

Indirect Benefits to Indians
(thousand dollars 1981)

Evaluation Units	Hypothesis Combinations I	II	III	IV
1	187	15	101	0
2	89	12	- 89	0
3	980	28	139	0
4	589	18	66	0
5	5,477	256	1,861	0
6	1,319	89	390	0
7	2,359	106	869	0
8	6,645	278	1,724	0

Induced changes in management practices and in land use as a result of flood protection are captured in above benefits. These benefits represent possible additional net benefits[1] to the Indians since costs of the dykes are to be funded through ARDSA grant. Total benefits of flood control (direct and indirect benefits) to Indians and to society are given in Table 3.13. These total benefits illustrate a situation where flood control is in place without a development program. These results in Table 3.13 might be compared with those reported by WIAC (see Table 3.3). In WIAC results, the 'current situation' represents the direct benefits of flood control; the 'alternative situations' might represent indirect benefits of some sort, but no rationale was indicated to attain these indirect benefits. A development program including extension, training and finance to overcome possible institutional constraints was not considered by WIAC in the evaluation of the indirect benefits of this project. Therefore, it was implicitly assumed that constraints preventing a better utilization of the land and preventing higher productivity in the area would be automatically removed by providing flood protection. This would imply acceptance of hypothesis combination I. In that case, the WIAC calculation of indirect benefits is incorrect. If a combination of flood hazard and institutional constraints is assumed (Hypothesis combination II or III), then the imputation of indirect benefits as done by WIAC is also incorrect. Furthermore, if Hypothesis combination IV is to assume, then there

[1]To the above benefits, direct benefits should be added.

Table 3.13

Total Benefits of Flood Control
(thousand dollars 1981)[a]

Evaluation Units	Indians[b] Hypothesis Combinations I	II	III	IV	Society[c] Hypothesis Combinations I	II	III	IV
1	192	20	106	5	147	-25	61	-40
2	95	18	-83	6	-176	-252	-353	-265
3	999	47	158	19	486	-466	-355	-494
4	597	26	74	8	73	-498	-450	-516
5	5,666	445	2,050	189	3,362	-1,859	-254	-2,115
6	1,385	155	456	66	889	-341	-40	-430
7	2,442	189	952	83	1,631	-622	141	-728
8	6,863	496	1,942	218	5,092	-1,275	171	-1,553

[a]Rounded figures

[b]Direct and Indirect Benefits without subtracting costs of dykes.

[c]Direct and Indirect Benefits minus costs of dykes

are not indirect benefits. Since no rationale was indicated in the estimation of indirect benefits by WIAC, that estimation is probably not correct.

Surveys among Indian farmers (Western Indian Agricultural Corp., 1980, 1982 and 1983) in the Similkameen area have indicated that low yields are primarily associated with less use of fertilizer when and where required, variety chosen, less seed and other critical crop management practices such as stand establishment, irrigation practices, cutting schedules, harvest and storage. Also, under investment has been suggested as a reason for obtaining low yields, (inappropriate machinery and equipment).

On the other hand, plant specialists from the Ministry of Agriculture, Indian Affairs and Western Indian Agriculture Corp., have indicated that unless floods actually occur, crop yields should be as high as the average of a flood free area if crops are properly managed. Consequently, Hypothesis Combination I and II can be eliminated from the analysis.

Combination III still considers floods as limiting factors of land use changes. In interviews, however, Indian farmers have put more emphasis on other factors such as financing than flooding. The survey among the farmers in 1980 did not reveal intention of diversification of production activities nor produced evidence that diversification has not been implemented because of floods in the area. None of the sixteen applications to Special ARDA for funding assistance in 1980 (in the project area) considered crop diversification.

The Band, however, started a 5 hectare orchard operation in flood free land some years ago to introduce the idea of different crop opportunities among Band members, but no other farmers until now have followed the intention of the Band planners.

No evidence has been found which supports Combination III. On the contrary, there is evidence which suggests that this is not the most likely situation: the 728 hectares of EU 8, the best land of the project, has been protected against flooding since January 1983, and five months later, Indian farmers have been still unable to define plans to incorporate this area into production. Moreover, the Band farming activities -- comprising about 200 hectares (flood-free land) have been recently reported in financial difficulties because of management problems (Western Indian Agricultural Corp., 1983, Department of Indian Affairs 1983). It is pertinent to indicate also that about 80 hectares of this land has been maintained in forage crops, and that there is no signal to anticipate any change in land use.

A close examination to the relevant constraints that farmers face suggests that a participation rate such as the one described for Alternative Plans is not very likely, even in the presence of extension programs. Financing for instance, a secular constraint that has affected Indian farmers, represents a need of over 2 million dollars annually for at least the first five years to support a development such as that suggested in the alternative plans, for EU 8 only; for the eight EU's the annual financial needs of farmers surpass the amount of 5 million, in additional investments.

Other factors that affect the participation rate and that extension does not solve are: tenure situation, organizational conflicts within the Band, etc. There is evidence that these types of factors still exist in the area (Similkameen Indian Band 1982 & 1983).

Patterns of development such as those described as the Farmer Plans are indeed more likely than those described as Alternative Plans. After all, Farmer plans -- based on a survey among the farmers -- may capture production intentions in the future as opposite to Alternative Plans which only reflect the land potential but not farmers' intentions (see Appendix C). However, for the same reasons that Alternative Plans are not considered to be a dominant feature of the agriculture scene in the near future, the "instantaneous" implementation rate of Farmer Plans is not considered as the most likely. This consideration implies that Farmer Plans should have a time lag of at least 5 years[1] which will make the economic description for this scenario a reduced version of the corresponding benefits.

