



DevTreks –social budgeting that improves lives and livelihoods

Net Present Value Calculation 1

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Version: DevTreks 2.0.0

A. Net Present Value (NPV) Introduction

This reference summarizes the main price adjustments, or discounting, used in NPV calculators. With the exception of Inputs and Outputs, DevTreks requires running NPV calculators before other types of calculations or analyses can be completed. We consider NPV calculations to be a foundation for understanding costs and benefits. Most calculations used in this reference derive from the *Commodity Cost and Returns Estimation Handbook* reference (referred to as the *Handbook*). That reference should be reviewed, if not fully read, before this reference.

B. Data URLs

The *Handbook* contains most of the examples used in this reference and can be used to verify the discounting techniques employed. While early precursors of DevTreks (1*) could match the *Handbook's* numbers exactly, years of testing and evolution no longer make that possible, or important. All of the *Handbook's* examples relate to Operating Budgets, as do examples used in this reference. The *Net Present Value 2* reference contains Capital Budget examples.

The NPV calculators and operating budget demonstrated in this reference can be found at the following URLs (2*). The examples go through periodic testing for various purposes over the years that can result in differences from the calculations documented in this reference. Unless the source code changes, no attempt is made to keep the online calculations synchronized with this reference. Clubs and networks are assumed to have the technical skill needed to replicate these examples.



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NPV Calculators:

[https://www.devtreks.org/agtreks/preview/crops/linkedviewgroup/Net Present Value Calculators Group/5/none/](https://www.devtreks.org/agtreks/preview/crops/linkedviewgroup/Net%20Present%20Value%20Calculators%20Group/5/none/)

Input Service:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Inputs, Sample Calculations/1216/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Inputs,%20Sample%20Calculations/1216/none/)

Output Service:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Outputs, NASS/1217/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Outputs,%20NASS/1217/none/)

Operation Service:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Operations, Samples/1218/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Operations,%20Samples/1218/none/)

Outcome Service:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Outcomes, Agricultural Examples/2637/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Outcomes,%20Agricultural%20Examples/2637/none/)

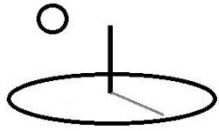
(Version 2.0.0 does not properly update children calculators for NPV Outcome Calculators)

Operating Budget Service:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Operating Budgets, Samples/1818/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Operating%20Budgets,%20Samples/1818/none/)

Multimedia:

[https://www.devtreks.org/agtreks/select/crops/resourcegroup/Dictionary Media Support Group/53/none/](https://www.devtreks.org/agtreks/select/crops/resourcegroup/Dictionary%20Media%20Support%20Group/53/none/)



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Stories:

[https://www.devtreks.org/agtreks/select/crops/servicebase/Agricultural Production, Dictionary/2451/none/](https://www.devtreks.org/agtreks/select/crops/servicebase/Agricultural%20Production,Dictionary/2451/none/)

C. Work Breakdown Structure (WBS)

Chapter 13 in the *Handbook* discusses the need to use WBS standards to classify NPV data (see Table 13B.5 in the Handbook). That need has been compounded by the networking capability now possible using DevTreks. In order to aggregate data successfully, clubs should use a WBS defined by a network. If the WBS does not exist, invent it (see the *Work Breakdown Structure* tutorial).

D. Input and Output NPV Properties

Input and Output base element properties are documented in the *Price Analysis 1* reference.

Cost elements have the following properties:

TOC: total operating cost

TOC_INT: total operating cost interest (2*)

TAOH: total allocated overhead cost

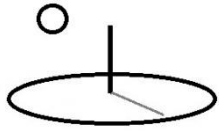
TAOH_INT: total allocated overhead cost interest

TCAP: total capital cost

TCAP_INT: total capital cost interest

TINCENT: total incentive-adjusted cost

TAMOC: total annual operating cost



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TAMOC_INT: total annual operating cost interest

TAMOC_NET: total revenues minus total operating costs

TAMAOH: total annual allocated overhead cost

TAMAOH_INT: total annual allocated overhead cost interest

TAMAOH_NET: total annual revenue minus annual operating costs and minus annual allocated overhead costs

TAMCAP: total annual capital cost

TAMCAP_INT: total annual capital cost interest

TAMCAP_NET: total annual revenue minus annual operating costs minus annual allocated overhead costs minus total annual capital costs

TAMINCENT: total annual incentive-adjusted cost

TAMTOTAL: total annual costs

Benefit elements have the following properties:

TR: total revenue

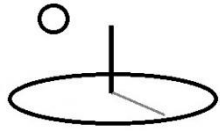
TR_INT: total revenue interest

TRINCENT: total incentive-adjusted revenues

TAMR: total annual revenue

TAMR_INT: total annual revenue interest

TAMRINCENT: total annual incentive-adjusted revenues



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TRAmount: total of output quantity

TRPrice: total output price

TRUnit: output unit of measurement

TRName: output name

TRCompositionAmount: total output composition amount

TRCompositionUnit: unit of measurement for composition amount

Net results use the following properties:

