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# A Preliminary Benefit Cost Analysis of the Inland Diversion of the Coastal Rivers of New South Wales

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The Water Resources Commission of New South Wales has calculated the capital and operating costs of diverting the amount of water which would be available in the driest year from the major coastal rivers to the inland streams of New South Wales.

A preliminary benefit cost analysis of the least cost diversion to each inland stream, using a discount rate of 3 per cent, indicates that at present prices and yields none of the projects would have a benefit cost ratio of greater than 0.93, even if all of the diverted water were utilized immediately by farmers for the most profitable activity. If a discount rate of 7 per cent is used, this benefit cost ratio would decline to 0.52.

If water is taken up at the same rate as it was after Copeton Dam was completed on the Gwydir River and utilized for the same purposes as it is on the inland rivers at present, no scheme would have a benefit cost ratio of more than 0.31, and most would have a benefit cost ratio of less than 0.22, using a 7 per cent discount rate.

The Water Resources Commission (W.R.C.) of New South Wales has published an initial assessment of the cost of diverting the coastal rivers of N.S.W. into the headwaters of the western flowing rivers of the State (W.R.C. 1981).

Many of the projects examined involve the investment of large sums of capital. The same capital, if it is not invested in the water diversion projects studied, would be available for investment elsewhere in the economy. Whether investment in the irrigation works suggested is justified could only be determined by a complete economic analysis which took into account all of the benefits and all of the costs associated with them.

Any investigation of the control and usage of water resources in N.S.W. should recognize that there is increasing competition between alternative users for controlled water supplied. Although at present a high proportion of stored water in N.S.W. is used for irrigation, there is an increasing demand for water for industrial and domestic purposes. In addition there is an increasing awareness that irrigation can often have an adverse effect on the environment. This can arise directly from irrigation through the salination of land and rivers, or indirectly through the effect that the control of river flow has on wildlife, particularly on birds and fish. On the other hand, water storages provide recreational facilities for an increasing proportion of the population.

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It is against this background that any decision to divert the eastern flowing streams in N.S.W. into the westward flowing streams in the interior must be made. It is possible that a proportion of the water in the eastern flowing streams will be needed for industrial or domestic purposes in the future. Demand for water for these purposes is likely to be much greater east of the Great Divide than west of it. As domestic and industrial users are able and prepared to pay a higher price for water than irrigators, it is probable that the economic returns from water are greater in the former type of usage.

It is also possible that some additional water could be supplied to irrigators west of the Great Divide at a lower cost than by diverting the eastern flowing streams westward. This might be achieved by building additional reservoirs on these streams or by constructing weirs and regulators which would decrease the loss of water from existing streams. On-farm losses of irrigation water could also be decreased by better management practices by farmers. Supplies west of the Divide could also be increased by drawing on groundwater in some cases.

The existing demand for irrigation water could also be decreased by introducing a different pricing policy. At present water is sold to irrigators at a price equal to or sometimes less than that needed to raise sufficient revenue to maintain the irrigation projects. A pricing policy aimed at maximizing the returns to the State for irrigation water would lead to a higher price for water, a decrease in the demand for it, a greater willingness on the part of farmers to exploit alternative sources such as groundwater supplies, and to a decrease in the wastage of water by irrigators.

A recent publication of the W.R.C. indicates that all of the above factors would be taken into consideration before a major work such as the diversion of the eastern flowing streams into the western rivers was undertaken (W.R.C. 1982). However, with the data which is available at present it is possible to make a preliminary examination of some of the economic aspects of the diversion in which it is assumed that all of the water diverted will be used for irrigation west of the Divide without considering the economics of using the water east or west of the Divide for other purposes. Environmental effects and the returns from recreation are also ignored.

The W.R.C. report on river diversion in N.S.W. contains a description of the different projects and an estimate of the total capital required to contruct them (W.R.C. 1981). In addition the annual capital and operating costs of delivering the amount of water which could be diverted in the driest year (the safe yield) into inland streams has been calculated. In doing so it was assumed that the projects would be built in one year and be paid for over a period of 40 years with the invested capital bearing an interest charge of 10.4 per cent per annum (W.R.C. 1981, p. 26). The results of the W.R.C. study for projects delivering water into each inland river at the lowest cost per annum are shown in Table 1.

*Table 1: Diversion of Water from the Coastal to the Inland Rivers in N.S.W.*

| W.R.C. scheme reference No. | Coastal basin | Inland basin | Total capital cost | Operating cost per Ml† | Annual cost per Ml* | Water diverted | |
|---|---|---|---|---|---|---|---|
| | | | | | | To inland river | To farms |
| | | | $ m | $ m | $ | '000 Ml | '000 Ml |
| *Northern N.S.W.*— | | | | | | | |
| CLA-1 | Clarence | Condamine-Culgoa | 91 | 3.2 | 190 | 67 | 54 |
| CLA 7C | Clarence | Dumaresq-MacIntyre | 656 | 29.8 | 130 | 755 | 604 |
| MAC-2A | Macleay | Gwydir | 181 | 0.5 | 350 | 56 | 45 |
| MAC-2AE | Macleay and Clarence | Gwydir | 239 | 0.7 | 360 | 73 | 58 |
| MAC-5 | Macleay | Namoi | 60 | 0.2 | 300 | 22 | 18 |
| MAN-1 | Manning | Namoi | 116 | 0.4 | 310 | 41 | 33 |
| *Southern N.S.W.*— | | | | | | | |
| SNO-4 | Snowy | Murray | 118 | 6.8 | 120 | 162 | 130 |
| TUR-2 | Tuross | Murrumbidgee | 27 | 0.1 | 210 | 14 | 11 |

† Ml = Megalitre

* Annual operating costs plus repayment of capital over 40 years at an interest rate of 10.4 per cent.

*Source:* Water Resources Commission of N.S.W. (1981, p. 23).

The cost of delivering greater quantities of water than the safe yield and the number of years in which such deliveries could be made was not examined, although this would affect the area irrigated and the total net benefits of all of the schemes. No attempt was made to assess the benefits of the projects, although this is essential in determining whether any of the projects could be justified on economic grounds.

In spite of its limitations, the W.R.C. study can be used as the basis for a preliminary benefit cost analysis of the projects. However, because of the limited cost data contained in the study it is only possible to calculate the benefit cost ratios and net present value of benefits arising from the amount of water which could be delivered in all years.

The critical factors which must be taken into consideration when assessing the benefits and costs of a proposed irrigation project are the capital invested by the State and by farmers, water transmission losses, the additional net returns produced by farmers, the secondary benefits arising from the project, the discount rate used and the life of the project. The results of such an examination are of limited use as the method does not indicate the distributional impact of benefits and costs, but only their magnitude. Benefit cost analysis is of little use in determining whether a project is justified on welfare grounds.

## 1. State Capital

Although the W.R.C. study assumes that all projects were constructed in one year, nearly all large water conservation works built in N.S.W. have taken a number of years to complete. The capital invested in projects completed in the last 20 years and the time taken to construct them is tabulated in Table 2. Small projects have been completed in 4 years and larger ones have taken from 6 to 8 years to build. The capital required for the larger diversionary projects is greater than that invested in the largest reservoirs constructed in N.S.W. in the last 30 years (Tables 1 and 2). The rate of construction is often determined by the funds available and provided these are not limited, the diversionary projects could be constructed over a period of 4 years (W.R.C. personal communication 1982). However, past experience indicates that construction could take 6 to 8 years to complete. Capital invested in dam construction in the years prior to the dam's water being available must be compounded forward until the year when irrigation commences, as the capital invested is not available for investment in other sectors of the economy. Thus the longer a dam takes to construct, the higher its initial cost.

