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# EVALUATION OF TILE DRAINAGE OF IRRIGATED LAND: MARGINALIA AND SUSTAINABILITY

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Tile drainage protects and enhances soil quality. Investment in this technology may be economic depending on the magnitude of value marginal product relative to project costs. Where existing gross margin is already sufficient to cover fixed costs, additional short run value marginal product is available to finance investment. If pressures for structural adjustment arise, or a large proportion of farm area must be drained, the use of long run value marginal product (net margin) becomes increasingly appropriate and investment breaks even only at higher levels of degradation. Sensitivity of sustained investment to various factors is discussed.

## *Introduction*

*Salt Action:Joint Action* is a Government strategy for improving salinity management in Victoria. Salinity Management Plan (SMP) evaluation involves consideration of the economic, environmental and social accounts of management proposals jointly developed by the regional community and government agencies. Government assistance is generally limited to a cost share of projects that will be profitable in economic terms. Uneconomic projects are not funded unless significant non-market valued social or environmental benefits are expected.

Sub-surface drainage is essential for adequate leaching of salts to avoid or reduce soil salinisation. Where there are persistent high water tables root zone dewatering is necessary to protect or enhance plant productivity. In irrigation areas, groundwater pumping, with or without conjunctive use of pump effluent with irrigation water, is usually the most cost effective solution if suitable shallow aquifers exist. While groundwater pumping is the preferred option in SMP's, there are areas with high watertables where the stratigraphy is unsuitable for pumping. In these areas tile drainage, although more expensive, may be an economic alternative. In this ancient technology, porous pipe drains are sunk 1.5 to 2 metres below the soil surface to lead effluent to a disposal drain or pumping pit. Consequent lowering of the watertable between the drains provides restoration of previous productivity and protection against future losses.

This paper looks at procedures for estimating project benefits when developing a planning option in the Campaspe West sub-region in Northern Victoria and discusses issues arising when setting the appropriate level of costs to include in a benefit:cost analysis framework. Benefits and costs are estimated in 1989 dollars.

A trial on part of a dairy farm had demonstrated the practical usefulness of tile drainage for watertable control in Campaspe West (Dickinson, 1987). Productivity of the drained area was not measured separately and the benefits were

unquantified so no detailed economic or financial assessment of that project was possible (Stent 1989). Option evaluation for management planning purposes was based on the expected average levels of productivity assumed for the "with plan" and "without plan" scenarios.

## *Estimation of Benefits*

The most basic assumption in the estimation of benefits regards the expected non-salinised productivity in the non-intervention scenario. In this analysis it is assumed to be constant. This assumption disallows inclusion of benefits due to increased efficiencies arising from improved management and technological change. It has been strongly argued that this approach underestimates project benefits (Dwyer Leslie, 1989).

1. Water Use Efficiency (WUE)

As tile drainage affects soil quality,the appropriate unit of productivity is pasture water use efficiency. This is proxied as kg butterfat per Ml of total water use (or effective rainfall plus irrigation). Adjustments to observed butterfat is made to allow for other feed sources and other pasture based production to estimate pasture based butterfat production. The WUE of 23 kg fat/ML imputed from 1982/83 survey data for Campaspe West (Gyles 1992a) was adjusted upward to 26 kg fat/Ml consistent with the view that WUE of salt affected farms in 1982/3 was 88% of that obtained on non salt-affected farms (Anon 1984, Sayer 1986). This is the same WUE achieved at Girgarre after implementation of sub-surface drainage (Gyles and Young 1991).

2. Total Water Use

Water use intensity should be as high as possible, consistent with maintaining productivity, if the cost of tile drainage per unit of butterfat output is to be minimised. Total water use of 13.5 Ml/ha is assumed (effective rainfall plus irrigation).

3. Existing and Projected Future Relative Productivity

Values are the same as those assumed for the groundwater pumping evaluation in the plan (Shaw 1989), but a fall to 65% by year eight and thereafter is assumed for the non intervention scenario. The rate of reclamation implied is that outlined for the lighter soils in the area by the Rural Water Corporation (RWC)(Shaw, 1992). Recovery on heavier soils may be slower, but the discussion on leaching rates in Lyle and Wildes (1986) suggests that equilibrium salinity profiles should be established after about 20 irrigations. The present analysis assumes the same level of inputs is maintained on salt affected land so the cost of fairly rapid leaching is covered in the analysis.

4. Price of Butterfat

The economic price of butterfat set by the Salinity Economics Working Group, Government of Victoria was used. $3.20 /kg.