TAMNET: total annual net returns

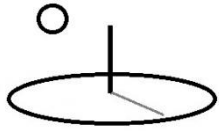
TAMINCENT_NET: total annual incentive-adjusted net returns

E. Discounting

Discounting is based on the principle that money has value based on the time it's held. Deposit the money in the bank and it accrues interest. This time value of money can be measured using discounted interest. Discounted interest is calculated as follows:

Within period for inputs and outputs:

- a. Calculate number of days between this time period's end of period date and the date the input or output is used (i.e. $\text{DaysToEndofPeriod} = 100$).
- b. Divide DaysToEndofPeriod by 30 to derive the number of months to compound interest (i.e. $\text{NumberOfMonths} = \text{DaysToEndofPeriod} / 30$)
- c. Calculate the discount factor by:
 1. converting the nominal annual interest rate to a monthly rate



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$$\text{MonthlyRate} = ((1 + \text{AnnualRate})^{(1/12)}) - 1$$

2. calculating the discount factor

$$\text{DiscountFactorByMonths} = (1 + \text{MonthlyRate})^{\text{NumberofMonths}}$$

- d. Multiply the input or output cost ($p * q$, after adjusting for indices, allocated OH factor, times over) by this factor

Between period for inputs and outputs:

- a. Calculate the within period interest charge using part 1 (i.e. InputorOutputCost)
- b. Calculate number of days between this input or output's time period end of period date and the common reference date (i.e. DaysToCommonReference = 365).
- c. Calculate the number of periods (i.e. years) to discount:

$$\text{RealYears} = \text{DaysToCommonReference} / 365.25$$

- d. Calculate the real discount factor:

$$\text{RealDiscountFactor} = 1 / ((1 + \text{RealRate})^{\text{RealYears}})$$

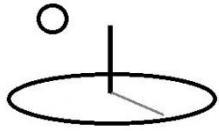
- e. Determine real interest charge using formula:

$$\text{InterestCharge} = \text{InputorOutputCost} * \text{RealDiscountFactor}$$

F. Preproduction inputs and outputs

- a. Calculate the within period interest charge using part 1 (i.e. InputorOutputCost)
- b. Calculate the number of time periods in the preproduction period

$$\text{PreProductionTimePeriods} = \text{DateDiff}(\text{years}, \text{ThisPeriodEndOfPeriodDate}, \text{CommonReferenceDate})$$



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- c. Calculate number of days between this input or output's time period end of period date and the common reference date

$\text{CommonRefPtDays} = \text{DateDiff}(\text{days}, \text{ThisPeriodEndOfPeriodDate}, \text{CommonReferenceDate})$

- d. Calculate number of days in a time period

$\text{DaysPerPeriod} = \text{CommonRefPtDays} / \text{PreProductionTimePeriods}$

- e. Subtract out the first production year

$\text{RealInterestDays} = \text{CommonRefPtDays} - \text{DaysPerPeriod}$

- f. Calculate a discount factor using an annual, real rate (but only if the RealInterestDays exceed 360. That is, leave out the within time period productive year. The five days is arbitrary.)

$\text{RealYears} = \text{RealInterestDays} / 365.25$

$\text{RealDiscountFactor} = 1 / ((1 + \text{RealRate}) ^ \text{RealYears})$

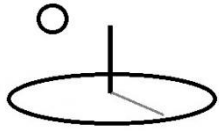
- g. Determine real interest charge using formula:

$\text{InterestCharge} = \text{InputorOutputCost} * \text{RealDiscountFactor}$

h. Annuities (preproduction or regular)

All annuities have their dates set to their time period's end of period data -so only real interest charges accrue.

- a. Calculate number of days between this input or output's time period end of period date and the common reference date



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$\text{DaysToCommonReference} = \text{DateDiff}(\text{days}, \text{ThisPeriodEndOfPeriodDate}, \text{CommonReferenceDate})$

b. Calculate the number of periods (i.e. years) to discount:

$$\text{RealYears} = \text{DaysToCommonReference} / 365.25$$

c. Calculate the real discount factor:

$$\text{RealDiscountFactor} = 1 / ((1 + \text{RealRate}) ^ \text{RealYears})$$

d. Determine real interest charge using formula:

$$\text{InterestCharge} = \text{AnnuityCost} * \text{RealDiscountFactor}$$

e. Allocated Overhead Factor

$$\text{AdjustedPrice} = \text{InputorOutputPrice} * \text{AllocatedOverheadFactor}$$

G. More Annuities

DevTreks employs two principal types of capital recovery annuities -preproduction annuities and regular annuities. Equivalent annual annuities are also included in the Budget section of budgets. Inputs and Outputs do not have annuity properties –the annuities are added to Operation, Component, Outcome, Time Period, Budget, and Budget Group elements.

a. PreProduction Annuities

The Task Force defines the preproductive period for a multiyear crop enterprise as “begin[ning] with the first expense associated with establishing the enterprise and end[ing] in the year just before the enterprise yields a substantial percent of its expected mature yield (usually 70-80%)”. This is done in DevTreks by setting the common reference point to any period after the first year. Preproduction annuities follow the principle that the discounted cash flows of the investment