*Table 2: Size and Time Taken to Construct Reservoirs in N.S.W.*

| Reservoir | Storage capacity | Capital cost* | Year completed | Construction time |
|---|---|---|---|---|
| | '000 Ml | $ m | | years |
| Burrendong .. .. | 1 164 | 158 | 1967 | 8 |
| Blowering .. .. | 1 600 | 140 | 1968 | 6 |
| Copeton .. .. | 1 353 | 127 | 1976 | 8 |
| Carcoar .. .. | 37 | 22 | 1971 | 4 |
| Lostock .. .. | 24 | 20 | 1971 | 4 |
| Toonumbar .. .. | 17 | 19 | 1971 | 4 |

* In 1981 dollar values.

*Source:* Annual Reports, N.S.W. Water Conservation and Irrigation Commission, Water Resources Commission of N.S.W.

On some rivers such as the Murray and Murrumbidgee a high proportion of the existing irrigation water is delivered to farms in channels constructed by the State. However, existing irrigators on these rivers have a reasonably secure supply of water. In these circumstances any additional water diverted to these rivers would probably be used to introduce irrigation onto dry-land farms and water would be pumped from the rivers by the irrigators themselves (W.R.C. personal communication 1982). This system is the method now used by irrigators on the rivers of northern N.S.W.

## 2. Water Transmission Losses

The W.R.C. has estimated the quantity of water which would be diverted into the headwaters of the inland streams, but only a proportion of the diverted water would reach the irrigation farmers downstream. The remainder would be lost through evaporation, seepage and from other causes. In the Murray-Goulburn system between 30 and 60 per cent of water is lost between the diversion and the farm off-take (Burton 1974). However, the water diverted inland will be delivered into streams which are already used for irrigation and losses due to seepage and evaporation would be far less than from a stream in which the water was not already controlled. Even so, it is thought that only 80 per cent of the water delivered to the inland stream would reach the farm off-take (W.R.C. personal communication 1982).

## 3. Water Usage

Both the amount of capital which would have to be invested by farmers to utilize additional irrigation water and the net returns obtained from it depend on the rate at which the newly available water is utilized by the farmers and the purpose for which it is used.

## 3.1 The Rate of Utilization of Additional Water

A delay in utilizing irrigation water after is becomes available reduces the net present value of both the benefits obtained from it and the capital farmers must invest to use it.

In most irrigation projects all of the available water is not used immediately, either because of the time taken for the dam to fill, a lack of knowledge of how to use it, a lack of capital, the risk involved, or even because the controlling authorities are slow in permitting farmers to use it. Copeton Dam was completed and fully charged with water in 1977, yet in 1981 only 55 per cent of its safe yield was used (W.R.C. records 1982). This delay occurred even though the techniques for profitable use of irrigation water had been clearly demonstrated in the similar neighbouring Namoi Valley. Assuming suitable land is not limiting (and it is not in most Australian irrigation areas) available water will be utilized more readily if it is used to supplement the supply of existing farmers. They are normally familiar with the techniques and risks involved in using it and can often do so without investing in additional machinery.

## 3.2 Farmer Capital

The area of land irrigated may be expanded either by clearing unused or lightly grazed land, or by converting intensively used dry land to irrigation. Most irrigators select the best land for irrigation, and this is normally that previously used for dry-land cropping. Thus any expansion of irrigation causes a decline in the net returns from dry-land cropping. As machinery, fences and buildings are still required for the remaining area of dry land cropped, and for cropping irrigated land, the decrease in returns for a farmer caused by increasing the area irrigated is equal to the gross margin of the dry-land crop replaced by irrigation. As different irrigated cropping activities require different amounts of water, the area which can be irrigated with a given amount of water will vary with crop type. Thus the loss in gross margin from dry-land cropping will depend on the type of irrigated crop introduced.

If the additional water is supplied to farmers already irrigating, it may be possible for them to utilize it without purchasing additional equipment. This situation is most likely to exist if the additional water supplied is only a small proportion of that already used by farmers. On the other hand, additional farming equipment would be required if water were utilized by non-irrigators or if the additional water supplied was a high proportion of that already utilized in the region. In situations where farmers require additional equipment, its capital value must be included as an additional capital cost in the year in which it is purchased.

## 4. Benefits

The additional returns from any irrigation scheme consist of the primary benefits from farmers' additional net returns, and the secondary benefits arising from any increases in net returns from other industries due to increased regional economic activity attributable to the construction of the scheme and the increased returns from irrigation farming.

If additional capital expenditure by the farmer has already been accounted for, additional primary benefits will be equal to the discounted sum of the additional farm gross margin (gross revenue—variable costs) arising from the project, less project operating costs and the gross margin of any dry-land farming activity that irrigation replaces. Total gross margins will depend on the farming activity or activities selected. If water is the only limiting factor, farmers will maximize returns if all water is utilized for the activity giving the highest gross margin per megalitre of water. However, a lack of knowledge, a lack of capital, aversion to risk, or agronomic constraints may induce farmers to utilize some water for activities other than that giving the highest gross margin.

In a free market the opportunity cost of resources used and commodities produced will be equal to their market price. However, if prices are supported by bounties or home support price schemes, benefits to the nation will be overstated. Thus benefits must be calculated using unsubsidized prices.

Secondary benefits in the form of additional profits to industries servicing an expanded irrigation area are bound to arise and are of value to the region in which expansion occurs. However, secondary benefits would also arise if the capital were invested in some other sector of the economy. The size of the secondary benefits and their distribution would depend on the labour and capital intensity of both the alternative investment and the associated industries. As these are unknown it is impossible to say whether total secondary benefits arising from the water diversionary projects would be greater or less than from some alternative investment, or whether their distribution would be more or less desirable. Studies in the United States of America suggest that while secondary benefits have a large regional impact, their effect at the national level is extremely small (Subcommittee of Evaluation Standards 1958). Thus in assessing the project's effect on the national economy it is better to ignore secondary benefits.

Other benefits which might arise from additional water storage are the recreational facilities provided by new dams. Disbenefits could arise from additional salination of the western rivers and from adverse effects on wildlife, particularly on fish and bird life. As these benefits and disbenefits could not be quantified, they were not included in the calculation.

## 5. The Discount Rate

As irrigation projects are constructed over a number of years before the project commences to operate and net benefits are earned over a period of years after it becomes operational, construction costs must be compounded to the year in which irrigation commences. Similarly net returns and farmers' replacement of capital items must be discounted to the same year.

As the future stream of net benefits from an irrigation project are spread over a long period of time the discount rate chosen can have a large effect on the present value of net benefits. If the capital used to construct the project is raised by reducing investment in the private sector of the economy, the discount rate should be equal to the rate of return of the same amount of capital invested in the private sector, i.e., its opportunity cost. On the other hand, if the capital utilized is raised by reducing consumption, the discount rate should be equal to society's rate of time preference for future consumption, i.e., the social rate of time preference. However, even if the capital is raised by reducing consumption, and it is possible for the State to invest the amount raised in the private sector, the opportunity cost of capital should still be used. Moreover, if the State is precluded from investing in the private sector for political or social reasons and the capital is raised by reducing consumption, then the social rate of time preference should be used as the discount rate (Mishan 1972).

In the past, many irrigation projects were constructed for political or social reasons. However, in recent years there has been an increasing tendency to limit construction to those projects which can be justified on economic grounds. In addition, there has been an increasing tendency to oppose projects even when they can be justified on economic grounds because they are thought to have adverse effects on the environment. In these circumstances, the use of the opportunity cost of capital as a discounting rate is more appropriate.

The opportunity cost of capital as defined above is not easy to determine. However, it should not be less than the return obtained from commercial investments. These should be at least as great as the rate at which capital is borrowed by commercial investors less the rate of inflation (Levy and Sarnot 1978).

## 6. The Life of the Project

A well-designed irrigation project might have a life of some hundreds of years. In view of the high risks involved in predicting future prices of commodities and inputs used by irrigators, and the large effect of changes in technology, it is better to limit the economic life of a project to a shorter period than its physical life.

Providing the economic life chosen is not too short, it has little effect on the benefit cost ratio because discounted net returns beyond this period are negligible. At a discount rate of 7 per cent, the net present value of returns in the 50th year are only 3 per cent of their nominal value in that year.