The implication of the above is that the most likely scenario of benefits derived from flood control in the Similkameen Indian

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[1]Five year period is considered in alternative plans for the participation rate to be at its maximum expression.

lands is determined by the Hypothesis combination type IV.

3.5 Benefits from a Development Program

A successful development program as explained in Chapter 2 may have a considerable impact on flood protection benefits for all hypothesis combinations except I. The estimation of this impact is shown in Table 3.14. The major impact of such a program can be related to possible change in land use. This can be clearly seen by comparing Combination II of Table 3.13 and 3.14. For Combination III and IV, the economic impact is less, but still important. In terms of Net Present Value (NPV) the benefits to the Indians increase up to 20 times or more (Combination II) compared to the NPV of flood control without a development program. The value of this program to society is clear. In Table 3.14 benefits of the program combined with flood are shown. The benefits of the program in a context of no flood control are shown in Table 3.15. In this case, figures illustrate the maximum amount that society may spend on that program. For a situation described as Combination IV, a development program appears a better alternative than flood control.

Table 3.14

Benefits to Indians from a Development Program
With Flood Control
(thousand dollars 1981)

Evaluation Units	Hypothesis Combinations			
	I	II	III	IV
1	192	117	182	49
2	95	230	86	4
3	999	1,035	952	276
4	597	609	587	123
5	5,666	5,155	5,560	2,200
6	1,385	1,318	1,348	557
7	2,442	2,183	2,400	994
8	6,963	6,954	6,752	2,933

Formulas as in Table 2.6

Table 3.15

Benefits to Indians from a Development Program
Without Flood Control
(thousand dollars 1981)

Evaluation Units	Hypothesis Combination I	II	III	IV
1	0	76	10	144
2	0	-135	9	91
3	0	-36	47	723
4	0	-12	11	474
5	0	512	107	3,466
6	0	67	37	828
7	0	262	42	1,448
8	0	-91	111	3,929

Estimated as formulas in Table 2.7

CHAPTER 4

CONCLUSIONS

This chapter summarizes the most important conclusions that can be drawn from this study relating to both the subject of analysis as well as the general methodology. The main limitations of the sudy and implications for further research are also indicated.

4.1 Specific to the Project

A number of conclusions can be related specifically to the project.

a) Agricultural practices among Indian farmers differ from those of non-Indian farmers in the Similkameen area. Therefore, an economic description of the current Indian agricuture in that area, based on Consensus Data Series (B.C. Ministry of Agriculture) is not a realistic representation of the system and introduces bias in economic analysis.

b) The causes of low productivity among the Indians in the Valley as well as the current land use in agriculture are not well known.

c) The current situation (CS) represents the existing production situation among the Indian producers in the Similkameen Valley.

Farmer plans (FP) represent intentions of the Indian farmers to develop their resources further. Alternative plans (AP) represent hypothetical situations where even further agricultural development (higher yield and more intense use of the land) may be achieved, given the agricultural capacity of the area.

d) Direct benefits of dyking protection represent important increases of net income to Indian farmers in the area (from on-going operations).

e) Direct benefits of the flood control projects to society are substantially less than the costs of the dykes in any EU. Consequently, the protection in the area is not economically justified.

f) Because of the substantial amount of indirect benefits in this project, it is extremely important to determine the most likely response of the farmers to the provision of protection in the area, since this kind of benefit will directly depend on the kind of farmers' responses to the protection.

g) Results indicate that in a project such as the Similkameen project most of the benefits are in the form of indirect benefits. If the most likely scenario corresponds to Hypothesis combination IV, then indirect benefits of flood control do not exist. In this situation, benefits to society are less than the cost of the flood protection.

h) However, a development program including extension, training, finance and land tenure improvement associated with flood control may induce changes in land use and management practices in the area. The combined benefits from flood protection and the development may eventually exceed the cost of the projects and make them economically justifiable to society as described in Table 3.14.

i) For a situation such as Hypothesis combination IV, more benefits to society can be obtained through implementing the development program without flood control. In this situation such a program is clearly a superior alternative in terms of economic efficiency criterion as can be seen in Table 3.15.

4.2 General Methodology

A number of points can be concluded in regard to the methodology used in this study.

a) The cost-benefit approach enables us to evaluate the direct benefits and indirect benefits of a particular flood control design. Its relative simplicity is an advantage to other more refined evaluation methods especially when quantity and quality of the data is scarce.

b) The evaluation approach based on the net value of agricultural production is indeed more appropriate (but less simple) than the alternative of evaluating benefits based on land values when the land market in the area is not well defined or not existing in the case of Indian lands.

c) Although no formal prediction model was used to forecast the response of farmers to the provision of protection, the analysis of benefits in separable component and the combination of hypotheses relating yields and crop pattern (as described in this thesis) permitted us to determine the most likely scenario.

d) Output price estimates represent competitive market conditions without short-term abnormalities and therefore are a reliable estimate of the benefits. On the other hand, adjustment to the production costs as described in Chapter 3 corrected distortions introduced in the analysis. The new estimates for alternative plans adjusting the cost to reflect changes in productivity (different yield scenarios) is more appropriate to better assess the possible impact of providing flood protection to the area.

e) Although cost-benefit analysis is not an optimizing procedure, it was possible in this study to determine that an extension program in a context of no flood protection can be superior to providing protection in the context of no extension (Table 3.15).

f) Projects including structural and non-structural control measures, training and extension and financing combined, as an integrated package of rural development appears to make more economic sense than a mere construction of dykes.

g) The ARDSA procedure of cost-benefit analysis as implemented by WIAC for the evaluation of the Similkameen River Dyking Project was essentially based upon indirect benefits. Little consideration was given to the likelihood of realizing these benefits without an extension component within the project. Extension which transfers modern technology to the farm situation and guides Indian producers in all aspects of farm production and business management encourages efficient use of agricultural resources. Measured by what labour contributes to output the productive capacity of human beings has been indicated as tremendously larger than all other forms of wealth taken together (Shultz 1961). Consequently, investment in human capital in the form of training and extension as broadly defined above must be a non-separable component of the project and therefore considered in the assessment of the benefits. The evaluation procedure is otherwise incorrect.