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must equal the discounted annuity flows. The Totals column (discounted cash flow minus discounted annuities) must equal the Annuals (discounted net cash flows minus preproduction and regular annuity principal plus discounted annuity flow) column at the end of every analysis. Please refer to the alfalfa and almonds examples.

b. Regular Annuities

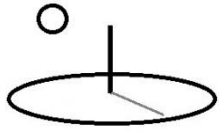
Set when an operation or component has an effective life greater than one. Inputs are treated in the totals column like any other input -a nominal interest charge (compounded) will accrue normally in the first year and they'll be added to costs like any other cash expense. Operating, allocated overhead or capital costs can all be amortized using this method. In subsequent time periods the annuity will only be inserted into allocated overhead costs. For example, if Year 1 includes both an amortized replacement cow under AOH and an amortized soil amendment under OC, both annuities will show up in their respective cost categories in year 1, but will be added together in subsequent periods and only show up under AOH (because their multi-year nature means they can't be expendables, or operating costs).

This nominal cost will then be amortized over the life of the operation using a real interest rate. In order to enforce the principal that the discounted cash flows must equal the discounted annuity flow (the two columns must be equal) the annuity is handled in the Annuals column following these rules:

Rule 1. Include the real annuity in the year when the operation takes place

The \$247 annual replacement cost for the cow will show up in the Annuals column and the \$1050 cash replacement will show up in the Totals column in the year when the replacement is first purchased. See Table 13.3, page 13-24, dairy budget, in the Handbook -the annual column is the correct average 1 year profitability for a dairy enterprise.

Rule 2. Include only an interest charge in the first year after this initial year



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The first year annuity was already displayed in the year when the purchase took place -it was calculated based on the end of period date. This period must remove the real interest associated with that initial \$247.

Rule 3. Include principal and interest charges for each period of the remaining life of the annuity.

So year 2 will be \$247 minus interest...

Rule 4. If the last time period of the annuity is fractional, use a fractional annuity factor

The cow's 2.5 year life includes a fractional .5 last time period. The annuity and interest charges for this period should be based on this fraction (please refer to HANDBOOK'S equation 2B26 and page 13-20). Means the \$247 is multiplied by the fractional annuity factor (0.49390) and then interest deducted in normal fashion for this sum.

Rule 5. Add discounted salvage value to the last time period

Add discounted salvage value to the last time period.

Rule 6. Follow these same rules when annuities are added to growth periods

If the current time period includes a newly amortized operation or component (i.e. the \$1050 replacement cow) keep that principal (i.e. the \$1050 replacement cow) out of the growth. Include all annuities in the growth periods using the regular rules (i.e. the cow's year 1 interest charge of \$11+ will be included in the first growth period ...).

Rule 7. Follow these same rules when annuities are added to preproduction years.

But keep the initial principal cash flow (the \$1050) out of the amortized preproduction expenses.

Rule 8. Follow these same rules when annuities are added at the end of analyses to clean them up.)



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Rule 8 was ‘turned off’ due to the complexity of displaying the data. (Any annuities that are still left over when an analysis ends will be inserted into a new time period and fully discounted in the Annuities column.)

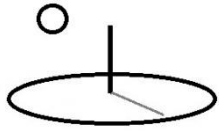
c. Equivalent Annual Annuity

This annuity can be found in the summary rows for the investment (near the end). This number can be used to compare investments with unequal lives -for example a 15 year orange grove investment vs. a 25 year almond grove. As stated on page 10-29 of the Handbook "An annual equivalent is constant return which, when summed over the life of the investment, is equal to the net present value of the returns from the investment." This constant return is calculated using equation 10.23, and results in \$74.78 for the second dairy investment. This means "the establishment and production of a dairy over a 3-year period yields a return equivalent to \$74.78 at the end of each year of the enterprise's life" (using a real annuity). The almond orchard example gives a better example (i.e. using the full, effective life of the enterprise investment).

H. Example 1. Corn-soybean rotation

This example explains the most common price adjustments found in all operating and capital budgets. A corn-soybean crop rotation will be used. In year 1, revenues and expenses are discounted from the date they are received or expended (the output or input dates) to the ending time period date (12-31-03). Nominal interest rates, with monthly compounding, are always used for this "within-time period" discounting.

Year 2's revenues and expenses are first discounted using nominal within time period discounting. The nominal discounted sum is then discounted back to Year 1's ending time period date, 12-31-03, using a real interest rate. Real interest rates are always used for this "between-time period" discounting. This discounting always takes place between the date the cost is incurred and the "common reference date" being used in an analysis. In this case, the property named "Common Time?" at the top of Year 1's budget is marked "true", meaning that it's being used as the common date for carrying out all "between time period" discounting.



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The following budget will be used in this example (please refer to tables 14-2 and 14-3 in the Handbook).