## 7. The Benefit Cost Calculation

The type of benefit cost ratio used depends on which resources are regarded as being scarce. If State capital is regarded as the only scarce resource, then the appropriate ratio to use is summarized in equation (1):

$$\frac{\text{Benefits—Private operating costs—Private capital}}{\text{Public operating costs + Public capital}} \qquad (1)$$

If on the other hand, both farmer and State capital are regarded as being scarce, while State operating costs could be met from revenue from water sales and farmer operating costs from additional gross revenue from irrigation, then the appropriate ratio to use is as summarized in equation (2):

$$\frac{\text{Benefits—Private operating costs—Public operating costs}}{\text{Public capital + Private capital}} \qquad (2)$$

If gross margins are positive, farmers will be able to pay their additional farm operating costs, and revenue from sales of water should be sufficient to pay State operating costs. There is no reason to suppose that State capital is less scarce than private capital. Given the appropriate fiscal policy, the two are interchangeable in the long term. In these circumstances, equation (2) is the appropriate benefit cost ratio to use.

Benefit cost ratios were calculated for all projects using the following formula:

$$\frac{B}{C} = \frac{\dfrac{b_1 - o_1}{(1 + r)} + \dfrac{b_2 - o_2}{(1 + r)^2} \cdots + \dfrac{b_n - o_n}{(1 + r)^n}}{\dfrac{K_1 + k_1}{(1 + r)} + \dfrac{K_2 + k_2}{(1 + r)^2} \cdots + \dfrac{K_n + k_n}{(1 + r)^n}}$$

Where—

$B$ = the net present value of the sum of future gross margins from additional irrigation activities;

$C$ = the present value of capital invested by farmers and the State;

$b$ = the total annual farm gross margin from additional irrigation;

$o$ = the annual operating costs of the diversionary project;

$K$ = the capital invested by the State;

$k$ = additional capital invested by farmers;

$r$ = the discount rate.

and the subscripts 1, 2, . . . $n$ indicate the year in which gross margins were produced or farm capital invested.

The following assumptions were made in the calculations:

(i) State capital works will be constructed over periods of either 4 or 6 years and at a rate similar to the average rate of construction of reservoirs built in N.S.W. in recent years (Table 3).

*Table 3: Rate of Capital Investment Assumed for Diversionary Works*

| Period of construction | Per cent of capital invested per year | |
|---|---|---|
| | 4 years | 6 years |
| | per cent | per cent |
| Year from commencement of construction | | |
| 1 | 15 | 10 |
| 2 | 25 | 15 |
| 3 | 45 | 20 |
| 4 | 15 | 25 |
| 5 | .. | 20 |
| 6 | .. | 10 |
| Total | 100 | 100 |

*Source:* Adapted from Annual Reports, N.S.W. Water Conservation and Irrigation Commission, Water Resources Commission of N.S.W.

(ii) Eighty per cent of the water diverted into inland streams will reach irrigation farm boundaries.

(iii) On all rivers it was assumed that irrigated cropping would replace dry-land wheat growing.

(iv) In all areas land irrigated with diverted water will have to be levelled and farm channels constructed at a cost of $1,000 per hectare.

(v) On all rivers the cost of distributing additional water would be equal to the price paid by farmers for it in 1982. On the northern rivers this probably understates the operating cost of the scheme, as only metering costs are charged for water.

(vi) On all northern rivers except the Dumaresq-MacIntyre Rivers, the water diverted is less than 25 per cent of the total that is available for irrigation at present (Table 4). Thus on these rivers a high proportion of water would be utilized by farmers already irrigating and it was assumed that available water was the only factor limiting the expansion of irrigation. Thus no additional labour, pumping equipment, or farm machinery would be required. On the Dumaresq and MacIntyre Rivers the water diverted would be 134 per cent of that now available for irrigation and a high proportion of water would be utilized by dry-land farmers. These would probably have sufficient tractor power and equipment to produce crops other than cotton.

*Table 4: Ratio of Water Diverted from Coastal Rivers to Inland Streams to That Available from Storages on Inland Streams*

| Inland river | Water available from inland streams | Coastal river | Water diverted inland and available on farms | Per cent |
|---|---|---|---|---|
| | Ml | | Ml | |
| Condamine-Culgoa | n.a. | Clarence .. | 53 600 | n.a. |
| Dumaresq-MacIntyre | 258 000 | Clarence .. | 604 000 | 134 |
| Gwydir .. | 522 000 | Macleay .. | 44 800 | 9 |
| Namoi .. | 246 000 | Macleay and Clarence | 58 400 | 24 |
| Namoi .. | 246 000 | Macleay .. | 17 600 | 7 |
| Namoi .. | 246 000 | Manning .. | 32 800 | 13 |
| Murray .. | 672 000 | Snowy .. | 129 600 | 19 |
| Murrumbidgee | 600 000 | Tuross .. | 11 200 | 2 |

*Source:* Water Resources Commission of N.S.W. (1981): Water Resources Commission of N.S.W., Personal Communication (1982).

*Table 5: Additional Capital Needed on Farms Receiving a Water Allocation from Water Diverted*†

| Item | Life | Cost per farm |
|---|---|---|
| | years | $ |
| (i) *The Dumaresq and MacIntyre Rivers, assuming 200 hectares of cotton are irrigated*— | | |
| Irrigation pump and motor, (including delivery pipe $2,500) | 10 | 42,500 |
| Cotton picker (4 row) .. .. .. .. .. | 5 | 100,000 |
| Cotton planter .. .. .. .. .. .. .. | 10 | 12,000 |
| Ripper .. .. .. .. .. .. .. .. | 10 | 15,000 |
| Row cropping equipment .. .. .. .. .. | 10 | 50,000 |
| Module builder .. .. .. .. .. .. .. | 10 | 25,000 |
| | | $244,500 |
| (ii) *The Murray and Murrumbidgee Rivers*— | | |
| Assuming farms milking 200 cows .. .. .. .. | n.a. | |
| Cows, 200 @ $250 .. .. .. .. .. .. | n.a. | 50,000 |
| Establishment of pastures— | | |
| Summer, 46 ha @ $161.7 per ha .. .. .. .. | n.a. | 7,438 |
| Winter, 34 ha @ $105.7 per ha .. .. .. .. | n.a. | 3,594 |
| Milking shed .. .. .. .. .. .. .. | 50 | 100,000 |
| Irrigation pump and motor .. .. .. .. .. | 10 | 10,000 |
| | | $171,032 |
| (iii) *The Murrumbidgee River*— | | |
| Assuming farms grazing 1 000 ewes .. .. .. .. | n.a. | |
| Ewes, 1 000 @ $30 .. .. .. .. .. .. | n.a. | 30,000 |
| Winter pasture, 100 ha @ $105.7 per ha .. .. .. | n.a. | 10,570 |
| Irrigation pump and motor .. .. .. .. .. | 10 | 10,000 |
| | | $50,570 |

† Note that it was assumed that pastures are maintained and livestock are self-replacing and that the terminal value of these items equals the initial value.

If water were used for cotton production on the Dumaresq and MacIntyre Rivers, it was assumed that sufficient water would be allotted to each farmer to produce 200 hectares of cotton, the maximum area which can be harvested by a 4-row picker, and that farmers would have to purchase irrigation pumps and specialized cotton growing equipment. Details of the cost and life of this equipment are given in Table 5.

Water diverted to the Murray and Murrumbidgee Rivers would be allotted to existing dry-land farmers who would obtain water by pumping from the river. These farmers would have to invest in pumps, improved pastures and additional livestock (Table 5).

(vii) If irrigation water were used for livestock, cows would be grazed at a stocking rate of 2.5 milking cows per hectare on irrigated pastures with a ratio of 0.43 hectares of winter pasture to 1 hectare of summer pasture (Earle 1982). Ewes would be grazed on winter pasture only at a rate of 10 ewes per hectare.