4.3 Further Research

Even though relatively simple data are required for cost-benefit evaluations compared to other research operation procedures, it can be concluded from this study that there is a lack of important information which deserves further investigation. The reasons for lack of development in Indian lands is a crucial issue to determine more rigorously the response of Indian farmers to different projects. To construct appropriate decision models incorporating uncertainty and/or test different hypotheses by using a profit function, for example, or mathematical programming to evaluate different policies on Indian lands, more data are required. Basic data on costs of production and/or yield obtained on Indian reserves is an area which must be investigated. If these data are available, a number of areas concerning Indian development could be explored and appropriate extension or development programs could be designed.

REFERENCES

Barichello, R. "An Economic and Distributive Evaluation of Community Pasture Programs." Vancouver. Dept. of Agricultural Economics, University of British Columbia (1978).

Becker, G. The Economics of Discrimimation 2nd ed., Chigago (1971) cited by R. Trosper, "American Indian RElative Ranching Efficiency." The American Economic Review 68:4 (September 1978):503-504.

Bennet, R. "Economic Development as a Means of Overcoming Poverty" in U.S. Congress, Joint Economic Committee, Toward Economic Development for Native American Communities, 91st Congress, 1st session, Washington (1969) cited by R. Trosper, "American Indian Relative Ranching Efficiency." The American Economic Review 68:4 (September 1978):503-504.

British Columbia. Ministry of Agriculture and Food, Farm Economic Branch, Producer Consensus Costs and Returns Non-Irrigated Alfalfa Hay Production Armstrong-Enderby, CDS 224, Victoria, February (1978).

British Columbia. Ministry of Agriculture and Food, Farm Economic Branch, Producer Consensus Costs and Returns Alfalfa and Grass Hay Production in the Oliver District, CDS 225, Victoria, February (1978).

British Columbia. Ministry of Agriculture and Food, Farm Economic Branch, Producer Consensus Costs and Returns Field Tomato Production South Okanagan and Similkameen, CDS 238, Victoria, February (1980).

British Columbia. Ministry of Agriculture and Food, Agriculture Profile Oliver District, Victoria, December (1980).

British Columbia. Ministry of Agriculture and Food, Agricultural Statistics Factsheets, Victoria, July (1981).

British Columbia. Ministry of Agriculture and Food, Census of Agriculture in B.C., Victoria (1981).

British Columbia. Ministry of Economic Development, Economic Development Commission, Socio-Economic Study of the Indian Population of B.C., Victoria, July (1977).

British Columbia. Ministry of Environment, Water Investigation Branch, Report 2124, Victoria (1973).

Brown, J. "The Economic Effect of Floods: Investigations of a Stochastic Model of Rational Investment Behaviour in the Face of Floods." Dept. of Economics, Brown University (1972).

Campbell, H. "A Benefit Cost Rule for Evaluating Public Projects in Canada." Canadian Public Policy - Analyse de Politiques 1:2 (1975):171-175.

Campbell, H. "Shadow Prices for the Economic Appraisal of Public Sector Expenditures." Canadian Public Policy - Analyse de Politiques II:3 (1981).

Canada. Department of Regional Economic Expansion and British Columbia Ministry of Agriculture, Agriculture and Rural Development Subsidiary Agreement (1977).

Canada. Department of Indian Affairs, Program Statistic Division, Number and Acreage of Indian Reserve by Band (1976).

Canada. Department of Indian Affairs, The Socio-Economic Development of Indian People, Ottawa, October (1977).

Canada. Department of Indian Affairs, B.C. Region, "Planning: Similkameen", News and Views 12 (December 1979).

Canada. Department of Indian Affairs, Central District, Letter to the Similkameen Indian Band, September 24 (1982).

Canada. Statistics Canada, Farm Input Price Index (Grass and Legume Component).

Canada. Statistics Canada, Gross National Expenditure Implicit Price Index, Income and Expenditure Accounts, Catalogue 13-001 Ottawa (1981).

Canada. Statistics Canada, Farm Input Price Index for Western Canada, Catalogue 62-004, Ottawa (1981).

Cooke, R. and Johnson, J. Trends in Geography. London: Pergamon Press (1969).

Canada. Ministry of Environment, Water Planning and Management, Inland Waters Directorate, Estimating Flood Damages in the Fraser River Basin, Pacific and Yukon Region, Vancouver, December 1975.

Dorner, P. "The Economic Position of the American Indians: Their Resources and Potential for Development." Unpublished doctoral dissertation, Harvard University (1959) cited by R. Trosper, "American Indian Relative Ranching Efficiency." The American Economic Review 68:4 (September 1978):503-504.

DPA Consulting. Special ARDA in B.C. Report for the Special ARDA Advisory Board, Victoria (1981).

Eckstein, O. Water Resource Development. The Economics of Project Evaluation. Massachusetts: Harvard University Press (1958).

Feldstein, M. "Net Social Benefit Calculation and the Public Investment Decision." Oxford Economic Papers (1964).

Feldstein, M. "The Inadequacy of Weighted Discount Rates" in R. Layard (ed.), Cost Benefit Analysis. London: Penguin (1973).

