Chapter 3

Socio-economic analysis of mine action

With the transition from open conflict to sustained peace, mine action programmes are challenged to extend their focus from risk reduction alone to contributing to the broader goals of national socio-economic development. This chapter illustrates how cost-benefit approaches can be used to assess mine action programmes. Based on case studies of Lao PDR and Mozambique, it demonstrates how such analysis can inform mine action programme managers and policy-makers — in two countries at similar levels of development but with quite different social, economic and cultural characteristics.

Introduction

In brief, economic analysis is concerned with decisions. Some of these relate directly to the use of scarce resources and entail an evaluation or comparison of:

- The costs and benefits expected to arise from deciding on one course of action (is the decision justifiable in any sense?); ***and,***
- The different sets of expected costs and benefits arising from alternative courses of action (is the decision justifiable when compared to other feasible alternatives?).

As such, economic analysis applies certain techniques (to ensure logic and consistency) to selected information and evaluates the results. However, economic analysis is also concerned with a broader set of decisions relating to:

- What is to be valued (the information basis, including whose information counts); ***and,***
- How it is to be valued (the evaluative framework)?[1]

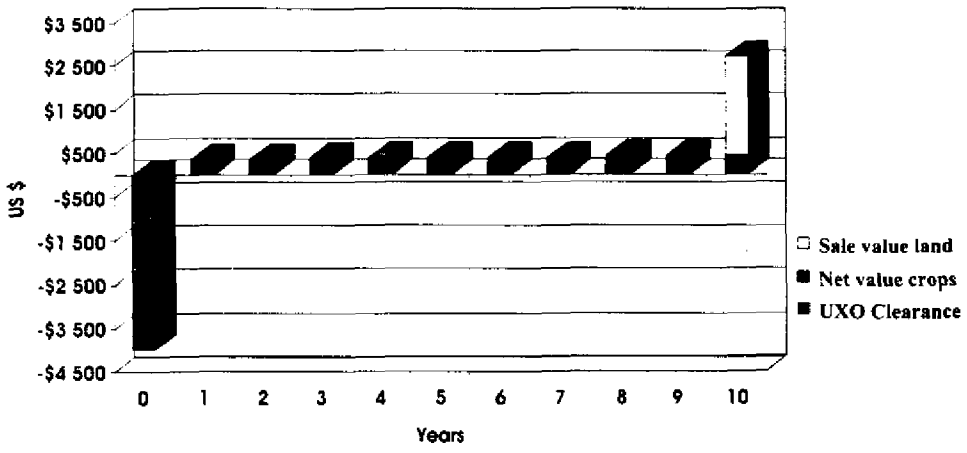
These underlying decisions or value judgements are often implicit or hidden. One of the most important benefits of thorough economic analysis is that it often brings into the open the value judgements that policy- and decision-makers are making implicitly.

[1] Those interested in these broader aspects — economics as a "worldly philosophy" — can refer to books by two recent Nobel laureates Sen (1999) and North (1990) See also the section *The Mine Impact Score as a compassionate measure* in Chapter 2, p 28.

Cost-benefit analysis[2]

Consider a simple example of the type of decision that a UXO LAO manager might face. She has been requested to clear some land for "wet season" rice paddies. Based on UXO survey information and on unit cost data from headquarters, she estimates it will cost about US$4,000 per hectare to clear the land. Based on information obtained by headquarters, she also knows the average yield per hectare should be worth about US$370 to the farmer next year, and that this will rise on average by over 2 per cent per year thereafter. Good rice land is a valuable asset in Lao PDR. Although such land is rarely sold, headquarters has developed a formula for "imputing" the sale value of land. With this information, the manager could prepare the following chart (Figure 7) depicting the likely economic costs and benefits relating to the clearance of one hectare of land over the coming ten years.

Figure 7: Simple Cost-Benefit Example



Is the UXO clearance justified on economic grounds?