Corn revenues:

Grain output:

$$\$279.50 = 1 * 130 \text{ bushels} * \$2.15/\text{per bushel}$$

Nominal Discounting:

The output is sold on 10-15-03. Nominal interest will accrue on this revenue between the date sold and the end of period date (12-31-03).

$$\text{Days: } 77 \quad \text{Months: } 2.53 \quad \text{Amortization Factor: } 1.0186 \quad \text{Interest: } \$5.20 = \$279.50 - (\$279.50 * 1.0186)$$

$$\$284.70 = \$279.50 + \$5.20 \text{ (nominal interest accrued)}$$

Grain outcome revenue:

$$\$336.45 = (\$284.70 + \$51.75) * 1 \text{ acre}$$

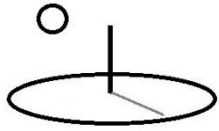
*Grain outcome revenue total = sum(output revenues) * amount of outcome*

Corn operating costs:

Dry Grain input:

$$\$13.00 = 1 * 130 \text{ bushels} * \$0.10/\text{per bushel}$$

Nominal Discounting:



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The input is applied on 10-16-03. Nominal interest will accrue on this cost between the date applied and the end of period date (12-31-03).

Days: 76 Months: 2.53 Amortization Factor: 1.0184 Interest: $\$0.24 = \$13 - (\$13.00 * 1.0184)$

$\$13.24 = \$13.00 + \$0.24$ (nominal interest accrued)

Dry Grain operation cost:

$\$13.24 = (\$13.24) * 1$ acre

*Dry Grain operation operating cost total = sum(input operating costs) * amount of operation per unit operation*

Corn allocated overhead costs:

All calculations are exactly the same as the operating costs.

Soybean revenues:

Grain output:

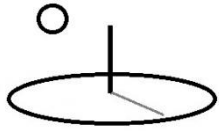
$\$220 = 1 * 40$ bushels * $\$5.50$ /per bushel

Nominal Discounting:

The output is sold on 12-15-04. Nominal interest will accrue on this cost between the date sold and the end of period date (12-31-04).

Days: 16 Months: 0.53 Amortization Factor: 1.0038 Interest: $\$0.84 = \$220 - (\$220 * 1.0038)$

$\$220.84 = \$220.0 + \$0.84$ (nominal interest accrued)



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Real Discounting:

Real interest will accrue on the nominal discounted revenue between the end of production date, 12/31/2004 and the common reference end of period date (12-31-03).

Days: 366 Years: 1 Amortization Factor: .9523 Interest: $-\$10.54 = -1 * (\$220.84 - (\$220.84 * .9523))$

$\$209.46 = \$220 + (-10.54)$ (nominal and real interest accrued)

Grain outcome revenue:

$\$209.46 = (\$209.46) * 1$ acre

Grain outcome revenue total = sum(output revenues) * amount of outcome

Soybeans operating costs:

Dry Grain input:

$\$4.00 = 1 * 40$ bushels * $\$0.10$ /per bushel

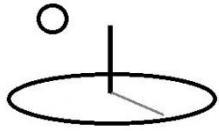
Nominal Discounting:

The input is applied on 10-17-03. Nominal interest will accrue on this cost between the date applied and the end of period date (12-31-04).

Days: 75 Months: 2.5 Amortization Factor: 1.0181 Interest: $\$0.04 = \$4.00 - (\$4.00 * 1.0181)$

$\$4.04 = \$4.00 + \$0.04$ (nominal interest accrued)

Real Discounting:



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Real interest will accrue on this nominal discounted cost between the end of production date, 12/31/2004 and the common reference end of period date (12-31-03).

Days: 366 Years: 1 Amortization Factor: .9523 Interest: $-\$0.19 = -1 * (\$4.04 - (\$4.04 * .9523))$

$\$3.81 = \$4.00 + (-\$0.19)$ (nominal and real interest accrued)

Dry Grain operation cost:

$\$3.81 = (\$3.81) * 1$ acre

Dry Grain operation operating cost total = sum(input operating costs) * amount of operation per unit operation

Soybeans allocated overhead costs:

All calculations are exactly the same as the operating costs. One calculation not covered in the operating costs section is worth examining here.

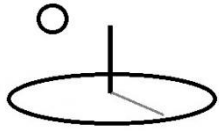
Allocated Overhead Factor

Each input can have a true/false value for a property named, *OH Used?*. This factor is set using the *Allocated Overhead Factor* property of a time period. If this value is true, the input's prices will be multiplied by that factor. Note that overhead can be allocated to different enterprises using several techniques. For example, the Office Expense input is calculated as follows:

$\$50.00$ AOH Price = $\$5,000$ (original AOH price) * $.01$ (allocated overhead factor)

Time Period totals and nets:

Time period totals are calculated as the sum of the time period's profits and costs multiplied by a Time Period property named 'Enterprise amount'. So:



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Corn Net Profit: $-\$30.89 = 1 \text{ acre} * ((\$336.40 - \$201.20 - \$166.14))$

Soybeans Net Profit: $-\$78.86 = 1 \text{ acre} * (\$209.47 - \$111.27 - \$177.05))$

Time Period Net Profits = Enterprise amount * (Revenue - Operating Costs - Allocated Overhead Costs)

Budget totals and nets:

Budget totals are calculated as the sum of the time periods' profits and costs So:

Budget Net Profit: $\$-109.75 = ((\$336.40 - \$201.20 - \$166.14) + (\$209.47 - \$111.27 - \$177.05))$

Budget Group totals and nets:

Budget group totals are calculated when the budgets are run at the budget group level. They are calculated as the sum of each budget's net discounted profits.