Fliegel, F. and Kilvin J. "Farm Practice Attributes and Adoption Rates." Social Forces 40:4 (1962) cited by Australian Water Resource Council. Technical Paper 30, Dept. of National Resources, Canberra (1977).

Harberger, A. "On Measuring the Social Opportunity Cost of Public Funds" (1969) cited by H. Campbell in "Shadow Prices for Economic Appraisal of Public Sector Expenditures." Canadian Public Policy 11:3 (1981).

Harberger, A. "The Opportunity Cost of public Investment Financed by Borrowing" in Project Evaluation: Selected Papers. Chicago: University Press (1971).

Hicks, J. Value and Capital. 2nd Ed., London: Oxford University Press (1939).

James, L. "Economic Analysis of Alternative Flood Control Measures." Water Resource Research 3:2 University of Kentucky (1964).

Jenkins, G. "Discount Rates for Economic Appraisal of Public Sector Expenditures." Canadian Public Policy - Analyse de Politiques 1:3 (1980):549-555.

Lind, R. The Nature of Flood Control Benefits and the Economics of Flood Protection. Institute in Engineering Economic Systems, Stanford University (1966).

McKean, R. Efficiency in Government through System Analysis. Publication in Operation Research 3, N.Y. Wiley & Sons (1967).

McLean, A. Range Management Handbook for B.C. Agriculture Canada Research Station, Kamloops (1979).

McNeill, R. "Production Functions for Apple Orchard Systems in the Okanagan Valley of British Columbia." M.Sc. Thesis Dept. of Agricultural Economics, University of British Columbia (1977).

McRoy, L. Assistant Manager Farm Credit Corporation Summerland. Personal Communication. July 8 (1983).

Marglin, S. "The Social Rate of Discount and the Optimal Rate of Investment." Quarterly Journal of Economics 77:1 (1963): 95-111.

Melichar, E. "Capital Gains versus Current Income in the Farming Sector" American Journal of Agricultural Economics (Dec. 1979).

Mishan, E. Cost Benefit Analysis. Expanded Edition, New York: Praeger Publishers (1976).

Mishan, E. Economic Efficiency and Social Welfare. Selected Essays on Fundamental Aspects of the Economic Theory of Social Welfare. London: Allen and Unwin (1981).

Pearce, D. and Nash, C. The Social Appraisal of Projects. London: The MacMillan Press (1981).

Renshaw, E. "The Relationship between Flood Losses and Flood Control Benefits." Papers on Flood Problems. The University of Chicago Press (1961).

Reynolds, L. Agriculture in Development Theory (1975) cited by R. Trosper "American Indian Ranching Efficiency." The American Economic Review 68:4 (September 1978):503.

Rogers, E. and Shoemaker, F. Communication of Innovation. New York: The Free Press (1971).

Shannon, L. Appraiser. B.C. Assessment Authority, Personal Communication, July (1983).

Shultz, T. "Investment in Human Capital" American Economic Review (March 1961).

Similkameen Indian Band. Community Development Plan, Keremeos (1980).

Similkameen Indian Band. Interview with Mrs. A. Lau, Band Planner, Keremeos (1981).

Similkameen Indian Band. Request to Western Indian Agricultural Corp. to Review Similkameen Band Agricultural Operation. Letter of the Band, December 9 (1982).

Similkameen Indian Band. Series of meetings with T. Snow, Band Manager Keremeos and Vancouver, January and February (1983).

Sorkin, A. American Indians and Federal Aid, Washington (1971) cited by R. Trosper, "American Indian Relative Ranching Efficiency." The American Economic Review 68:4 (September 1978):503.

Sudgen, R. and Williams, A. The Principles of Practical Cost-Benefit Analysis. Oxford: Oxford University Press (1978).

Swales, J. Horticulturist, B.C. Ministry of Agriculture, Summerland: Personal contact (1980).

Talbot, R. "Similkameen Valley Indian Lands: Flooding and Erosion Protection Requirements." Victoria, Ministry of Environment, Water Investigation Branch, (1979).

The Penticton Herald. "Farmlands of Similkameen Valley under Water". Penticton, B.C., May 31 (1972).

Tinbergen, J. (1966) cited by E. Mishan "The Nature of Economic Expertise Reconsidered" Economic Efficiency and Social Welfare, London (1981).

Treasury Board Secretariat. Planning Branch, Benefit Cost Analysis Guide. Ottawa (1976).

Trosper, R. "American Indian Relative Ranching Efficiency" The American Economic Review 68:4 (September 1978):503-514.

U.S. Water Resource Council. "Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resource Planning." Federal Register 44:242 (December 1979).

Western Indian Agricultural Corp. Field Survey, August (1980).

Western Indian Agricultural Corp. "Economic Feasibility Study of the Similkameen Indian Bands. Flood and Erosion Control Project." ARDSA Project No. 271305 Vancouver (1981).

Western Indian Agricultural Corp. "Addendum to the Economic Feasibility Study of the Similkameen Flood Erosion Control Project." Vancouver July (1981).

Western Indian Agricultural Corp. Various local surveys - by WIAC Field-workers. September and October (1982).

Western Indian Agricultural Corp. "Lower Similkameen Indian Band: Current Agricultural Operation." Report March 3 (1983).

Winch, D. Analytical Welfare Economics. Penguin Education, B.J. McCormick, G. Britain (1971).