In this example, simply adding the figures gives a total economic benefit of over US$6,350.[3] Costs will be only US$4,000, but these must be incurred today, while the benefits are spread over the coming 10 years. Might not the farmer be better off if he was simply given US$4,000 today to put in the bank to earn interest over the coming ten years?[4] The answer to this question depends, of course, on the interest rate available on bank deposits and it turns out in this example that, if the expected interest rate is over 6.95 per cent, the farmer would be better off with the money than the land.

Discounting

Making an economic comparison between costs and benefits that will arise in the future requires "discounting" to convert future values into "present values" (see

[2] This section uses data from Lao PDR and the study of UXO LAO – the Mine Action Centre (MAC) in that country.

[3] About 64 per cent of this is from the rice produced and 36 per cent from the value of the land.

[4] If UXO LAO's ultimate objective was to increase incomes of poor farm households, ***in theory*** it could do this by spending money on UXO clearance or, alternatively, by giving the money directly to the poor households.

Box 3· Discounting and the Time-Value of Money). The basic formula used is PV = FV/(1 + r)^{y}, where: PV = present value, FV = future value, r = annual discount rate, and y = number of years.

Box 3: Discounting and the Time-Value of Money

If given a choice between receiving money today and the same amount sometime in the future, people typically choose to take the money immediately. This phenomenon is termed the "time-value of money", but it holds more generally for any "good" or benefit: most chocolate-lovers will choose chocolate today over the promise of the same chocolate in a month. Similarly, most people will want to delay a cost (or a "bad"). Put in other words, people "discount" the value of future benefits. The "rate of discount" is calculated by seeing how much more of the future benefit a person would demand to exchange it for the benefit today.

For example, if a person would be just willing to exchange US$100 today for US$110 a year from now, her annual discount rate is 10 per cent, and the calculation is US$100 x (1.10) = US $110. The equivalent amount in two years would be US$100 x (1.10)^{2} = US$121, and the general formula is FV = PV x (1 + r)^{y}, where.

FV = future value PV = present value

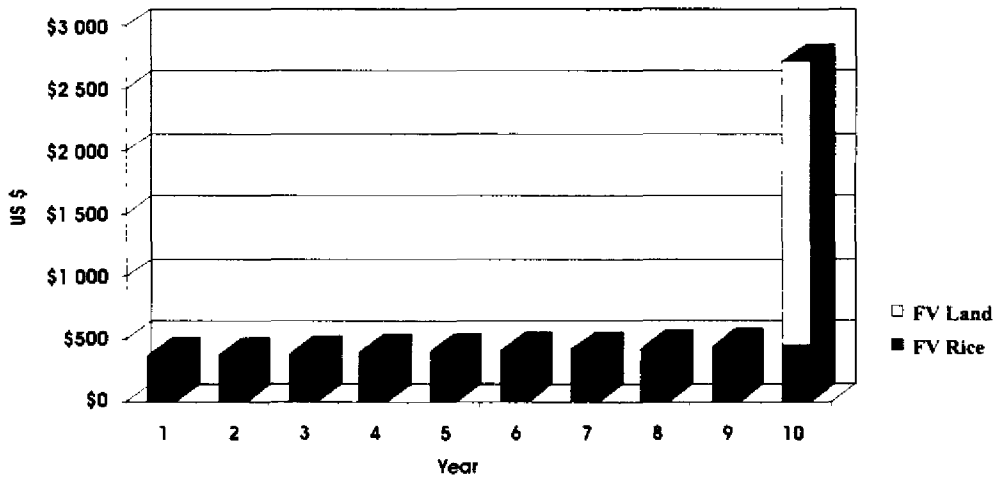
r = annual discount rate y = number of years

This is equivalent to the basic formula for discounting a future value to calculate the present value:

PV = FV/(1 + r)^{y}

Figure 8 depicts the stream of future benefits (both rice produced and the imputed sale value of the land) before discounting, while Figure 9 (page 44) compares the future and present (discounted) values of the rice produced.