### *Project Costs*

1. Discount Rate

4%. over 30 years. No allowance for residual values.

2. Capital Cost

Estimated by RWC. $2966/ha.

3. Operating and maintenance

$56.5/ha.

4. Pasture Establishment

No allowance. Pasture establishment costs are presumed to be unnecessary or already included in relayout costs in projects aimed at improving irrigation efficiency (landforming).

5. Effluent Disposal Cost

No allowance.

6. Variable cost

No allowance. Expected to be incurred without regard to salinity status or pasture performance.

## *RESULTS AND DISCUSSION*

The analysis work sheet is shown in Appendix 1. Results are summarised in Table 1. Tile drainage is economic under the assumptions used in the analysis. The positive NPV could be used for disposal cost. The project remains economic if costs are increased by 10% or without plan productivity drops only to 75% of potential.

Table 1: Net Present Value and Internal Rate of Return using Economic Prices and different assumptions.

| | ECONOMIC | |
|---|---|---|
| | NPV $/ha | IRR % |
| As analysed | 1411 | 7 |
| Without plan 75% | 11 | 4 |
| 10% cost increase | 1028 | 6 |

It is important to note this evaluation is carried out in terms of changes in gross value. That is, the overriding assumption in this analysis is that the current total gross margin for the farm is adequate to cover operator's allowance and the necessary overhead and long run sustainability costs such as depreciation. Where this is the case all project benefits are available to fund project costs. For the costs, prices and productivities assumed, tile drainage is economic on fully irrigated land when the loss due to high water tables in the non intervention scenario exceeds approximately 25% of current productivity. Even where the level of loss exceeds the economic threshold, the prospect of shifting water and other mobile inputs to land where the salinity loss is less than the economic threshold should be examined.

Although tile drainage is economic at the margin defined above, after a certain proportion of the area of an existing farm is degraded, the gross margin from the remaining undegraded land may not meet fixed overheads and other long run costs. When this point is reached, the farm will may longer be self-sustaining unless there is sufficient surplus from tile drainage projects to make up the shortfall. The inclusion of only 10% of average per hectare farm costs (VDIA 1989 cost of production data) is not sustainable (Appendix 3) Successful investment in higher productivity or structural adjustment will then necessary. That is while tile drainage will provide an environment where investment in higher productivity will be protected, it will not, of itself, guarantee financial viability. Thus proposed farm tile drainage projects should be evaluated in the light of the circumstances which apply in each case.

If farmers are already withdrawing inputs from salt affected land in proportion to the decline in pasture productivity, some variable costs must be included in the project. If 35% of variable costs/Ml total water use are included NPV/ha falls by $2451 (Appendix 2).

Should a contribution to variable, overhead and other farm capital costs equivalent to 20% of that made by undegraded land be necessary, Appendix 4 shows that investment will only be as profitable the base case when productivity in the non-intervention scenario will fall to 45% of potential.

Water resource management authorities are committed to real increases in irrigation water prices to increase revenue to meet costs. Where variable costs

must be funded from tile drained land, increasing water prices will result in reduced profitability. Even where only 20% of variable costs must be funded, a rise in water price from $15/Ml to $50/Ml means that the project can only be as profitable if productivity is expected to fall from 45% to 37%. A policy for increased water prices is a policy for increased degradation *ceteris paribus*.

### *W(h)ither Productivity?*

One solution to the dilemmas outlined above is increased productivity. In the field there are expectations that WUE can be increased. Empirical evidence suggests that WUE of 35 kg fat/Ml total water use are achievable. However these results have been achieved at the cost of the increased level of management associated with experimental sized plots noted by Davidson and Martin (1967). On the water supply side the potential for increased productivity can only be guessed, but the work of Harberger (1954) suggests that water resource economists should turn their attention to measuring and seeking improvements in operational efficiency rather than considering allocative efficiency alone. This is particularly so where water markets already exist to encourage efficient allocation.