I. Dairy with heifer replacement

This example demonstrates how heifer replacements, and other multi-year investments, might be handled (i.e. capital recovery method) in a budget. Two dairy budgets will be used to explain smart annuities. Both are based on the Handbook sample dairy budget. The first is a one year budget, and the second is a three year budget.

Dairy replacements:

Dairy cull cow output's total revenue: As stated on page 13-13 of the Handbook "Because the [budget] uses the capital recovery method to value investment in the breeding herd, no income from cull cows is included in the estimates. The value of the cull animal is included as a negative cost in computing the cost of a breeding herd replacement". The income from this capital asset is accounted from the flow of milk sales produced by the asset during its 2.5 year productive life.



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Dairy replacement heifer cost: Replacements are treated as purchased capital investments and amortized (using the capital recovery method) over their effective life. The capital recovery method is computed, as of the end of year, using their 2.5 year effective life, a real interest rate of 5%, an initial purchase price of \$1,050.40 and a salvage value of \$542.88 . Page 13-19, part m, in the Handbook points out that the \$1,050.40 purchase price represents the real market value of bred heifer (at the start of the year). The \$542.88 salvage value represents sale of a 1,170 pound cull cow at \$46.40 per cwt, or \$542.88 received three years later. The 1,170 pounds represents a 1,200 pound cull cow adjusted by 2.5% to account for mortality.

The final amortized value is calculated as follows (see the calculations listed on page 13.20).

Discounted Salvage Value: \$480.54

Capital Recovery Factor (2.5 years, 5% real rate): 0.435427

Amortized Allocated Overhead Cost: $\$248.13 = (\$1050.40 - \$480.54) * .435427$

Note the slight difference from the Handbook (and note the 0.40 difference in purchase price).

Total vs. Annual Cost Columns: The \$1,050.40 market value purchase price for the replacement heifer is included in the Totals column and treated as a cash-flow type expense (because cash flows are important, even in 1 year budgets). The actual resource flows are shown in the Annual column as the \$248.13 amortized cost of the replacement investment. The Annual column accounts for the economics (resource flows) of the investment.

J. 5 year alfalfa with preproduction annuity

This example demonstrates how to properly account for the preproduction period found in some budgets like alfalfa and orchards. The following budget will be used in this example (please refer to tables 10.2 and 10.4).:

Alfalfa 5 year:



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Preproduction period: The preproductive period of an enterprise, as defined in the Handbook's glossary, is "the period that begins with the first expense associated with establishing the crop, [or livestock,] enterprise and ends in the crop year just before the crop yields a substantial percent of its expected mature yield (usually 70-80%)".

Alfalfa preproduction period: Using the definition, the preproductive period for a typical alfalfa crop is the first year. The crop is seeded and established in year one and usually comes into full production in the second year. The net preproductive return shown in the budget is (\$168.59). The first productive year of alfalfa production, year 2, is defined as the common reference date in this budget. Common reference dates establish the point at which all "between time period" discounting throughout any budget will take place.

The interest calculations for year 1 are as follows:

Revenues: using the Alfalfa cutting sold on 8-31-03

a) Within-period nominal interest is computed for the \$81 alfalfa revenue using 122 days to the end of period date (12-31-03), or 4.0667 months, .07 nominal rate, and 1.0232 discount factor.

$$\$1.88 = (\$81 * 1.0232) - \$81$$

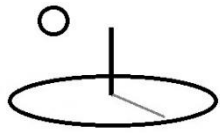
b) Real interest accumulates between the end of period date and the common reference date using a real interest rate. In this example, because of the way DevTreks calculates the number of days in years, the real discounted interest adds \$.01 to the total interest.

$$\$1.89 = \$1.88 + \$.01$$

c) The first year's revenues are then adjusted to the end of the first production year, year 2, using nominal interest, (please refer to the top of Handbook page 10-9) as follows:

$$\$7.69 \text{ (total interest charge)} = \$1.89 \text{ (from part b)} + ((\$81 + \$1.89) * .07 \text{ (nominal interest)})$$

Costs: using the Cut, bale, stack alfalfa bought on 9-30-03



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a) Within-period nominal interest is computed for the \$25 input using 92 days to the end of period date (12-31-03), or 3.07 months, .07 nominal rate, and 1.0174 discount factor.

$$$.44 = (\$25 * 1.0174) - \$25$$

b) Real interest accumulates between the end of period date and the common reference date using a real interest rate. In this example, because of the way DevTreks calculates the number of days in years, the real discounted interest adds \$.00 to the total interest.

$$$.44 = $.44 + $.0$$

c) The first year's costs are then adjusted to the end of the first production year, year 2, using nominal interest, (please refer to the top of Handbook page 10-9) as follows:

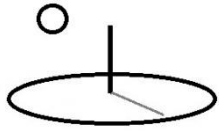
$$\$2.22 \text{ (total interest charge)} = \$0.44 \text{ (from part b)} + ((\$25 + \$0.44) * .07 \text{ (nominal interest)})$$

Year 2's interest is calculated using nominal within-period monthly compounding. Year's 3 through 5 are discounted, using annual, real compounding, back to the common reference date.