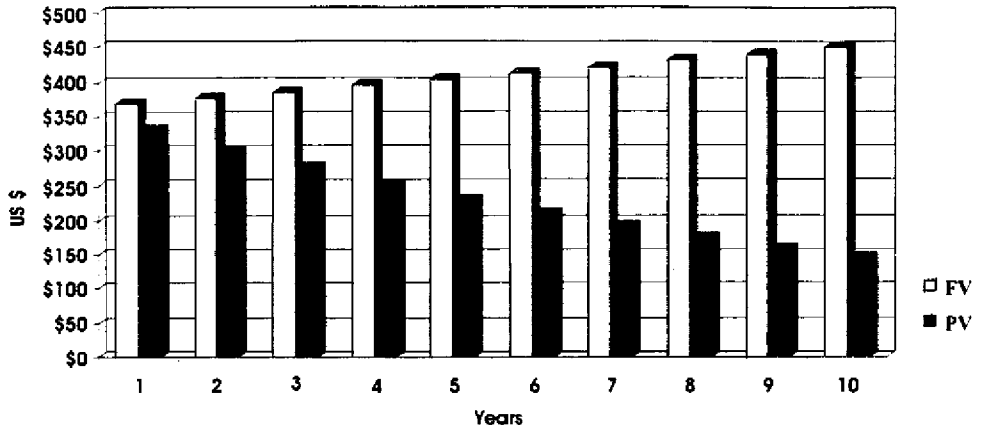
Figure 8: Future Values of Crops and Land



Building a useful model: Key parameters

A very simple model is useful for explaining basic cost-benefit concepts, but even the simple "rice economy" in Lao PDR is more complicated, and it is important to understand its features to ensure the model can usefully (and safely!) serve as a tool

Figure 9: Comparing Present and Future Values of Crop



for decision-making. The key features of the rural economy is Lao PDR are:

- Almost all rural households farm, and the vast majority of these grow rice;
- Land is allocated to households by the community authorities. While most farmers have "ownership-like" control over their land, households cannot generally buy or sell land. Therefore, there is no market for agricultural land, and land values cannot be gleaned from market prices;
- Rice yields vary by farming system, as follows:

Farming system	Average yield per hectare (1997)	Annual growth in yield per hectare (1985-97)
Rain-fed "wet-season" rice	2.9 tons	1.47%
Irrigated "dry season" rice[5]	4.0 tons	4.20%
Upland (sloping land) rice	1.6 tons	1.48%
Overall (weighted average)	2.7 tons	2.45%

- The average farm-gate[6] price for rice was US$177.10 per ton in 1997.
- Farmers save some of their crop to use as seed the following year, and there are spoilage losses during storage;
- Use of improved seeds, fertiliser, and other modern inputs is low, but rising quickly in the Mekong corridor (where there is little UXO contamination);
- The minimum acceptable economic "internal rate of return" (see Box 4: Net Present Value and the Internal Rate of Return) used by the Asian Development Bank for its projects is 12 per cent per annum. This is an appropriate, albeit conservative, discount rate;
- Many rural households do not have enough arable land, so household members spend a significant amount of time on non-agricultural pursuits, including hunting;
- The rural agricultural wage rate is about US$1 per day, but few opportunities for wage work exist in rural areas except during seasonal planting and harvesting peaks (i.e., when farmers are fully engaged on their own land).

[5] The yield figure for irrigated land is for the dry season irrigated crop only. Farmers might also plant rain-fed wet season crop on the same land.

[6] This refers to the price actually paid to farmers, which is much lower than the price in shops due to transport, processing, and marketing costs.

Box 4: Net Present Value (NPV) and the Internal Rate of Return (IRR)

The NPV is simply the present value of benefits minus the present value of costs. The basic formula for any one future year is $NPV_y = (B_y - C_y)/(1 + r)^y$, where ...

NPV_y = NPV for year "y"

B_y = Value of benefits in year "y"

C_y = Costs in year "y"

The symbol Σ is often used as shorthand to indicate the calculation is repeated (in this case, done for each year) and the results are added together. Therefore, the full formula is

$$\Sigma\, NPV_y = \Sigma\, (B_y - C_y)/(1 + r)^y.$$

The IRR is the discount rate that would have to prevail for the NPV to equal zero (i.e., for the present value of the stream of benefits to equal the present value of the stream of costs). A high IRR indicates a good investment.