(viii) As future prices and yields are unknown, benefits were calculated assuming existing prices and yields, and also with prices and yields 10, 20 and 50 per cent greater than those obtained at present.

(ix) The returns of safe investments in Australia at present are as high as 13 per cent and the interest rate on some commercial loans exceeds 17 per cent. With an inflation rate of 10 per cent it is probable that the opportunity cost of capital is approximately 7 per cent after allowing for inflation. To examine the sensitivity to interest rates, discount rates of 3, 5 and 7 per cent were used in examining all projects which were assumed to have a life of 50 years.

(x) As the rate of uptake of diverted water and the purpose for which it will be used are unknown, the benefits and costs of the inland diversion of the coastal rivers were calculated on three distinct bases as follows:

**A. Immediate Uptake Optimum Use (IO)**

All of the water will be utilized by farmers in the year it becomes available and all of it will be used for the activity giving the highest gross margin per megalitre (Table 6 and Appendix I). On the Condamine, MacIntyre, Gwydir and Namoi Rivers, cotton fulfils this condition and on the Murray and Murrumbidgee additional milk produced for manufacturing at current prices has a higher gross margin per megalitre than any other activity.

*Table 6: Gross Margins of Irrigated Farming Activities*

| Activity | Yield per ha | Price | Gross margin | |
|---|---|---|---|---|
| | | | per ha | per Ml |
| | | $ | $ | $ |
| *Northern N.S.W.—* | | | | |
| Cotton .. .. .. | 5 bales | 300 per bale | 762 | 127 |
| Soybeans .. .. .. | 2.8 tonnes | 240 per tonne | 480 | 64 |
| Maize .. .. .. | 7.0 tonnes | 110 per tonne | 366 | 41 |
| Wheat (irrigated) .. .. | 4.0 tonnes | 104 per tonne | 258 | 69 |
| Wheat (dry-land) .. .. | 1.5 tonnes | 113 per tonne* | 114 | n.a. |
| *Southern N.S.W.—* | | | | |
| Rice .. .. .. | 5.7 tonnes | 123 per tonne | 395 | 26 |
| Sunflowers .. .. | 2.25 tonnes | 275 per tonne | 355 | 51 |
| Lucerne .. .. .. | 14.0 tonnes | 80 per tonne | 429 | 44 |
| Wheat (irrigated) .. .. | 3.6 tonnes | 103 per tonne | 190 | 53 |
| Wheat (dry-land) .. .. | 1.3 tonnes | 103 per tonne | 74 | n.a. |
| Dairying .. .. .. | 362.5 kg butterfat | 2.50 per kg | 558 | 74 |
| Merino ewes .. .. | 10 ewes per ha | 2.74 per kg | 228 | 30 |

* Includes premium for hard wheat.

n.a. = not applicable.

*Source:* Bailey, D. R. and Buffier, B. D. (1982); Penman, P. (1981); Earle, D. (1982).

**B. Immediate Uptake Normal Use (IN)**

As in **(IO)** except that it was assumed that the additional water on the Condamine, MacIntyre, Gwydir and Namoi Rivers would be utilized to irrigate a combination of crops in approximately the same proportion as those irrigated on the Namoi at present. On the Murray and Murrumbidgee Rivers it was assumed that diverted water would be allotted between crop species and pastures in the same proportion as at present on those rivers (Table 7). On the Murray where dairying is a dominant activity it was assumed that all pasture would be utilized for this purpose. On the Murrumbidgee where very little dairying is undertaken it was assumed that all pasture would be used for grazing breeding ewes.

*Table 7: Approximate Utilization of Irrigated Land on Inland Rivers in N.S.W.*

| Enterprise | Namoi | Murray and Murrumbidgee |
|---|---|---|
| | per cent | per cent |
| Cotton .. .. .. .. .. | 70 | .. |
| Soybeans .. .. .. .. | 10 | .. |
| Wheat .. .. .. .. .. | 20 | 16 |
| Rice .. .. .. .. .. | .. | 3 |
| Lucerne .. .. .. .. | .. | 2 |
| Sunflower .. .. .. .. | .. | 1 |
| Summer Pasture .. .. .. | .. | 22 |
| Winter Pasture .. .. .. | .. | 56 |
| Total .. .. .. .. | 100 | 100 |

*Source:* Water Resources Commission of N.S.W., Personal Communication (1982).

### C. Normal Uptake Normal Use (NN)

As in **(IN)** except that it was assumed that diverted water would be taken up by farmers at the same rate as on the Gwydir River after the construction of Copeton Dam (Table 8).

Table 8: *Rate of Uptake of Available Irrigation Water by Farmers on the Gwydir River*

| Year in which water was available | Percentage of available water utilized by farmers |
|---|---|
| | per cent |
| 1 .. .. | 15 |
| 2 .. .. | 20 |
| 3 .. .. | 30 |
| 4 .. .. | 40 |
| 5 .. .. | 60 |
| 6 .. .. | 100 |

*Source:* Water Resources Commission of N.S.W., Personal Communication (1982).

## Results

The results are tabulated in Tables 9 to 11 for northern N.S.W. and in Tables 12 to 14 for southern N.S.W.

The use of all water for the most profitable activity immediately it is available as in Option **IO** has never been achieved on any Australian irrigation project and cannot be regarded as a realistic assessment of economic viability, but merely as a basis for further calculation. Option **IN**, which assumes a more normal mix of activities, and all water being used immediately, is probably the best result which would be achieved. Option **NN**, in which uptake is delayed and some water used for the less profitable crops, is probably the most likely result.

The results obtained are extremely sensitive to changes in prices and yields, the discount rate used and to the mix of farming activities practised by irrigators. They are less sensitive to small differences in the time taken to construct the dam and to whether water is utilized immediately or taken up at the normal rate by farmers.

With the same assumptions concerning prices, yields, discount rate and the uptake and use of water, better returns are obtained from all of the northern river diversions than from diversions to the Murray and Murrumbidgee. On the northern rivers a high proportion of the diverted water is used for cotton and the gross margin from this activity is higher than from any crop or livestock activity on the Murray or Murrumbidgee.

At 1982 prices and with the average yields of recent years no project has a positive benefit cost ratio at a discount rate as low as 3 per cent, even if all irrigation water is used for the optimum farming activity and is taken up immediately the dam is constructed (Option **IO**). The highest benefit cost ratio obtained under these conditions is from the diversion from the Clarence to the Dumaresq and MacIntyre (Scheme CLA7C) with a benefit cost ratio of 0.93 and an internal rate of return of 2.5 per cent.

In the much more likely case of water being taken up at the normal rate after a scheme is constructed and utilized for the same mix of farming activities in a region as at present (Option **NN**) no project has a benefit cost ratio of greater than 1, even if yields or prices are 10 per cent higher than at present, using a discount rate of 3 per cent. With the exception of the diversion from the Clarence to the MacIntyre, this result is only achieved if increases in prices or yields exceed at least 20 per cent. Using a discount rate of 5 per cent and a normal farming mix and uptake of water (Option **NN**) yields or prices would have to be more than 20 per cent higher than at present for any project to have a benefit cost ratio of more than 1. With a discount rate of 7 per cent and a normal uptake and use of water the Clarence-MacIntyre diversion (Scheme CLA7C) is the only project with a benefit cost ratio of greater than 1, even if prices and yields are 50 per cent higher than at present.

In the past the ratio of the price of most farm products to that of farm inputs has declined, and increases in yields and improvements in farming technology have been required to offset the effect of the decline of the price cost ratio on net farm income. Thus, although the Clarence-MacIntyre diversion (Scheme CLA7C), and to a lesser extent the Clarence-Condamine diversion (Scheme CLA1), give satisfactory results if higher yields are assumed, the benefits of these in the future as in the past are likely to be largely absorbed by the rising price of farm inputs.