Preproduction Annuity

The preproduction nets of \$168.59 are divided by (1 + real rate, or 1.05) to adjust them to the beginning of the first production year (year 2). This results in the final preproduction amount, \$160.56. This final amount is converted into an annuity, \$45.28, using a real rate, over the remaining productive life of the enterprise (4 years in this case). The annuity is discounted, using a real rate, between the common reference date and subsequent ending year's dates (i.e. 12-31-05, 12-31-06, 12-31-07).

Totals vs. Annual Totals: The totals column in these budgets represent discounted cash flows (and include preproductive net returns but do not include subsequent preproduction annuities). The Annual Totals column represents discounted cash flows minus preproductive returns (i.e. the zeros in year 1's revenues and costs) plus preproductive annuities (i.e. the \$45.28 adjusted by the



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Interest charges). Because the discounted cash flow cost of the preproduction net returns equals the sum of the discounted preproduction annuities, the two columns must be equal at the end of the production period. As they do: \$426.27 equals \$426.26 (given rounding errors).

Note the differences between operating costs and allocated overhead costs between the two columns.

K. Almonds - 25 years, 7 years and Growth, and Nested Time Periods

This example demonstrates how to calculate preproduction periods in budgets that have long, multi-time period lives where, in some cases, the time periods may be more conveniently represented by uniform (or linear or geometric) series of expenses and revenues. The following orchard budgets will be used in this example (please refer to tables 10.5 and Appendix 10A).

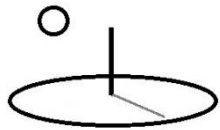
Almonds - 25 years

Preproduction period: The preproductive period of an enterprise, as defined in the Handbook's glossary, is "the period that begins with the first expense associated with establishing the crop, [or livestock,] enterprise and ends in the crop year just before the crop yields a substantial percent of its expected mature yield (usually 70-80%)".

Almond preproduction period: Using the definition, the preproductive period for the almond orchard used in this example is six years. The crop is staked, planted, and established in years 1 through 6 and starts producing the 70-80% yield threshold in year 7. The net preproductive return shown in the budget is (\$4710.12, as shown in Year 7's preproduction capital recovery annuity).

The interest calculations for year 4 (and for years 1 through 6) are as follows:

Revenues: using the first Almond harvest sold on 11-30-06



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a) Within-period nominal interest is computed for the \$500 almond revenue using 31 days to the end of period date (11-30-06), or 1.03 months, .09 nominal rate, and 1.0074 discount factor.

$$\$3.72 = (\$500 * 1.0074) - \$500$$

b) Between period real interest is computed from 12-31-06 to the end of the preproduction period (year 6, which is also the beginning of the first production year) using 731 days, or 2 years; 0.04 real rate; 1.0816 discount factor:

$$\$44.85 = \$3.72 \text{ (part a)} + ((\$503.72 * 1.0816) - \$503.72)$$

c) Nominal interest is added for the first production year using, year 7, using (please refer to the top of Handbook page 10-9) 0.09 nominal rate, as follows:

$$\$93.89 \text{ (total interest charge)} = \$44.85 \text{ (from part b)} + ((\$500 + \$44.85) * .09) \text{ (nominal interest)}$$

Costs: using the Harvest input bought on 10-01-06

a) Within-period nominal interest is computed for the \$87.5 harvest input using 91 days to the end of period date (10-01-06), or 3.03 months, .09 nominal rate, and 1.022 discount factor.

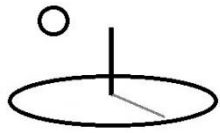
$$\$1.93 = (\$87.5 * 1.022) - \$87.5$$

b) Between period real interest is computed from 12-31-06 to the end of the preproduction period (year 6, which is also the beginning of the first production year) using 731 days, or 2 years; 0.04 real rate; 1.0816 discount factor:

$$\$9.23 = \$1.93 \text{ (part a)} + ((\$89.43 * 1.0816) - \$89.43)$$

c) Nominal interest is added for the first production year using, year 7, using (please refer to the top of Handbook page 10-9) 0.09 nominal rate, as follows:

$$\$17.93 \text{ (total interest charge)} = \$9.23 \text{ (from part b)} + ((\$87.5 + \$9.23) * .09) \text{ (nominal interest)}$$



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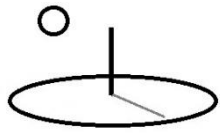
Year 7's interest is calculated using nominal within-period monthly compounding. Years 8 through 25 are discounted, using annual, real compounding, back to the common reference date (12-31-09).