Based on the above, our "baseline" cost-benefit model will use the following eight parameters[7] to calculate the PV of benefits:

1. Farming system/crop: lowland wet season rice
2. Yield: 2.9 tons per hectare
3. Growth in average yield per hectare: 2 per cent per annum
4. Less: inputs and spoilage losses: 20 per cent of production
5. Price: US$177.10 per ton
6. Number of future years: 20
7. Discount rate: 12 per cent

The above yields an interim figure – the NPV of the next 20 years of rice production on a hectare of cleared land. This is US$3,545.37. We will use this amount as the imputed sale value of the land 20 years hence.[8]

8. Imputed sale value of land: PV benefits = US$3,545.37

For costs, we have two items: the cost of UXO clearance itself, and the value of the extra household labour that will be required to farm the cleared land. For the latter, the new land only provides economic benefit if a farm household spends time clearing it of vegetation, planting, tending, and harvesting. This means household members will not have as much time available for other activities, including hunting, tending livestock, fishing/aquaculture, gathering firewood/making charcoal, weaving, etc. Such activities bring economic benefits, which the household will lose if it cultivates more land.

Wet season rice cultivation lasts about five months, farm households cultivate about 1.6 hectares on average, and the rural daily wage rate is about US$1 per day. Assuming the new land is allocated to "land-poor" households that now have only 0.6 to 1.0

[7] We have not included the value of livestock production in this model, because UXO does not impose significant risks for grazing, and Lao farmers graze stock on rice lands after harvest so no significant grazing land is lost as rice fields are expanded. Livestock is an important issue for land mine clearance in countries such as Afghanistan. The *Socio-Economic Impact Study for Afghanistan* (Mine Clearance Planning Agency, 1999) found milk and meat from livestock was the most significant economic benefit from mine clearance.

[8] One generally must be very careful not to double count various costs and benefits, but this example does not imply double counting. Rather, the sale price for land to be used for agricultural purposes will be based on the expected profits from the land's future crops. Past profits would be a good predictor of future profits, so we are simply using a measure of past profitability to establish a "guesstimate" for the land value. Any reasonable figure would do – the advantage of this one is that it is already generated by the model and no additional calculations are required.

hectares, this suggests an extra hectare would take about half a farmer's time over about 100 days, so 1/2 x 100 days x US$1/day = US$50 opportunity cost of labour per hectare per year

Before UXO clearance costs are considered, the NPV result for the baseline model is equal to US$3,539.43, implying that clearance costs averaging US$3,540 per hectare would be justified on economic grounds alone.

Preliminary cost studies commissioned by UXO LAO indicate its average unit cost[9] in 1999 to clear a hectare of land was between US$4,000 and US$4,400 [10] This is projected to fall to perhaps US$3,000 for the year 2000 due to higher productivity. These various clearance cost figures give the following results.

UXO clearance	NPV before clearance	Final NPV[11]	IRR[12]
US$3,000	US$3,540	US$540	14.2%
US$4,000	US$3,540	(US$460)	10.5%
US$4,400	US$3,540	(US$860)	9.4%

Upland rice land

UXO LAO also clears land for households to grow upland rice. Productivity in terms of yield per acre is significantly lower for upland rice — 1.6 tons per hectare rather than 2.9 tons per hectare. Also, it takes far more labour to grow rice using shifting cultivation practices: slashing existing vegetation, burning biomass (twice), fencing (to keep out cattle), and much more weeding than is required for lowland rice, where flooding the rice paddies controls weeds. Using the lower yield figure and doubling the imputed cost for household labour yields an NPV before UXO clearance costs of only US$1,412, and the following results for the various clearance costs:

UXO clearance	NPV before clearance	Final NPV	IRR
US$3,000	US$1,412	(US$1,588)	4.7%
US$4,000	US$1,412	(US$2,588)	2.4%
US$4,400	US$1,412	(US$2,988)	1.7%

Irrigated land

The yield for irrigated land is significantly higher than for wet season rice as used in our baseline scenario. Because of better water control, average yield per hectare is four tons for the dry season crop alone. But this is the second crop; normally farmers would plant a wet season crop on the same land, growing this without irrigation, so

---

[9] The unit cost includes direct clearance costs (labour, explosives, fuel, etc) plus overheads for capital equipment and administration including salaries of Lao managers It does not include salaries for international personnel, treating these as "start-up and capacity-building costs" We incorporate these costs in the final sections of this chapter

[10] The higher figure is based on the number of hectares cleared as reported in the UXO LAO study (579) The Work Plan 2000 reports a higher figure for hectares cleared (622), implying a lower cost per hectare

[11] Discounted at 12 per cent.