APPENDIX A

Terms of Reference - Agricultural Benefit Evaluation
Similkameen Indian Bands Flood Control Project

Terms of Reference - Agricultural Benefit Evaluation -
Similkameen Indian Bands Flood Control Project (March 4, 1980)

The proposed Similkameen Flood Control Project will have an impact on Indian and non-Indian lands along the river from Princeton to the Canada/U.S. border. The feasibility study to be undertaken should encompass this Princeton-to-border region. Terms of reference regarding agricultural aspects of the project should contain the following elements:

1. Detailed description of the agricultural land base affected by the project. Such details should include:

a) maps of the area with indication as to which agricultural activities they will be devoted and are currently devoted;

b) specification of acreages involved in agricultural production

i) currently employed in agriculture;

ii) land whose productivity will be increased by the project;

iii) land to be developed toward future production (i.e. expansion of existing production)

c) a table to disclose the breakdown of the agricultural activities into the acreage devoted to each existing and proposed use. This provides a means of comparing the present situation with the scenario after the project is implemented.

d) any additional information relating to land use should be provided. Material such as soil maps, flood frequency/

severity data, etc. which could be helpful in the ARDSA review process is welcome in the report presented to the Sub Committee.

2. Current and expected levels of crop yields, product prices and on-farm production costs should be specified.

   a) crop yields given should be representative for the area and projection based on realistic expectations of industry members or local agriculturalists;

   b) products prices must be referenced and related to market conditions/prospects for the products in question. A rationale for price expectations should be given whenever possible;

   c) production costs must be clearly specified or referenced (e.g. Consensus Costs and Returns, Farm Economic Branch, BCMA) so that cost components may be identified as realistic or representative.

3. Markets and market opportunities be identified and evaluated for the agricultural products produced on lands within the project area.

4. Any methodology employed to evaluate benefits to flood control and erosion prevention should be clearly described in the report so that valuation procedures may be followed by the reader.

5. The Similkameen Indian Band Council is empowered to act as a dyking authority and represent Indian interests in project

implementation. Discussions with the Band or its administrative representatives should yield the following information:

a) employment patterns of band members;

b) employment benefits arising from the project and accruing to band members;

c) band farm management experience and Indian plans or expectations regarding development of their agricultural resources as related to the floodcontrol project;

d) socio-economic benefits from agriculture which are promoted through integration of the development projects listed (last page) with the dyking/erosion control project.

6. The development projects listed on the last page of these terms may be under review for funding by other federal or provincial agencies (e.g. Special ARDA). ARDSA is interested in those projects showing development potential in agriculture. With this in mind, the consultant should clearly establish the Band's development plans in terms of the dyking/erosion control project in relation to its agricultural benefits. The Technical Sub Committee wishes to know:

a) Project layout/location in relation to both the dyking works and proposed agricultural activities.

b) which projects (if any) are currently under review by Special ARDA or other agencies and which may have an impact on the feasibility of the proposed projects under the ARDSA proposal.

c) the results of any analysis undertaken on behalf of or by the Band regarding submissions to other agencies regarding agricultural project funding.

d) benefits to projects eligible for other agency funding should not be counted again as benefits to this ARDSA project if the possibility of double-counting should arise.

7. Detailed Benefit-Cost analysis to determine economic project feasibility under ARDSA is to be conducted in accordance with Technical Sub Committee, Part III guidelines and the following points:

a) a table which "streams" relevant project capital costs, on-farm production costs and agricultural benefits over each year of the assumed 25-year life of the project is to be provided in the report. This table should present the costs and benefits incurred each year over the 25-year period in a way that members of the Sub Committee can replicate the calculations performed by the consultant.

b) the Net Present Value and Benefit/Cost ratio to each project scenario should be calculated using a discount rate of 10 percent (10 %).

c) the Internal Rate of Return to each project scenario should also be given.

d) sensitivity analysis of the project to changes in the values attributed to key economic parameters presented in the benefit/cost table should be performed. Sensitivity analysis should consist of at least one or all of the following adjustments to the benefit analysis:

i) varying agricultural product prices over a range of alternative values;

ii) reducing the level of agricultural benefits by 5 %, then 10 %, to determine effects on the net present value, benefit/cost ratio and internal rate of return;

iii) varying the assumed risk and extent of flood damage to areas under proposed protection to determine effects on benefit levels from the project.

8. Reference material to be used a guidelines in preparing the feasibility study is listed as follows:

a) Project Appraisal Guidelines, Canada-British Columbia Agricultural and Rural Development Subsidiary Agreement, Primary Resource Development, Agriculture Canada, Regional Development Analysis Division, June 1979.

b) Hardie, J. Handbook for Agricultural Project Appraisal. Regional Development Analysis Division, Agricultural Canada. Ottawa, November 1976.

c) Treasury Board Secretariat, Planning Branch. Benefit Cost Analysis Guide. Ottawa, 1976.

d) Provincial Ministry of Environment, Environmental and Engineering Services, R.J. Talbot, P. Eng., Similkameen Valley Indian Lands Flooding and Erosion Protection Requirements. Victoria, June 1979.

e) Also, any engineering information regarding flood and erosion protection for non-Indian lands may be acquired from the Environmental and Engineering Services, should such information be deemed necessary during the course of the study.

9. Allowance should be made in the feasibility study for the fact that the whole project area under analysis may not prove eligible for ARDSA funding. The consultant should stratify his analysis to indicate which areas appear to provide sufficient agricultural benefits to justify funding of the capital costs required to protect some feasible portion of the total project area. That is, if the total project does not appear viable, an analysis of various subsets within the total area may point to certain activities which meet ARDSA funding requirements.

The method of stratification is left up to the consultant and interagency committee (see point 10). A suggested basis for stratification is the engineering report cited in reference 8 (d) above. The areas of work given project priorities on page (iv) of this report provide a means of analyzing costs and benefits to each respective area shown in the table.