Preproduction Annuity

The preproduction nets of \$5424 (3767 revenues – 5334 operating costs – 3857 allocated overhead costs) are divided by $(1 + \text{real rate, or } 1.04)$ to adjust them to the beginning of the first production year (year 7). This results in the final preproduction amount, \$5216.73. This final amount is converted into an annuity, \$397.19, using a real rate, over the remaining productive life of the enterprise (19 years in this case). The annuity is discounted, using a real rate, between the common reference date and subsequent ending year's dates (i.e. 12-31-10, 12-31-11, 12-31-12).

Totals vs. Annual Totals: The *Totals* column in this budget represents discounted cash flows. It includes the preproductive net returns but does not include subsequent preproduction annuities. The *Annual Totals* column represents discounted cash flows minus preproductive returns (i.e. the zeros in year 1 through 6's revenues and costs) plus preproductive annuities (i.e. the \$397.19 adjusted by the Interest charges). Because the discounted cash flow cost of the preproduction net returns equals the sum of the discounted preproduction annuities, the two columns must be equal at the end of the production period. As they do: \$9637.04 equals \$9636.96 (given rounding errors).

Equivalent Annual Annuity: This annuity can be found in the summary rows for the investment (near the end). This number can be used to compare investments with unequal lives -for example a 15 year orange grove investment vs. a 25 year almond grove. As stated on page 10-29 of the Handbook "An annual equivalent is constant return which, when summed over the life of the investment, is equal to the net present value of the returns from the investment." This constant return is calculated using equation 10.23, and results in \$616.89 for the almond investment. This means "the establishment and production of almonds over a 25-year period yields a return equivalent to \$616.89 at the end of each year of the orchard's life" (using a real annuity).



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Almonds - 7 years and growth

Almond Production period: The 25 year almond budget has a uniform series of revenues and expenses beginning in year 6. This means that the non-discounted revenues, operating costs, and allocated overhead costs, are equal for years 6 through 25. Uniform series (and non-uniform, but predictable, series) can be conveniently displayed by summing the uniform series together (using the same discounting as found in the full 25 year budget) and displaying the result as one single time period. In this example, the uniform series is displayed as a 18 year time period covering years 8 through 25. All revenues and expenses have been summed and discounted over the 18 years.

Note that the summation introduces rounding errors. Given the uncertainty of the underlying data to begin with, in most cases these rounding errors are acceptable.

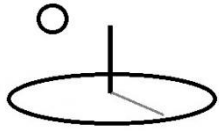
Most orchards (or other multi-year, depreciable investments) do not produce the same revenues and expenses in the latter years of their effective lives as they do in their prime. They are more likely to increase to a peak and then start declining in some way. The resulting series -production climbing for several years, peaking, and then declining, can be dealt with by using one of the following time growth type methods (note: all of these series kick in by setting the Growth Type and Growth Periods property of a Time Period):

Uniform Series Growth

The example above demonstrates this method. Year 7's growth type has been set to "Uniform" and its growth periods have been set at 18. The uniform, 18 years of numbers simply use year 7's expenses, costs, revenues or costs.

Linear Series Growth

Note that this section has not been tested for DevTreks 1.0.



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Changing Year 7's growth type to "Linear" would have resulted in final net profits of \$11,448 - a substantial difference from the uniform series net. The calculations used for linear series are as follows:

GradientRevenueFactor = Year 7's Revenue Total - Year 6's Revenue Total (operating, allocated, and capital expenses gradient factors similarly derive this lump sum amount to be added to each subsequent time period; the difference between the annuals columns is not calculated because preproduction expenses in year 6 for this column are zero).

*Year 8's Revenue Interest Total = RunningSum (starting with year 7's revenue) + (((Year 7's Revenue Total + (iCount * GradientRevenueFactor)) - ((Year 7's Revenue Total + (iCount * GradientRevenueFactor)) * DiscountFactor)) * -1)*

*Year 8's Revenue Total (not including interest) = RunningSum (starting with year 7's revenue) + (Year 7's Revenue Total + (iCount * GradientRevenueFactor))*

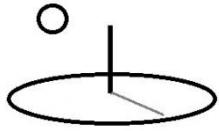
where iCount increments for each time period starting with 1 and the discount factor is based on real, annual rates; annuities are kept out of the growth and are just discounted normally

These equations show that a lump sum, representing the change in revenues and expenses between the last two time periods, is added to the uniform series and discounted normally. That lump sum (Gradient Revenue Factor) is multiplied by the current time count. So, if Gradient Revenue Factor starts at \$100, year 2 would add \$200 (year 1's \$100 plus year 2's \$100), year 3 would add \$300 etc.

Geometric Series Growth

Note that this section has not been tested for DevTreks 1.0.

Changing Year 6's growth type to "Geometric" would have resulted in final net losses of \$-171 million - a warning that geometric series need careful use. The calculations used for linear series are as follows:



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GradientRevenueFactor = the uniform series (established as *Year 7's Revenue Total* - *Year 6's Revenue Total*) is raised, each period, to the power: $(\wedge (\text{TimePeriodCount}-1))$.