[12] The IRR figures indicate what the discount rate would need to be for UXO clearance to be a break-even proposition Higher rates indicate a better investment.

the total annual yield for the land is 6.9 tons per hectare. Conversely, some arable land is lost to irrigation canals. UXO will need to be cleared from this land as well. Assuming this averages a little over 11 per cent, the average yield per hectare of cleared land (both crop growing and irrigation canals) would be 6.2 tons per hectare.

Farmers using irrigation also make greater use of inputs, which our model captures because we calculate input costs as a percentage of yields. Greater use of modern inputs also means yields are growing faster – say 3 per cent per year rather than 2 per cent. Finally, labour requirements are significantly higher, both for the second crop and to maintain the irrigation canals. We will assume imputed labour costs to be four times higher than the baseline case, or US$200 per annum

The above adjustments yield an NPV before UXO clearance costs of US$7,524, and the following results for the various clearance costs:

UXO Clearance	NPV before clearance	Final NPV	IRR
US$3,000	US$7,524	US$4,524	27.4%
US$4,000	US$7,524	US$3,524	21.3%
US$4,400	US$7,524	US$3,124	19.7%

Future prospects

The analysis is conducted on the basis of 1999 clearance operations and 1997 rice production and price data (the latest available). The model predicts the same clearing operations would yield higher NPVs in 2000 because (1) clearance costs are dropping as productivity increases, and (2) agricultural productivity is rising.[13] For example, considering only the effect of 2 per cent/annum increases in agricultural productivity, the model projects a hectare of wet season rice land cleared in 2000 will be worth 2.21 per cent more than one cleared in 1999. This effect will grow at compounded rates with rising agricultural productivity, so UXO clearance will look increasingly attractive over time, particularly if UXO LAO can also continue increasing its productivity.

Sensitivity analysis

Cost-benefit and other types of economic analysis are based on models, which are simplifications of reality. Often, important elements are unwittingly left out or the social scientists do not have in-depth knowledge of the real situation and use inappropriate figures. As such, analysts should always be prepared to alter their analysis based on new information. But the cost of monitoring information is high, so it helps to hone in on those items that make a significant difference. Sensitivity analysis is sometimes used to identify the parameters in a model that cause significant changes in the results.

[13] This assumes rice prices will remain constant in real terms (i.e., adjusted for inflation), as will the major UXO LAO cost elements (salaries, equipment, explosives, etc.), or that the two move in parallel. Rice prices tend to fluctuate significantly because of the agricultural protectionism of developed countries. Agricultural productivity also fluctuates from year-to-year because of the weather and pests, so it is important to consider multi-year averages and long-term trends in productivity.

The following table shows changes in the final results as the various parameters are changed (using the baseline case and "medium" clearance costs of US$4,000 per hectare).

Parameter	10% change to ...	% change in NPV before clearance costs	Absolute change in IRR (at US $4,000 cost)
Average rice yield per hectare	3.19 tons	+11.1	+1 26%
Average sale price		Same as above	
Productivity increase per year	2.2%/yr	+1.7	+0.2%
Input/spoilage costs	22%	-2.8	-0.32%
Discount rate	13.2%	-9.5	-0.11%
Household labour costs per year	US$55	-1.1	-0.12%

From this, the critical parameters are: first, rice yield and farm-gate price (equal changes to these have the same effect in the model);[14] second, input/spoilage costs; and third, the rate of productivity increase. Changes in yields and prices should, therefore, be monitored [15]

So What (1)? Analysis for management

While UXO LAO managers should be interested in the sensitivity analysis results concerning what information and trends they should be monitoring, they have no control over things like average crop yields or rice prices. To be truly useful, a model should address some of the typical decisions that managers and policy-makers are required to make – the things they can influence, at least in part.