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APPENDIX 1: COSTS AND BENEFITS OF TILE DRAINAGE OF DAIRY PASTURE AT CANPASPE WEST.

| PRICE $ | POT YIELD kg/ha | POT VALUE $/ha | MJE kg/ML | TOTWATUS ML/HA | IRRN ML/HA | VAR COST $/ML | CASH OP $/ML | LABOUR $/ha | DEP $/ha | GM/MLI $/ML | GM/MLT $/ML |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.20 | 351 | 1123 | 26 | 13.5 | 10 | 0 | 0 | 0 | 0 | | |
| | | | 1 | | | 0 | 0 | 0 | 0 | | |

| YR | CAP | O&M | VAR | CASHO | LAB | CAP | TOT COST | WITH PROJ PROD | WITH PROJ YIELD | W/O PROJ PROD | W/O PROJ YIELD | PROJ BEN | NET PROJ BEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2966 | 57 | 0 | 0 | 0 | 0 | 3023 | 85% | 298 | 85% | 298 | 0 | -3023 |
| 2 | | 57 | 0 | 0 | 0 | 0 | 57 | 90% | 316 | 82% | 288 | 90 | 33 |
| 3 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 79% | 277 | 202 | 146 |
| 4 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 76% | 267 | 236 | 179 |
| 5 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 73% | 256 | 270 | 213 |
| 6 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 70% | 246 | 303 | 247 |
| 7 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 67% | 235 | 337 | 280 |
| 8 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 9 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 10 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 11 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 12 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 13 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 14 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 15 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 16 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 17 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 18 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 19 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 20 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 21 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 22 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 23 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 24 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 25 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 26 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 27 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 28 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 29 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| 30 | | 57 | 0 | 0 | 0 | 0 | 57 | 97% | 340 | 65% | 228 | 359 | 303 |
| | | | | | | | | | | | | | 1411 |
| | | | | | | | | | | | | | 0.07 |

APPENDIX 2: COSTS AND BENEFITS OF TILE DRAINAGE OF DAIRY PASTURE AT CAMPASPE WEST.

| PRICE $ | POT YIELD kg/ha | POT VALUE $/ha | WUE kg/ML | TOTWATUS ML/HA | IRRN ML/HA | VAR COST $/ML | CASH OP $/ML | LABOUR $/ha | DEP $/ha | GM/ML1 $/ML | GM/ML2 $/ML |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.20 | 351 | 1123 | 26 | 13.5 | 10 | 11 | 0 | 0 | 0 | | |
| | | | 1 | | | 0.35 | 0 | 0 | 0 | | |

| YR | CAP | O&M | VAR | CASH0 | LAB | CAP | TOT COST | WITH PROJ PROD | WITH PROJ YIELD | W/O PROJ PROD | W/O PROJ YIELD | PROJ BEN | NET PROJ BEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2966 | 57 | 142 | 0 | 0 | 0 | 3164 | 85% | 298 | 85% | 298 | 0 | -3164 |
| 2 | | 57 | 142 | 0 | 0 | 0 | 198 | 90% | 316 | 82% | 288 | 90 | -108 |
| 3 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 79% | 277 | 202 | 4 |
| 4 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 76% | 267 | 236 | 38 |
| 5 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 73% | 256 | 270 | 71 |
| 6 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 70% | 246 | 303 | 105 |
| 7 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 67% | 235 | 337 | 139 |
| 8 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 9 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 10 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 11 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 12 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 13 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 14 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 15 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 16 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 17 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 18 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 19 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 20 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 21 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 22 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 23 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 24 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 25 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 26 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 27 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 28 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 29 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| 30 | | 57 | 142 | 0 | 0 | 0 | 198 | 97% | 340 | 65% | 228 | 359 | 161 |
| | | | | | | | | | | | | | +1040 |
| | | | | | | | | | | | | | 0.01 |

APPENDIX 3: COSTS AND BENEFITS OF TILE DRAINAGE OF DAIRY PASTURE AT CAMPASPE WEST.

| | PRICE $ | POT YIELD kg/ha | POT VALUE $/ha | WUE kg/ML | TOTWATUS ML/HA | IRRN ML/HA | VAR COST $/ML | CASH OP $/ML | LALAYOU $/ha | DEP $/ha | GM/MLI $/ML | GM/MLT $/ML |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.7 | 351 | 1123 | 26 | 13.5 | 10 | 3 | 2 | 1 | 8 | 5 | |
| | | | | 1 | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | |

| YR | CAP | O&M | VAR | CASHO | LAB | CAP | TOT COST | WITH PROJ PROD | WITH PROJ YIELD | W/O PROJ PROD | W/O PROJ YIELD | PROJ BEN | NET PROJ BEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2966 | 57 | 41 | 22 | 17 | 13 | 3115 | 85% | 298 | 85% | 298 | 0 | *3115 |
| 2 | | 57 | 41 | 22 | 17 | 13 | 149 | 90% | 316 | 82% | 288 | 90 | *59 |
| 3 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 79% | 277 | 202 | 53 |
| 4 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 76% | 267 | 236 | 87 |
| 5 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 73% | 256 | 270 | 120 |
| 6 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 70% | 246 | 303 | 154 |
| 7 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 67% | 235 | 337 | 188 |
| 8 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 9 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 10 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 11 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 12 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 13 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 14 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 15 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 16 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 17 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 18 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 19 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 20 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 21 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 22 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 23 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 24 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 25 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 26 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 27 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 28 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 29 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| 30 | | 57 | 41 | 22 | 17 | 13 | 149 | 97% | 340 | 65% | 228 | 359 | 210 |
| | | | | | | | | | | | | | *192 |
| | | | | | | | | | | | | | 0.04 |

APPENDIX 41 COSTS AND BENEFITS OF TILE DRAINAGE OF DAIRY PASTURE AT CAMPASPE WEST.

| PRICE $ | POT YIELD kg/ha | POT VALUE $/ha | WUE kg/ML | TOTWATUS ML/HA | IRRN ML/HA | VAR COST $/ML | CASH OP $/ML | LALAYOU $/ha | DEP $/ha | GM/ML I $/ML | GM/ML T $/ML |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.20 | 331 | 1123 | 24 | 13.5 | 10 | 6 | 3 | 3 | 17 | 10 | |
| | | | 1 | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | |

| YR | CAP | O&M | VAR | CASHO | LAB | CAP | TOT COST | WITH PROJ PROD | WITH PROJ YIELD | W/O PROJ PROD | W/O PROJ YIELD | PROJ BEN | NET PROJ BEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2966 | 57 | 81 | 43 | 34 | 27 | 3208 | 85% | 296 | 85% | 296 | 0 | -3208 |
| 2 | | 47 | 81 | 43 | 34 | 27 | 242 | 90% | 316 | 79% | 277 | 124 | -118 |
| 3 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 73% | 256 | 270 | 28 |
| 4 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 67% | 235 | 337 | 95 |
| 5 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 61% | 214 | 404 | 162 |
| 6 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 55% | 193 | 472 | 230 |
| 7 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 49% | 172 | 539 | 297 |
| 8 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 9 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 10 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 11 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 12 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 13 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 14 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 15 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 16 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 17 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 18 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 19 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 20 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 21 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 22 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 23 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 24 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 25 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 26 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 27 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 28 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 29 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| 30 | | 57 | 81 | 43 | 34 | 27 | 242 | 97% | 340 | 45% | 158 | 584 | 342 |
| | | | | | | | | | | | | | 1316 |
| | | | | | | | | | | | | | 0.07 |

APPENDIX 5: COSTS AND BENEFITS OF TILE DRAINAGE OF DAIRY PASTURE AT CAMPASPE WEST.

| PRICE $ | POT YIELD kg/ha | POT VALUE $/ha | WUE kg/ML | TOTWATUS ML/HA | IRRN ML/HA | VAR COST $/ML | CASH OP $/ML | LABOU $/ML | LAYOU $/ha | DEP $/ha | GM/MLI $/ML | GM/MLT $/ML |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.20 | 351 | 1123 | 26 | 13.5 | 10 | 11 | 3 | 3 | 17 | 10 | | |
| | | | 1 | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | | |

| YR | CAP | O&M | VAR | CASHO | LAB | CAP | TOT COST | WITH PROJ PROD | WITH PROJ YIELD | W/O PROJ PROD | W/O PROJ YIELD | PROJ BEN | NET PROJ BEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2966 | 57 | 151 | 43 | 34 | 27 | 3278 | 85% | 298 | 85% | 298 | 0 | -3278 |
| 2 | | 57 | 151 | 43 | 34 | 27 | 312 | 90% | 316 | 78% | 273 | 137 | -175 |
| 3 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 71% | 248 | 297 | -15 |
| 4 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 63% | 223 | 377 | 66 |
| 5 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 56% | 197 | 458 | 146 |
| 6 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 49% | 172 | 539 | 227 |
| 7 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 42% | 147 | 620 | 308 |
| 8 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 9 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 10 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 11 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 12 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 13 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 14 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 15 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 16 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 17 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 18 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 19 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 20 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 21 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 22 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 23 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 24 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 25 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 26 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 27 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 28 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 29 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| 30 | | 57 | 151 | 43 | 34 | 27 | 312 | 97% | 340 | 37% | 130 | 674 | 362 |
| | | | | | | | | | | | | | 1351 |
| | | | | | | | | | | | | | 0.07 |