10. An "Interagency Committee" comprised of members from DREE, Agriculture Canada, Ministry of Environment, Ministry of Agriculture and Department of Indian Affairs is to coordinate the study and discuss progress and results to the Technical Sub Committee as the feasibility study is being conducted. Once the feasibility study is complete, responsibility falls to the Technical Sub Committee

for final recommendation regarding acceptance or rejection of the Band proposal. A Band representative and the consultant are also members of the Interagency Committee.

In addition to the above points, there are some other questions of a general nature to which the report may be addressed as the consultant deems necessary:

11. Interaction of agriculture with other attributes of the project i.e. inclusion of any external effects of agriculture activity on the area such as: water quality changes, effects on downstream use of water, erosion prevention or other indirect effects may make themselves known. These effects should be identified and quantified where possible with methodology and calculations shown.

12. Consideration of planning and administration costs may be necessary. For example, the Indian and non-Indian agencies may request that project supervisors or managers be hired on a term basis during early stages of plan implementation - these are cost items which should be incorporated into the benefit-cost evaluation.

Finally, it is strongly recommended that the consultant maintain close contact with the Technical Sub Committee as well as the interagency committee and user groups in the field. With this in mind, progress reports should be scheduled to inform the Technical Sub Committee of project development. Meetings with the consultant should be timed at various stages during the course of the feasibility study.

These meetings may be called at the consultant's discretion or upon the TSC's request - at least two meetings are to be considered mandatory:

The first: Once the data has been gathered as necessary to evaluate the agricultural and socio-economic aspects of the project, consultants should report on:

i) any problems in data availability

ii) data available and collected

iii) intended approach or methodology to be used in utilizing data to qualtify project costs and benefits

iv) a time frame or schedule of activities required for feasibility study completion.

The Second: After data has been processed and preliminary results determined, the consultant should discuss these findings with the Sub Committee.

It goes without saying that a third meeting will of course be required, that to present the final report for ARDSA approval. The above meetings should be considered as a minimum. Others will arise during the course of the feasibility study itself as encounters with user groups may become necessary. Hopefully, the meetings will improve communication during the evaluation process and aid in the presentation of the final report.

Addendum to Enclosed Terms of Reference:

It is expected that the proposed river band protection will result in additional land being cleared, irrigated, and brought into production. The consultant should identify these lands and evaluate resulting benefits together with associated capital and annual costs of pumping equipment and distribution systems; on-farm equipment costs; clearing establishment and production costs. The Ministry of Agriculture should be contacted for recommendations regarding peak rates of application and design dutires for various soil types. Benefits and costs should be streamed in accordance with the expected time frame for this land to be brought into full production.

The above would also apply to costs and benefits to lands receiving improved drainage as a result of the project.

APPENDIX B

Cost Estimates for Various
Production Activities in the Area

Table B.1

Average Production Cost Estimates for Non-Indian Farmers in the Similkameen Area

(1981 dollars/hectare)

Items	IRRIGATED alfalfa	IRRIGATED grass	NON-IRRIGATED alfalfa	NON-IRRIGATED grass
Fertilizer	57	89	30	44
Seed	25	12	15	10
Electricity	52	35	7	5
Twine	17	12		
Machinery Operation	84	64	40	35
Labour	126	94	47	37
Cash Overhead	17	12	5	5
Sub-total	378	318	144	136
Contingency 10 %	38	32	14	14
[a]Total Operating Costs per year	416	350	158	150
[b]Capital Investment Cost	3,447	3,447	1,574	1,574

Source: Derived from CDS - 224 and 225. BCMA. Figures adjusted by means of the Farm Input Price Index for Western Canada to reflect 1981 dollars. (Statistics Canada Catalogue 62-004).

[a]Represents weighted average for each crop production cycle.

[b]For gross production, capital investment was assumed to be similar to alfalfa production (*) because no data was available. (Taxes, Interest and Depreciation excluded).

Table B.2

Capital Investment Costs for
Alfalfa Hay Production in the Similkameen Valley

(Dollars 1981)

IRRIGATED CROP	$ per hectare	years of use	NON-IRRIGATED CROP	$ per hectare	years of use
Disc, Plow, Cultivator, Seeder Wagon, Rake	531	20	Tractor	435	15
			Harrow	82	20
Fertilizer Spreader	25	15	Spreaders	77	20
Tractor	571	12	Truck	126	10
Loader	52	12	Bale Wagon & Elevator	287	15
Baler	165	10			
Swather	138	8	Baler	143	10
Truck Pick-up	170	5	Small tools	32	10
Small Tools	49	10	Hay Shed	175	40
Machinery Shed	86	40	Machinery Shed	37	40
Hay Shed	383	40			
Irrigation Pump	161	20	Shop	37	40
Pipels/Sprinkler	413	15			
Well	388	25			
Subtotal	3,132		Subtotal	1,431	
Contingency 10 %	314		Contingency 10 %	143	
TOTAL	3,447		TOTAL	1,574	

Source: CDS 224 and 225, BCMA - 1979

Adjusted with Farm Input Price Index to reflect 1981 dollars.

Table B.3

Average Production Costs for Alfalfa Irrigated in the Similkameen Valley

(per hectare)

Item	Non-Indian Farmers (dollars) (1981)	Indian Farmers (dollars) (1981)
Fertilizers[a]	57	28
Seed[b]	25	16
Electricity	52	52
Twine[b]	17	11
Machinery Operation[c]	84	63
Labour (own/hired)[d]	126	66
Cash Overhead	17	12
TOTAL	378	248

Rounded figures

[a] Fertilizer applications in alternate years

[b] Proportional to the yield

[c] About 20 to 25 % time reduction in machinery operation

[d] Man hours saved because less yields and less cultural practices estimated @ 30 %. Adjustment to the dollar-hour of 25 % has been made to reflect a shadow price for Indian labour (unemployment on reserve reported as high as 75 % in winter months and as low as 25 % in summer).