We have already seen that changes in the cost of UXO clearance are extremely important in determining whether clearing agricultural land will be justified in economic terms (whether measures in NPV or IRR terms). Cost control and staff productivity are, therefore, ***always*** very important for mine/UXO clearance programmes. In Lao PDR, UXO LAO has already taken steps to (1) reduce staff salaries by over 20 per cent and (2) improve its logistics management to control costs and reduce equipment downtime. Plans are also in place to adapt the training programme based on experience to date, which should means new staff will be more productive.

There are other areas in which UXO LAO, and mine action managers in general, have some influence over outcomes. An important area is work planning, including co-ordination with other agencies. A common problem is that land is cleared of UXO with the expectation that it will be farmed in the coming crop year, but for various

[14] Note however that an increase in price would not benefit a farm household if it was entirely in the subsistence economy (i.e., they neither buy nor sell rice) ***unless*** the increase causes it to engage in marketing. As well, an increase in price would be slightly more attractive to a household that does market rice, because no extra labour would be required. Conversely, an increase in yield would require some additional labour in harvesting and processing the crop. To keep the model simple, we have assumed this additional labour is small.

[15] Although the study team could not obtain official figures, the average price of rice seems to have fallen in recent years to an estimated US$135 per ton in 1998 and as low as US$112 per ton in 1999. Prices also vary significantly within Lao PDR, with average prices being highest in the central provinces and lowest in the north (Bourdet, 2000)

reasons[16] it lies fallow. Because of the time value of money, such delays can significantly reduce the economic benefits accruing to UXO clearance For example, using the baseline case and clearance costs of US$4,000 per hectare, a one-year delay in putting the land to use after clearance will reduce the NPV by US$330 and the IRR by 0.92 per cent. Clearance costs would then need to be below US$3,210 per hectare to justify UXO clearance on economic grounds alone In general, UXO clearance offers ***contingent benefits*** (i.e., whether potential benefits accrue is contingent on other things happening). As such, co-ordination with other agencies – and with the communities themselves – is critical to increase the likelihood that benefits will accrue as planned.

Mine action managers must also sequence their work over the year. Generally, they consider climatic conditions that complicate transportation to work sites and the effectiveness of certain equipment. However, there is also a seasonal pattern to agriculture. In Lao PDR, land preparation for lowland wet season rice begins about mid-May (with some regional variations), while transplanting from seedbeds is done in late June and early July. Therefore, clearance would need to be completed by late June if the land is to be planted the same year. Conversely, upland rice growing entails land clearance and burning from January through early April, so clearance would have to be completed much earlier if the land is to be used.

In general, mine action managers should factor the seasonal dimensions of the local agricultural economy into their work planning.

So What (2)? Analysis for policy

While economic analysis can help with work planning and day-to-day management decisions, in fact mine action managers do not base decisions on cold financial logic alone. Quite properly, they consider many factors when setting work priorities. Many of these relate to logistics, but some are, broadly, socio-economic (poverty, food security, child safety, etc.) or environmental (e.g., reduction of slash-and-burn practices).

For both effective management and accountability, it is important that the evaluative framework and information basis of decision-makers is made ***explicit*** (See Box 5: *Values, Information and Policies*). Policy decisions and the publication of policy statements serve these purposes, but only to a degree. Acknowledging that trade-offs will be made between, say, maximising the income stream to "society as a whole" and meeting the food security requirements of impoverished households in remote areas does not answer the question: How much weight is given to food security relative to income maximisation? Without answering this question, how can donor governments be sure their taxpayers' money given to mine action is being used in a manner consistent with their country's humanitarian values? How can senior managers in a national mine action programme be sure that the decisions made by implementing partners and provincial co-ordinators reflect the same values and priorities?