Year 8's Revenue Interest Total = *RunningSum* (starting with year 7's revenue) + (((*Year 7's Revenue Total* * *GradientRevenueFactor*) - (*Year 7's Revenue Total* * *GradientRevenueFactor*) * *DiscountFactor*)) * -1)

Year 8's Revenue Total (not including interest) = *RunningSum* (starting with year 7's revenue) + (*Year 7's Revenue Total* * *GradientRevenueFactor*)

for each time period and the discount factor is based on real, annual rates; annuities are kept out of the growth and are just discounted normally

These equations show that the uniform series is multiplied, each period, by an exponent that is determined by the period.

Almonds -Nested Time Series

Note that this section has not been tested for DevTreks 1.0.

The budget, Almonds-Nested Growth (found in the training database), shows how nested time series might be used. This budget includes, in order, a 6 year preproduction period, 1 year full production period, 5 uniform time series periods, 5 normal time period years, and 8 year uniform time series periods. The results for this 25 year period are within a dollar of the non-nested 25 year almond budget.

These nested time series, along with the geometric or linear time series, can be used to model normal increases and decreases in enterprise production over time. For example, the 5 year uniform time series might use a geometric time series to show yields increasing at an increasing rate.

L. Corn Planting With Incentives



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DevTreks incentives, referred to as "*Incentive Amount*" or "*Incentive Rate*", keep track of subsidies and penalties in budgets. We recommend that only market value, or opportunity cost, prices, costs, or benefits be used in all inputs, outputs, operations, outcomes and time periods. In other words, don't distort these prices with subsidies or penalties. Instead, use the '*Incentive Amount*' or '*Incentive Rate*' properties of inputs, outputs, operations, outcomes, and time periods to document subsidies and penalties. *Incentive Amount* is a lump sum incentive that changes benefits and costs by the lump sum. *Incentive Rate* is a percentage-based incentive that changes benefits and costs by the rate. Rates should be entered as decimals.

Incentive Rates

A Hybrid Corn Seed input has been subsidized 10% by a government. The seed is an expendable input with a principal input cost of \$32.20. Discounted interest is another \$.67. The 10% subsidy has been entered as '.10' in the Incentive Rate property of the seed input. Note that it has been entered as a decimal. The subsidy reduces the total input cost by:

$$\$3.29 \text{ subsidy} = (\$32.20 \text{ total principal input cost} + \$.67 \text{ discounted interest}) * 10\%$$

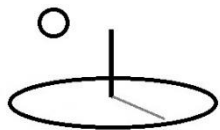
$$\$29.58 \text{ incentive adjusted cost} = \$32.87 \text{ total input cost} - \$3.29 \text{ subsidy}$$

Incentive Amounts

A Hybrid Corn Seed input cost has been subsidized \$10 by a government. Non-distorted costs are identical to the Incentive Rate example. The \$10 subsidy has been entered as '10' in the Incentive Amount property of the seed input. The subsidy reduces the total input cost by:

$$\$22.87 \text{ incentive adjusted cost} = (\$32.20 \text{ total principal input cost} + \$.67 \text{ discounted interest}) - \$10 \text{ subsidy}$$

Output subsidies increase the revenues of outputs. Penalties for both costs and revenues should be entered as negative numbers. Note that incentives do not affect the Annuals column (as of this version of DevTreks).



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M. Analyses

The *Benefit Cost Analysis 1* tutorial demonstrates how to aggregate and analyze net present value calculations.

Summary

Operating budgets document a basic story in modern society. They explain why some crops are better than others, some projects succeed while others fail, certain technologies become obsolete, and why some companies perform excellently. This basic Operating Budgeting data may help people to improve their lives and livelihoods.

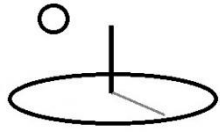
Footnotes

1. While working as an agricultural economist for the United States Department of Agriculture, the author built a two-tier Visual Basic budgeting software program, ProCosts, in the late 1990s. That evolved into an online budgeting program, The EconDoc Exchange, in the early 2000s. The author started DevTreks about six years ago for the purpose of working fulltime on this cloud computing version of the software. The author felt digits were the right path to follow for the last several decades and will remain the right path for the foreseeable future.
2. The quality of this data is “development server” rather than “production server”. The cloud computing server used the development server database to get started. A major role of networks is to set data quality standards for clubs in their network. Customers define the networks they need and contract with DevTreks to get started.

References

Hallam, Eidman, Morehart and Klonsky (editors). Commodity Cost and Returns Estimation Handbook, Staff General Research Papers, Iowa State University, Department of Economics, 1999

References Note



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We try to use references that are open access or that do not charge fees.

Improvements, Errors, and New Calculators

Please notify DevTreks (devtrekkers@gmail.com) if you find errors or can recommend improvements.

A video tutorial explaining this reference can be found at:

[https://www.devtreks.org/commonstreks/preview/commons/resourcepack/NPV Calculation 1, Operating Budgets/461/none/](https://www.devtreks.org/commonstreks/preview/commons/resourcepack/NPV%20Calculation%201,%20Operating%20Budgets/461/none/)