Table B.4

Apple Production Costs in the Similkameen Valley

High Density Dwarf Rootstock
(1981 dollars - first quarter)

Year	Mater-ials $/ha	Mach-inery $/ha	Labour $/ha	Harvest Costs $/ha	TOTAL COST $/ha	Yield ton/ha	Price $/ton	Gross Revenue $/ha
1	10,887	2,627	2,881	0	16,395	0	593	0
2	798	961	969	0	2,728	0	593	0
3	635	899	3,141	0	4,675	0	593	0
4	672	954	3,541	991	6,158	16	593	3,736
5	672	922	3,941	2,108	7,643	33	593	7,947
6	672	890	3,941	3,225	8,728	50	593	12,157
7	672	857	3,941	3,775	9,247	59	593	14,233
8	672	825	3,941	4,327	9,766	68	593	16,308
9	672	803	3,941	4,893	10,309	77	593	18,444
10	672	771	3,941	4,893	10,277	77	593	18,444
11	672	2,377	3,941	4,893	11,883	77	593	18,444
12	672	1,025	3,941	4,893	10,532	77	593	18,444
13	672	993	3,941	4,893	10,499	77	593	18,444
14	672	954	3,941	4,893	10,460	77	593	18,444
15	672	922	3,941	4,893	10,428	77	593	18,444
16	672	890	3,941	4,893	10,396	77	593	18,444
17	672	857	3,941	4,893	10,363	77	593	18,444
18	672	825	3,941	4,893	10,331	77	593	18,444
19	672	803	3,941	4,893	10,309	77	593	18,444
20	672	771	3,941	4,893	10,277	77	593	18,444
21	672	2,377	3,941	4,893	11,883	77	593	18,444
22	672	1,025	3,941	4,893	10,532	77	593	18,444
23	672	993	3,941	4,893	10,499	77	593	18,444
24	672	953	3,941	4,893	10,460	77	593	18,444
25	672	922	3,941	4,893	10,428	77	593	18,444

Source: WIAC estimation based on R.C. McNeill study "Production Functions for Apple Orchard Systems in the Okanagan Valley in B.C." U.B.C. Dept. of Agricultural Economics, Unpublished M.Sc. Thesis, 1977. (Cost figures do not include taxes, depreciation and interests).

ha = hectare

Notes

Figures presented include both operational production costs (i.e. fertilizer, labour, pesticides, etc.) and investment costs (i.e. buildings, tractors, sprayers, etc.) per hectare over a twenty-five year period.

The apple price per ton was based on the average price reported by the B.C. Tree Fruit Grower's Association in Kelowna (24 ¢ per Kg). This price represents the average price at the farm gate received by farmers for sales to processors and wholesalers aid at roadside stands.

Machinery includes a tractor in the 40 horsepower range, a sprayer adequate for the tree-size, a weed sprayer, an orchard mower, buildings used to house equipment and miscellaneous equipment such as ladders, pruning aids and harvesting equipment. It is assumed that the major machinery items are replaced after 10 years. Materials include pesticides, fertilizer, trace elements, and irrigation systems.

Labour costs do not include harvesting. These figures have been adjusted to reflect 1981 dollars (Farm Input Total for Machinery, Materials and Wages hourly rated for Labour - from Farm Input Price Index for Western Canada).

Harvesting costs were estimated as follows: McNeill's reported an average price less harvest costs of 11.2 ¢ per Kg for dwarf varieties (1974 dollars). After adjusting that figure to relect 1981 (first quarter) dollars by means of the Consumer Price Index for Vancouver, the obtained price was 17.8 ¢ per Kg. The harvesting cost per Kg was obtained by subtracting the computed figure from the average apple price for the 1981 crop, reported by the B.C. Tree Fruit Growers Association, of 24 ¢ per Kg. The estimated harvesting cost was 6.4 ¢ per Kg or $ 58.00 per ton. Harvesting costs per hectare were then obtained by multiplying the corresponding yield per hectare by the above computed figure. (The stream of yield per hectare estimations over the twenty-five year period was taken from the R. McNeill study; the stream was computed based on the estimated production functions).

Table B.5

Summary of Tomato Production Costs Per Hectare

(1981 $ - 1st quarter)

Item	Dollars/Hectare
Fertilizer	163
Seeds and plants	949
Pesticides	109
Custom Work	2,903
Containers	949
Other Supply & Service Items	954
Machinery Operating Costs	432
Hired Labour	670
Cash Overhead	363
Operator Labour	872
TOTAL	8,364

Table B.6

Field Tomato Production: Similkameen Valley

MARKET	YIELDS Kg per hectare	PRICE $ per hectare	GROSS RETURN $ per hectare
Fresh market - marketing board	3,700	.58	2,146
Fresh market - grower sales	7,500	.70	5,250
Farm gate sales	11,200	.41	4,592
Cannery	11,200	.10	1,120
TOTAL	33,600	,39	13,108

Source: CDS - 238 - 1980 - Figures adjusted to reflect economic value in 1981 dollars