[16] Such delays could occur for many reasons, including the land is not allocated to a farm household; critical inputs (e g , credit to buy bullocks, seed) are not available at the right time, the government does not complete planned resettlement in time, no agricultural extension services are available to resettled households, who do not know how to grow crops appropriate for their new land; too much food aid is delivered, depressing local food prices and making it unattractive to plant rice

Box 5: Values, Information and Policies

Decision-making always involves choices, and the choices made depend on what the decision-taker values and the information at his/her disposal Further, values influence the **information base** in two ways: by determining (1) in part, what information is collected, and (2) the weights placed on different types on information

Economists and accountants are often criticised for making decisions based purely on financial or "countable" income figures. More generally, there is a danger that "what isn't counted doesn't count" because many decision-makers give full value to quantitative data while discounting qualitative information, which often is of critical importance. However, neither is it acceptable for managers of publicly- funded programmes to discount quantitative data and base decisions on information they value more highly **without making these value judgements explicit.**

In this light, policies can be viewed as serving two main functions — as explicit statements of values, and as a means for allowing decentralisation.

In making values explicit through policy statements, elected officials and senior administrators inform subordinates what information to value, and how. Subordinates can then be expected to make — roughly — the same decision as the senior officials, and can be held to account if they do not.

Such questions will never be fully answered However, economic analysis, broadened into socio-economic analysis, can help make these value judgements more explicit. For example, in Lao PDR, farmers in flat terrain and close to roads produce higher average yields, for four main reasons:

- Their land is easier to farm, with less labour;
- They have access to modern inputs (high-yielding seed, commercial fertiliser, tractors, etc);
- They have access to markets, giving them financial incentive to buy modern inputs or invest in water control measures, increase yields, and sell their surplus production;
- They have access to markets supplying "incentive goods" such as televisions and inexpensive textiles, which improve their quality of life.[17]

UXO clearance of flat terrain close to roads is also cheaper. Therefore, economic analysis will show benefit-cost ratios are higher for flat lands close to roads because (1) benefits are higher and (2) costs are lower. High yields and low-cost delivery of public services are both socially desirable outcomes that are captured by economic cost benefit analysis ***Social cost-benefit analysis*** is sometimes used to modify analytic results by giving ***explicit*** weight to other socially desirable outcomes, in line with explicit policy decisions.

For example, we might distinguish three categories of land, with different yields and UXO clearance costs but holding all other parameters constant, as follows:[18]

Characteristics ⇨	Flat, all-weather road	Flat, dry-season road	Flat, remote
Average yield	3.5 tons per hectare	2.9 tons per hectare	2.5 tons per hectare
Clearance costs	US$3,500	US$4,000	US$4,400
NPV before clearance	US$4,349	US$3,540	US$3,000
IRR	14 9%	10.5%	7.7%

[17] Subsistence farmers must assume extra risk to engage in the market economy For example, they may have to borrow money to purchase modern inputs, and they may depend on agricultural extension workers — who might not be around when needed — to learn new farming practices Financial incentives alone are generally not sufficient to entice farmers to accept such risks unless they can also buy things that make life easier and more enjoyable.

[18] The medium "flat, dry-season road" example is our earlier baseline case

The results obtained by cost-benefit analysis can be modified in three ways: by adjusting the costs, the benefits, or the discount rate In this example, one simple way of adjusting costs to tilt results in favour of less-advantaged households is to use average UXO clearance costs – in this case, US$4,000 per hectare.[19] This does not alter the NPV before clearance, but changes the IRR results to 13.1 per cent, 10.5 per cent, and 8.7 per cent respectively.[20]

Social cost-benefit analysis typically adjusts the benefits to give extra weight to socially desirable outcomes. In Lao PDR, one of the national development priorities is "increased food production" to achieve food security.[21] UXO LAO could, via a policy decision, give higher value to rice that will be directly consumed by a food-deficit household – typically by multiplying the yield expected from their newly-cleared land by a number greater than 1. The "conversion factor" then makes it explicit how much extra weight we are giving to rice production that contributes to the household food security objective, in addition to the standard economic benefit. For example, if we set the food security conversion factor at 1.25, we are giving 25 per cent more weight to rice that will be directly consumed in a food-deficit household.