While the diversion of the Clarence to the MacIntyre has the highest benefit cost ratio at all discount rates and the highest internal rate of return, it is also the project requiring the most capital (Table 1). If losses are sustained they are greater from this project than from any other. Thus assuming existing yields and prices, a normal uptake and use of water and a 5 per cent discount rate, the present value of net loss from the Clarence-MacIntyre scheme, with a benefit cost ratio of 0.43 and an internal rate of return of 0.57 per cent, would be $538 million. This might be compared with the present value of loss of $84 million from the Clarence-Condamine diversion, the project with the lowest benefit cost ratio (0.24) and an internal rate of return (– 0.82 per cent), which is the lowest of any northern river project. The Clarence-MacIntyre diversion requires a capital investment of $656 million, compared with the $91 million which would be required for the Clarence-Condamine diversion. Thus, in spite of higher benefit cost ratios and internal rates of return, the large projects can produce larger losses than smaller projects with lower benefit cost ratios and rates of return.

*Table 9: Benefit Cost Ratios of Projects Diverting the Coastal Rivers into the Inland Streams of Northern New South Wales*

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Discount Rate | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| | | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| *4 year construction—* | | | | | | | | | | | | | | |
| Clarence to Condamine and Culgoa .. .. .. | CLA 1 | IO | 0.64 | 0.98 | 1.32 | 2.34 | 0.44 | 0.67 | 0.91 | 1.61 | 0.32 | 0.50 | 0.67 | 1.18 |
| | | IN | 0.41 | 0.69 | 0.96 | 1.78 | 0.28 | 0.47 | 0.66 | 1.22 | 0.21 | 0.35 | 0.48 | 0.90 |
| | | NN | 0.37 | 0.61 | 0.86 | 1.59 | 0.24 | 0.41 | 0.56 | 1.05 | 0.17 | 0.28 | 0.40 | 0.73 |
| Clarence to Dumaresq and MacIntyre .. .. | CLA 7C | IO | 0.93 | 1.33 | 1.74 | 2.96 | 0.68 | 0.97 | 1.27 | 2.16 | 0.51 | 0.74 | 0.97 | 1.65 |
| | | IN | 0.69 | 1.04 | 1.38 | 2.41 | 0.50 | 0.75 | 0.99 | 1.74 | 0.38 | 0.56 | 0.75 | 1.31 |
| | | NN | 0.62 | 0.92 | 1.23 | 2.15 | 0.43 | 0.64 | 0.86 | 1.50 | 0.31 | 0.47 | 0.62 | 1.08 |
| Macleay to Gwydir .. .. .. .. .. | MAC 2A | IO | 0.57 | 0.72 | 0.87 | 1.32 | 0.39 | 0.49 | 0.60 | 0.91 | 0.29 | 0.36 | 0.44 | 0.67 |
| | | IN | 0.47 | 0.59 | 0.71 | 1.07 | 0.32 | 0.40 | 0.49 | 0.74 | 0.24 | 0.30 | 0.36 | 0.54 |
| | | NN | 0.41 | 0.52 | 0.62 | 0.94 | 0.27 | 0.34 | 0.41 | 0.62 | 0.19 | 0.24 | 0.29 | 0.43 |
| Macleay to Gwydir .. .. .. .. .. | MAC 2AE | IO | 0.55 | 0.70 | 0.85 | 1.30 | 0.38 | 0.48 | 0.59 | 0.89 | 0.28 | 0.35 | 0.43 | 0.65 |
| | | IN | 0.47 | 0.60 | 0.72 | 1.10 | 0.32 | 0.41 | 0.49 | 0.75 | 0.24 | 0.30 | 0.36 | 0.55 |
| | | NN | 0.40 | 0.51 | 0.61 | 0.93 | 0.26 | 0.33 | 0.40 | 0.61 | 0.18 | 0.23 | 0.28 | 0.43 |
| Macleay to Namoi .. .. .. .. .. | MAC 5 | IO | 0.66 | 0.84 | 1.02 | 1.55 | 0.46 | 0.58 | 0.70 | 1.07 | 0.34 | 0.43 | 0.51 | 0.78 |
| | | IN | 0.55 | 0.69 | 0.83 | 1.26 | 0.38 | 0.48 | 0.57 | 0.87 | 0.28 | 0.35 | 0.42 | 0.64 |
| | | NN | 0.48 | 0.61 | 0.73 | 1.11 | 0.32 | 0.40 | 0.48 | 0.73 | 0.22 | 0.28 | 0.34 | 0.51 |
| Manning to Namoi .. .. .. .. .. | MAN 1 | IO | 0.64 | 0.81 | 0.98 | 1.49 | 0.44 | 0.56 | 0.67 | 1.03 | 0.32 | 0.41 | 0.49 | 0.75 |
| | | IN | 0.52 | 0.66 | 0.80 | 1.21 | 0.36 | 0.45 | 0.55 | 0.83 | 0.26 | 0.33 | 0.40 | 0.61 |
| | | NN | 0.46 | 0.58 | 0.70 | 1.07 | 0.30 | 0.38 | 0.46 | 0.70 | 0.21 | 0.27 | 0.32 | 0.49 |

*Table 9: Benefit Cost Ratios of Projects Diverting the Coastal Rivers into the Inland Streams of Northern New South Wales*—continued

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Discount Rate | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| | | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| *6 year construction—* | | | | | | | | | | | | | | |
| Clarence to Condamine and Culgoa | CLA 1 | IO | 0.62 | 0.95 | 1.28 | 2.28 | 0.42 | 0.64 | 0.87 | 1.54 | 0.30 | 0.46 | 0.63 | 1.11 |
| | | IN | 0.40 | 0.67 | 0.93 | 1.73 | 0.27 | 0.45 | 0.63 | 1.17 | 0.20 | 0.33 | 0.45 | 0.84 |
| | | NN | 0.36 | 0.60 | 0.83 | 1.54 | 0.23 | 0.39 | 0.54 | 1.00 | 0.16 | 0.27 | 0.37 | 0.69 |
| Clarence to Dumaresq and MacIntyre | CLA 7C | IO | 0.91 | 1.31 | 1.70 | 2.90 | 0.65 | 0.94 | 1.22 | 2.08 | 0.49 | 0.70 | 0.91 | 1.56 |
| | | IN | 0.68 | 1.01 | 1.35 | 2.36 | 0.48 | 0.72 | 0.95 | 1.67 | 0.36 | 0.53 | 0.71 | 1.24 |
| | | NN | 0.60 | 0.90 | 1.20 | 2.10 | 0.41 | 0.62 | 0.82 | 1.44 | 0.29 | 0.44 | 0.58 | 1.02 |
| Macleay to Gwydir | MAC 2A | IO | 0.55 | 0.70 | 0.84 | 1.28 | 0.37 | 0.47 | 0.57 | 0.86 | 0.27 | 0.34 | 0.41 | 0.62 |
| | | IN | 0.45 | 0.57 | 0.69 | 1.04 | 0.31 | 0.39 | 0.46 | 0.70 | 0.22 | 0.28 | 0.33 | 0.50 |
| | | NN | 0.40 | 0.50 | 0.61 | 0.92 | 0.26 | 0.32 | 0.39 | 0.59 | 0.18 | 0.22 | 0.27 | 0.40 |
| Macleay to Gwydir | MAC 2AE | IO | 0.54 | 0.68 | 0.83 | 1.26 | 0.36 | 0.46 | 0.56 | 0.85 | 0.26 | 0.33 | 0.40 | 0.61 |
| | | IN | 0.44 | 0.56 | 0.67 | 1.02 | 0.30 | 0.38 | 0.45 | 0.69 | 0.21 | 0.27 | 0.33 | 0.50 |
| | | NN | 0.39 | 0.49 | 0.59 | 0.90 | 0.25 | 0.32 | 0.38 | 0.58 | 0.17 | 0.22 | 0.26 | 0.40 |
| Macleay to Namoi | MAC 5 | IO | 0.65 | 0.82 | 0.99 | 1.51 | 0.44 | 0.55 | 0.67 | 1.00 | 0.31 | 0.40 | 0.48 | 0.73 |
| | | IN | 0.53 | 0.67 | 0.81 | 1.22 | 0.36 | 0.45 | 0.54 | 0.83 | 0.26 | 0.33 | 0.39 | 0.59 |
| | | NN | 0.47 | 0.59 | 0.71 | 1.08 | 0.30 | 0.38 | 0.46 | 0.70 | 0.21 | 0.26 | 0.31 | 0.48 |
| Manning to Namoi | MAN 1 | IO | 0.62 | 0.79 | 0.95 | 1.45 | 0.42 | 0.53 | 0.64 | 0.98 | 0.30 | 0.38 | 0.46 | 0.71 |
| | | IN | 0.51 | 0.64 | 0.77 | 1.17 | 0.34 | 0.43 | 0.52 | 0.79 | 0.25 | 0.31 | 0.38 | 0.57 |
| | | NN | 0.45 | 0.57 | 0.68 | 1.04 | 0.29 | 0.37 | 0.44 | 0.67 | 0.20 | 0.25 | 0.30 | 0.46 |