[a] weighted average

Table B.7

Capital Investment for Tomato Production in the Similkameen Valley

ITEM	YEARS OF USE	INVESTMENT PER HECTARE (1981 $)
MACHINERY	--	3,728
1. Harrow	20	86
2. Plow, disc, cultivator mulch and bi-wall layer, transplanter	15	843
3. Front loader	15	314
4. Tractor	15	1,391
5. Fertilizer spreader and sprayer	10	200
6. Truck	10	894
SMALL TOOLS	10	217
BUILDINGS	--	488
1. Machinery shed	30	272
2. Cool storage	20	217
IRRIGATION EQUIPMENT		2,290
1. Irrigation system - Trickle bi-wall	3	1,062
2. Filter, injector, fitting	15	677
3. Pump and motor	20	163
4. Well	25	388
TOTAL	--	6,723

(Taxes not included and figures rounded)

Source: CDS - February 1980, adjusted to reflect 1981 dollars

Table B.8

Summary of Normalized Market Prices for Current Crops
(1981 dollars)

CROP	UNIT	DOLLAR/UNIT
Irrigated Production		
Alfalfa hay	tons	91.0
Grass hay	tons	90.0
Non-Irrigated Production		
Alfalfa hay	tons	90.0
Grass hay	tons	90.0
Native Pasture	AU[a]	13.3

[a]Animal Unit

The value of production from native pasture was estimated based on the economic value of an animal unit month (AUM) determined by Barichello (1978). This value was adjusted to reflect 1981 dollars with the Farm Input Price Index (grass and legume component).

APPENDIX C

Land Use in the Project Area

Table C.1

Land Use in EU1
(hectares)

YEARS	LAND USE	CROPS	
		Irrig. Alfalfa	Vegetables
–	Current	12	0
1 - 25	Planned	12	0
1 - 25	Alternative	5	7

Total Land = 12 hectares

Table C.2

Land Use in EU2
(hectares)

YEARS	LAND USE	CROPS		
		Native Pasture	Alfalfa[i]	Orchard
–	Current	2	8	0
1 - 25	Planned	2	8	0
1 - 25	Alternative	2	0	8

Total Land = 10 hectares

i = irrigated

Table C.3

Land Use in EU3
(hectares)

LAND USE	YEARS	CROPS				
		Nat.past.	Grass	Alfalfa	Veg.	Orchard
Current	–	63	30 ni	0	0	0
Planned	1 – 25	3	22 i	68	0	0
Alternative	1	27	22	32	8	4
	2	19	22	30	14	8
	3	13	22	28	18	12
	4	7	22	26	22	16
	5 – 25	3	22	26	22	20

Total Land = 94 hectares

Table C.4

Land Use in EU4
(hectares)

LAND USE	YEARS	CROPS				
		Nat.past.	Grass	Alfalfa	Veg.	Orchard
Current	–	45	9 ni	5 ni	0	0
Planned	1 – 25	7	25 i	28 i	0	0
Alternative	1	33	9 i	9 i	4	4
	2	19	9 i	15 i	8	8
	3 – 25	7	9 i	19 i	12	12

Total Land = 59 hectares

i = irrigated
ni = not irrigated

Table C.5

Land Use in EU5
(hectares)

LAND USE	YEARS	CROPS					
		Shrubs	Native Pasture	Grass	Alfalfa	Veg.	Orchard
Current			147	226[ni]	26[ni]	0	0
Planned	1-25		6	91[i]	296[i]	7	0
Alternative	1	81	60	99	107	40	12
	2	21	46	99	140	73	20
	3	0	27	86	140	113	32
	4	0	6	47	140	162	60
	5-25	0	6	47	140	162	60

Total Land = 400 hectares

Table C.6

Land Use in EU 6
(hectares)

LAND USE	YEARS	CROPS				
		Nat.past.	Grass	Alfalfa	Veg.	Orchard
Current	-	11	80[ni]	9[ni]	0	0
Planned	1 - 25	0	6[i]	93[i]	0	0
Alternative	1	6	26	61	8	4
	2	0	14	61	16	8
	3	0	0	61	24	14
	4 - 25	0	0	61	44	14

Total Land = 100 hectares

Table C.7

Land Use in EU7
(hectares)

LAND USE	YEARS	CROPS				
		Nat.past.	Grass	Alfalfa	Veg.	Orchard
Current	-	73	114	0	0	0
Planned	1 - 25	15	102	62	4	4
Alternative ⇨	1	21	53	89	20	4
	2	6	53	89	20	4
	3	6	38	91	40	12
	4	6	4	91	70	16
	5 - 25	6	0	91	70	20

Total Land = 187 hectares

i = irrigated

ni = not irrigated

Table C.8

Land Use in EU8
(hectares)

LAND USE	YEARS	CROPS				
		Nat.past.	Grass	Alfalfa	Veg.	Orchard
Current	-	431	297[ni]	0	0	0
Planned	1 - 25	55	142[i]	532	0	0
Alternative	1	152	297	243	20	16
	2	61	251	323	60	32
	3	20	182	364	120	40
	4	20	67	399	182	60
	5 - 25	20	46	399	180	80

Total Land = 728 hectares

i = irrigated
ni = not irrigated

Table C.9

Current Land Use in the Project Area
(hectares)

ACTIVITY	%	EVALUATION UNITS 1	2	3	4	5	6	7	8	Total
Irrig. Alfalfa	1.2	12	8	0	0	0	0	0	0	20
Irrig. Grass	0	0	0	0	0	0	0	0	0	0
Non-irrig. Alfalfa	2.5	0	0	0	5	26	9	0	0	40
Non-irrig. Grass	47.5	0	0	30	10	226	80	113	297	756
Grazing (Native pastures)	48.8	0	2	63	45	147	11	74	431	774
TOTAL	100.0	12	10	94	60	400	100	187	728	1,590

Source: WIAC Field Survey, 1980.