*Table 10: Internal Rates of Return of Projects Diverting the Coastal Rivers into the Inland Rivers of Northern N.S.W.*

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Yield or price ratio to existing prices or yields | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 1.1 | 1.2 | 1.5 |
| | | | per cent | per cent | per cent | per cent |
| *4 year construction—* | | | | | | |
| Clarence to Condamine and Culgoa . . | CLA 1 | IO | 1.00 | 2.90 | 4.45 | 8.27 |
| | | IN | -0.65 | 1.30 | 2.78 | 6.27 |
| | | NN | -0.82 | 1.00 | 2.32 | 5.25 |
| Clarence to Dumaresq and MacIntyre . . | CLA 7C | IO | 2.55 | 4.82 | 6.73 | 11.65 |
| | | IN | 1.04 | 3.21 | 4.95 | 9.28 |
| | | NN | 0.57 | 2.59 | 4.11 | 7.54 |
| Macleay to Gwydir . . . . . . | MAC 2A | IO | 0.53 | 1.49 | 2.32 | 4.44 |
| | | IN | -0.20 | 0.68 | 1.43 | 3.34 |
| | | NN | -0.43 | 0.39 | 1.07 | 2.75 |
| Macleay to Gwydir . . . . . . | MAC 2AE | IO | 0.45 | 1.41 | 2.24 | 4.35 |
| | | IN | -0.15 | 0.74 | 1.50 | 3.43 |
| | | NN | -0.50 | 0.31 | 1.00 | 2.68 |
| Macleay to Namoi . . . . . . | MAC 5 | IO | 1.17 | 2.19 | 3.09 | 5.39 |
| | | IN | 0.40 | 1.33 | 2.13 | 4.18 |
| | | NN | 0.13 | 0.98 | 1.70 | 3.47 |
| Manning to Namoi . . . . . . | MAN 1 | IO | 0.99 | 2.01 | 2.89 | 5.17 |
| | | IN | 0.22 | 1.15 | 1.94 | 3.97 |
| | | NN | -0.03 | 0.82 | 1.53 | 3.29 |
| *6 year construction—* | | | | | | |
| Clarence to Condamine and Culgoa . . | CLA 1 | IO | 0.96 | 2.77 | 4.23 | 7.72 |
| | | IN | -0.63 | 1.26 | 2.67 | 5.91 |
| | | NN | -0.79 | 0.96 | 2.24 | 5.00 |
| Clarence to Dumaresq and MacIntyre . . | CLA 7C | IO | 2.46 | 4.59 | 6.36 | 10.71 |
| | | IN | 1.01 | 3.08 | 4.71 | 8.64 |
| | | NN | 0.55 | 2.50 | 3.94 | 7.14 |
| Macleay to Gwydir . . . . . . | MAC 2A | IO | 0.51 | 1.43 | 2.23 | 4.22 |
| | | IN | -0.19 | 0.65 | 1.38 | 3.18 |
| | | NN | -0.41 | 0.37 | 1.03 | 2.64 |
| Macleay to Gwydir . . . . . . | MAC 2AE | IO | 0.43 | 1.35 | 2.15 | 4.13 |
| | | IN | -0.27 | 0.58 | 1.30 | 3.10 |
| | | NN | -0.49 | 0.30 | 0.96 | 2.57 |
| Macleay to Namoi . . . . . . | MAC 5 | IO | 1.13 | 2.10 | 2.95 | 5.09 |
| | | IN | 0.38 | 1.28 | 2.04 | 3.98 |
| | | NN | 0.12 | 0.95 | 1.64 | 3.33 |
| Manning to Namoi . . . . . . | MAN 1 | IO | 0.96 | 1.93 | 2.76 | 4.89 |
| | | IN | 0.22 | 1.10 | 1.87 | 3.78 |
| | | NN | -0.03 | 0.79 | 1.48 | 3.16 |

*Table* 11: *Net Present Values of Projects Diverting the Coastal Rivers into the Inland Rivers of Northern New South Wales*

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Discount Rate: 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| | | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| | | | million dollars | | | | million dollars | | | | million dollars | | | |
| *4 year construction—* | | | | | | | | | | | | | | |
| Clarence to Condamine and Culgoa .. .. .. | CLA 1 | IO | 39.0 | -2.3 | 34.2 | 144.0 | -63.2 | -36.7 | -10.3 | 69.1 | -80.1 | -59.6 | 39.3 | 21.9 |
| | | IN | -63.5 | -33.9 | -4.7 | 83.8 | 81.1 | -59.7 | -38.6 | 25.4 | -94.0 | -77.5 | 61.2 | -11.9 |
| | | NN | -67.1 | 41.0 | 15.3 | 62.5 | -84.0 | -66.0 | -48.3 | 5.3 | 96.2 | -83.1 | -70.1 | -30.9 |
| Clarence to Dumaresq and MacIntyre .. .. .. | CLA 7C | IO | 74.5 | 339.5 | 749.8 | 1,987.5 | -325.8 | -26.7 | 270.4 | 1,165.6 | -493.2 | -262.8 | -33.9 | 655.7 |
| | | IN | 298.4 | 35.7 | 364.2 | 1,360.9 | -487.2 | -245.6 | -8.0 | 713.0 | -617.2 | -431.1 | -248.0 | 307.4 |
| | | NN | 365.8 | -71.9 | 217.0 | 1,093.7 | -538.3 | -335.7 | -136.4 | 468.1 | -656.1 | -507.8 | -362.0 | 80.4 |
| Macleay to Gwydir .. .. | MAC 2A | IO | -88.3 | -57.6 | -27.1 | 64.7 | -130.4 | -108.2 | 86.2 | -19.8 | -160.2 | -143.1 | -126.1 | -75.0 |
| | | IN | -108.8 | -84.1 | -59.7 | 14.3 | -145.4 | 127.4 | -109.8 | -56.3 | -171.8 | -158.0 | -144.4 | -103.2 |
| | | NN | -119.5 | -97.7 | -76.3 | -11.2 | -155.2 | -140.2 | -125.4 | -80.6 | -180.9 | -169.9 | -159.1 | -126.3 |
| Macleay to Gwydir .. .. | MAC 2AE | IO | -119.7 | -79.7 | -40.0 | 79.7 | 174.4 | -145.5 | -116.7 | -30.2 | -213.2 | -190.9 | -168.8 | -102.1 |
| | | IN | -136.9 | -104.6 | -72.8 | 23.6 | 184.0 | 160.6 | -137.6 | -67.9 | -218.0 | -200.4 | -182.3 | -128.6 |
| | | NN | -160.2 | -131.8 | -103.8 | -19.1 | 206.6 | 187.0 | -167.7 | -109.3 | -240.0 | 225.7 | -211.6 | -168.8 |
| Macleay to Namoi .. .. | MAC 5 | IO | -22.8 | -10.8 | 1.2 | 37.3 | 38.7 | -30.0 | -21.3 | 4.8 | -49.7 | -43.0 | -36.3 | -16.2 |
| | | IN | -30.8 | -21.1 | -11.6 | 17.5 | -44.6 | 37.5 | -30.6 | -9.6 | 54.3 | 48.8 | -43.5 | -27.3 |
| | | NN | -35.0 | -26.4 | -18.0 | 7.5 | 18.4 | -42.5 | 36.7 | 19.1 | 57.8 | 53.5 | -49.3 | -36.4 |
| Manning to Namoi .. .. | MAN 1 | IO | -47.7 | 25.0 | 2.9 | 64.7 | -77.4 | -60.9 | -45.0 | 3.9 | -98.1 | -85.4 | -73.1 | 35.4 |
| | | IN | 62.7 | -44.6 | -26.7 | 27.4 | 88.3 | 75.2 | 62.3 | -23.1 | -106.6 | -96.4 | 86.5 | -56.3 |
| | | NN | -70.4 | 54.5 | -38.8 | 8.8 | -95.4 | -84.4 | -73.6 | -40.8 | -113.1 | -105.1 | -97.1 | -73.1 |

*Table* 11: *Net Present Values of Projects Diverting the Coastal Rivers into the Inland Rivers of Northern New South Wales*—continued

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Discount Rate: 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| | | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| | | | million dollars | | | | million dollars | | | | million dollars | | | |
| *6 year construction*— | | | | | | | | | | | | | | |
| Clarence to Condamine and Culgoa . . . . . . | CLA 1 | IO | - 42.0 | - 5.3 | 31.2 | 141.0 | 68.6 | - 42.0 | - 15.6 | 63.8 | - 88.0 | - 67.6 | - 47.3 | 13.9 |
| | | IN | - 66.5 | - 36.9 | 7.7 | 80.7 | - 86.5 | - 65.0 | - 43.9 | 20.1 | - 101.9 | - 85.4 | - 69.2 | - 19.9 |
| | | NN | - 70.1 | - 44.0 | - 18.3 | 59.5 | 89.3 | - 71.3 | - 53.7 | 0 | - 104.2 | - 91.0 | - 78.1 | 38.8 |
| Clarence to Dumaresq and MacIntyre . . . . . . | CLA 7C | IO | 96.2 | 317.3 | 728.1 | 1,965.8 | - 364.3 | - 65.2 | 231.9 | 1,127.1 | - 550.6 | 320.1 | - 91.2 | 598.4 |
| | | IN | - 320.1 | 14.0 | 342.5 | 1,339.2 | - 525.7 | - 284.1 | - 46.5 | 674.5 | 674.6 | - 488.4 | 305.4 | 250.0 |
| | | NN | - 374.5 | - 93.6 | 195.3 | 1,072.0 | - 576.8 | - 374.2 | - 174.9 | 429.6 | - 713.5 | - 565.2 | - 419.4 | 23.0 |
| Macleay to Gwydir . . . . | MAC 2A | IO | 94.3 | - 63.6 | - 33.1 | 58.7 | - 141.0 | - 118.8 | - 96.8 | - 30.4 | 176.0 | - 158.9 | - 141.9 | - 90.8 |
| | | IN | - 114.8 | 90.0 | - 65.6 | 8.3 | 156.0 | - 138.1 | - 120.4 | 67.0 | - 187.6 | - 173.8 | - 160.2 | - 119.0 |
| | | NN | - 126.5 | - 103.7 | - 82.2 | - 17.2 | - 165.8 | - 150.8 | - 136.0 | 91.2 | - 196.7 | 185.7 | - 174.9 | 142.1 |
| Macleay to Gwydir . . . . | MAC 2AE | IO | - 127.6 | - 87.6 | 47.9 | 71.8 | - 188.4 | 159.5 | - 130.8 | - 44.2 | - 234.0 | - 211.8 | - 189.6 | - 123.0 |
| | | IN | - 154.3 | 122.0 | - 90.3 | 6.1 | - 207.9 | - 184.5 | 161.6 | - 91.9 | - 249.2 | 231.2 | - 213.5 | 159.8 |
| | | NN | - 168.1 | - 139.7 | - 111.7 | 27.0 | - 220.6 | - 201.0 | 181.7 | - 123.3 | 261.0 | - 246.6 | - 232.5 | - 189.7 |
| Macleay to Namoi . . . . | MAC 5 | IO | - 24.8 | 12.7 | - 0.8 | 35.3 | 42.2 | - 33.5 | - 24.8 | 1.2 | - 55.0 | - 48.3 | - 41.6 | - 21.5 |
| | | IN | - 32.8 | 23.1 | - 13.5 | 15.5 | - 48.1 | - 41.0 | 34.1 | - 13.1 | 59.5 | - 54.1 | - 48.8 | 32.6 |
| | | NN | 37.0 | - 28.4 | - 20.0 | 5.5 | - 51.9 | 46.0 | - 40.2 | - 22.6 | - 63.1 | - 58.8 | - 54.5 | 41.6 |
| Manning to Namoi . . . . | MAN 1 | IO | - 51.6 | - 28.9 | - 6.8 | 60.8 | - 84.2 | - 67.8 | - 51.8 | 2.9 | - 108.2 | - 95.5 | 83.2 | - 45.6 |
| | | IN | - 66.6 | 48.4 | - 30.6 | 23.5 | - 95.1 | - 82.0 | 69.1 | - 29.9 | - 116.7 | 106.6 | 96.6 | - 66.5 |
| | | NN | - 74.3 | 58.3 | - 42.6 | 5.0 | - 102.2 | - 91.2 | 80.4 | - 47.6 | - 123.3 | - 115.2 | - 107.3 | 83.3 |

*Table* 12: *Benefit Cost Ratios of Projects Diverting the Coastal Rivers into the Inland Rivers of Southern New South Wales*

| W.R.C. Diversion Scheme | | Water Uptake and Usage | Discount Rate | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| Name | No. | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| *4 year construction—* | | | | | | | | | | | | | | |
| Snowy to Upper Murray .. .. | SNO 4 | IO | 0.30 | 0.67 | 0.81 | 1.57 | 0.21 | 0.46 | 0.56 | 1.09 | 0.15 | 0.34 | 0.41 | 0.81 |
| | | IN | 0.07 | 0.29 | 0.39 | 0.88 | 0.05 | 0.20 | 0.27 | 0.62 | 0.03 | 0.15 | 0.20 | 0.46 |
| | | NN | 0.07 | 0.26 | 0.36 | 0.80 | 0.04 | 0.18 | 0.24 | 0.54 | 0.03 | 0.12 | 0.17 | 0.38 |
| Tuross to Murrumbidgee .. .. | TUR 2 | IO | 0.52 | 0.69 | 0.76 | 1.12 | 0.36 | 0.48 | 0.52 | 0.77 | 0.26 | 0.35 | 0.38 | 0.57 |
| | | IN | 0.28 | 0.33 | 0.38 | 0.52 | 0.19 | 0.23 | 0.26 | 0.36 | 0.14 | 0.17 | 0.19 | 0.26 |
| | | NN | 0.25 | 0.29 | 0.33 | 0.46 | 0.16 | 0.19 | 0.22 | 0.30 | 0.12 | 0.13 | 0.15 | 0.21 |
| *6 year construction—* | | | | | | | | | | | | | | |
| Snowy to Upper Murray .. .. | SNO 4 | IO | 0.30 | 0.65 | 0.79 | 1.54 | 0.20 | 0.44 | 0.54 | 1.06 | 0.14 | 0.32 | 0.39 | 0.77 |
| | | IN | 0.07 | 0.28 | 0.39 | 0.86 | 0.04 | 0.19 | 0.26 | 0.59 | 0.03 | 0.14 | 0.19 | 0.43 |
| | | NN | 0.06 | 0.26 | 0.35 | 0.78 | 0.04 | 0.17 | 0.23 | 0.52 | 0.03 | 0.12 | 0.16 | 0.36 |
| Tuross to Murrumbidgee .. .. | TUR 2 | IO | 0.51 | 0.67 | 0.74 | 1.09 | 0.34 | 0.46 | 0.50 | 0.74 | 0.25 | 0.33 | 0.36 | 0.53 |
| | | IN | 0.27 | 0.32 | 0.37 | 0.51 | 0.19 | 0.22 | 0.25 | 0.34 | 0.13 | 0.16 | 0.18 | 0.25 |
| | | NN | 0.24 | 0.28 | 0.33 | 0.45 | 0.16 | 0.18 | 0.21 | 0.29 | 0.11 | 0.13 | 0.14 | 0.20 |

*Table* 13: *Internal Rates of Return of Projects Diverting the Coastal Rivers into the Inland Rivers of Southern N.S.W.*

| W.R.C. Diversion Scheme Name | W.R.C. Scheme No. | Water Uptake and Usage | Yield or price ratio to existing prices or yields | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 1.1 | 1.2 | 1.5 |
| | | | per cent | per cent | per cent | per cent |
| *4 year construction—* | | | | | | |
| Snowy to Upper Murray .. | SNO 4 | IO | - 1.537 | 1.164 | 1.999 | 5.560 |
| | | IN | - 5.123 | - 1.898 | - 0.884 | 2.377 |
| | | NN | - 5.246 | - 2.064 | - 1.057 | 1.976 |
| Tuross to Murrumbidgee .. | TUR 2 | IO | 0.202 | 1.320 | 1.717 | 3.553 |
| | | IN | - 1.934 | - 1.428 | - 0.973 | 0.183 |
| | | NN | - 2.075 | - 1.591 | - 1.157 | - 0.072 |
| *6 year construction—* | | | | | | |
| Snowy to Upper Murray .. | SNO 4 | IO | - 1.507 | 1.132 | 1.940 | 5.322 |
| | | IN | - 5.054 | - 1.059 | - 0.864 | 2.300 |
| | | NN | - 5.185 | - 2.034 | - 1.045 | 1.902 |
| Tuross to Murrumbidgee .. | TUR 2 | IO | 0.196 | 1.275 | 1.657 | 3.403 |
| | | IN | - 1.880 | - 1.387 | - 0.943 | 0.177 |
| | | NN | - 2.020 | - 1.547 | - 1.124 | - 0.070 |

*Table* 14: *Net Present Values of Projects Diverting the Coastal Rivers into the Inland Rivers of Southern N.S.W.*

| W.R.C. Diversion Scheme | | Water Uptake and Usage | Discount Rate | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3 per cent | | | | 5 per cent | | | | 7 per cent | | | |
| | | | Yield or price ratio to existing yields or prices | | | | | | | | | | | |
| Name | No. | | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 | 1 | 1.1 | 1.2 | 1.5 |
| *4 year construction—* | | | | | | | | | | | | | | |
| Snowy to Upper Murray .. | SNO 4 | IO | -130.9 | -62.7 | 35.8 | -106.9 | -153.9 | -104.6 | -85.1 | -18.1 | -170.6 | -132.6 | -117.6 | -38.0 |
| | | IN | -169.4 | -130.0 | -110.3 | -21.6 | -179.1 | -150.3 | -136.4 | -72.1 | -187.8 | -165.6 | -154.9 | -105.4 |
| | | NN | -165.9 | -130.9 | -113.5 | -35.8 | -172.8 | -148.7 | -136.7 | -83.1 | -179.0 | -161.4 | -152.6 | -113.4 |
| Tuross to Murrumbidgee .. | TUR 2 | IO | -16.6 | -10.7 | -8.4 | 4.0 | -23.1 | -18.8 | -17.1 | -8.2 | -27.6 | -24.4 | -23.1 | -16.2 |
| | | IN | -22.7 | -21.2 | -20.0 | -15.2 | -26.6 | -25.5 | -24.4 | -21.2 | -29.6 | -28.8 | -27.9 | -25.4 |
| | | NN | -23.6 | -22.2 | -20.9 | -16.9 | -27.4 | -26.4 | -25.5 | -22.8 | -30.2 | -29.6 | -28.9 | -26.9 |
| *6 year construction—* | | | | | | | | | | | | | | |
| Snowy to Upper Murray .. | SNO 4 | IO | -134.8 | -66.6 | -39.7 | 103.0 | -160.8 | -111.5 | -92.0 | 11.2 | -180.9 | -142.9 | -127.9 | -48.4 |
| | | IN | -173.3 | -133.6 | -114.2 | -25.5 | -186.0 | -157.2 | -143.3 | -79.0 | -198.1 | -176.0 | -165.2 | -115.7 |
| | | NN | -170.5 | -135.5 | -118.0 | -40.4 | -180.5 | -156.3 | -144.3 | -90.8 | -190.1 | -172.5 | -163.7 | -124.5 |
| Tuross to Murrumbidgee .. | TUR 2 | IO | -17.5 | -11.6 | -9.2 | 3.1 | -24.7 | -20.4 | -18.7 | -9.8 | -30.0 | -26.7 | -25.4 | -18.6 |
| | | IN | -23.6 | -22.1 | -20.5 | -16.0 | -28.2 | -27.1 | -26.0 | -22.7 | -32.0 | -31.1 | -30.3 | -27.8 |
| | | NN | -24.5 | -23.1 | -21.8 | -17.8 | -28.9 | -28.0 | -27.1 | -24.4 | -32.6 | -31.9 | -31.3 | -29.3 |

## 9. Conclusion

A preliminary examination of the diversionary projects for N.S.W. coastal rivers suggests that none of them could be justified on economic grounds with the existing prices of resources and commodities using existing technologies if water is to be supplied on the basis of 100 per cent reliability in all years. Benefit cost ratios are certainly depressed by limiting irrigation to the area which could be supplied with water in all years. If diversion schemes were designed on the basis of average yield, rather than the safe yield which can be supplied every year, it would be possible to make a more reliable evaluation of their economic potential.

Further investigation into the diversion of projects with higher benefit cost ratios, particularly the diversion of the Clarence into the Dumaresq and MacIntyre Rivers, assuming a less than 100 per cent reliability of water supply, should yield better returns. Even so, this project only has an internal rate of return of 0.57 per cent, using the more realistic assumptions concerning the rate of uptake and water usage. Yields or prices would have to increase by 50 per cent and not be absorbed by increases in the price of inputs to be great enough to raise the rate of return to equal the opportunity cost of capital of 7 per cent. Satisfactory returns would also be entirely dependent on cotton remaining an extremely profitable crop. In addition, if losses are sustained, they are likely to be greater from this project than from other projects because of the large amount of capital required to construct it.

## Appendix I

Gross margins for various farming activities have been calculated by the Victorian Department of Agriculture, N.S.W. Department of Agriculture and the University of New England (Penman 1981; Earle 1982; Bailey and Buffier 1982). The results of these calculations, which are shown in Table 6, are used as a basis for estimating the net benefits from irrigation and the net benefits foregone from a decrease in dry-land farming.

The only adjustments which have been made are as follows:

(a) The price of cotton has been reduced from $310 per bale to $300 per bale, the average price prevailing at present.

(b) As any additional milk produced would be used for manufactured milk products which would be exported, the appropriate price to use for milk is the price farmers would receive from exported milk products. At present this is estimated by the B.A.E. at $2.90 per kg of butterfat. However, it is expected to decline. In 1980–81 the price paid to farmers was $2.10 per kg (Yearbook of Australia 1981). In view of the large changes in butterfat prices, gross margins and benefit cost ratios were calculated assuming farmers received a basic price of $2.50 per kg of butterfat for milk.

(c) The price of lucerne hay varies greatly with demand. In the past three years it has ranged from $40 to $150 per ton. The long term average price of $80 per ton was used in calculating the gross margin of this activity.

(d) To measure the long term effects of changing prices and yields, returns were also calculated assuming 10, 20 and 50 per cent increases above the existing levels.

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