Strictly speaking, we should only do this conversion for the portion of future production that is necessary for household food security. The arithmetic is modestly complicated, and we do not want UXO team leaders to do long calculations before making each clearance decision. Accordingly, the calculations can be done at headquarters and summarised on tables or graphs such as the following (for the sequence of calculations, see Box 6: *Calculating Food Security Adjusted Yields*)

Expected yield	Household size (hectares)					
	2	3	4	5	6	7
< 2.40 tons per hectare	Clearance not justified					
2.40 tons per hectare	X	X	X	X	X	Clear
2.47 tons per hectare	X	X	X	X	Clear	Clear
2.56 tons per hectare	X	X	X	Clear	Clear	Clear
2.65 tons per hectare	X	X	Clear	Clear	Clear	Clear
2.74 tons per hectare	X	Clear	Clear	Clear	Clear	Clear
2.82 tons per hectare	Clear	Clear	Clear	Clear	Clear	Clear
> 3.00 tons per hectare	Clearance always justified					

UXO LAO managers could use a similar approach to give greater weight to clearance that would allow slash-and-burn farmers to resettle on flat land to grow rice in less environmentally harmful ways. Once again, the advantage of this approach is that it makes explicit critical value judgements that policy-makers and managers are making anyway. Once these are in the open, they can be debated to ensure, in a more concrete manner, that the policies are consistent with government priorities and donor values, and that subordinates understand and can apply the policies more consistently

[19] This approach is often used, based on the value judgement that all citizens should have equal access to certain essential public services For example, Canada Post requires the same stamp on letters from one Toronto address to another as on letters sent 4,000 miles from Toronto to Vancouver

[20] Note that UXO LAO does not yet have cost accounting systems in place to give different standard costs for different combinations of terrain and road access In using the overall average clearance cost, it is implicitly favouring beneficiaries in more remote communities

[21] Food security must be assessed at various levels - national, regional, community, household, and individual - that are inter-related but not the same Our discussion focuses on household food security.

Box 6: Calculating Food Security Adjusted Yields

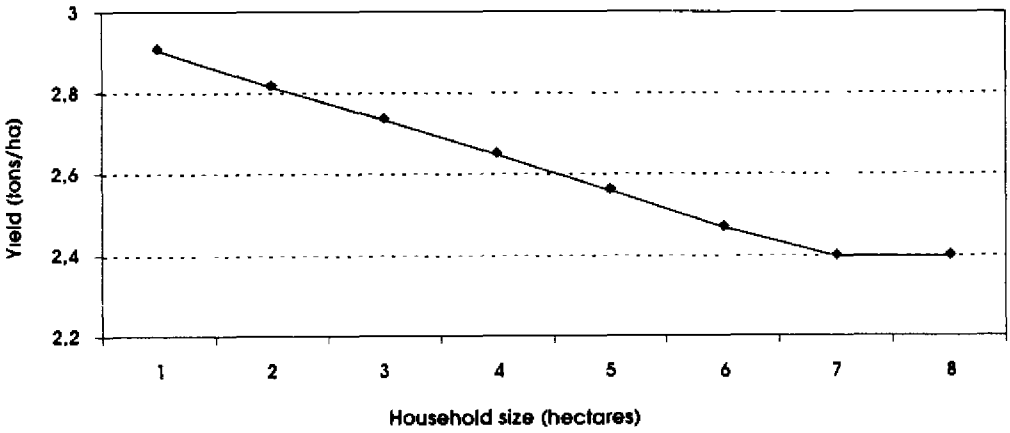
In the example above, we assume UXO clearance will be justified on social and economic terms if the "adjusted" yield promises to be above 3 tons per hectare. Starting with the **expected yield** obtained by the agriculture department or local informants, the adjusted yield is obtained in the following steps:[a]

1. Calculate the **milled rice requirements** by household size
2. Divide the result by 51 per cent to obtain the equivalent **paddy requirements** (i.e., 49 per cent of paddy rice by volume is lost in storage or milling, or saved as seed);
3. Subtract the paddy requirements from the expected yield to obtain the amount of **surplus paddy**. If the result is negative, use zero;
4. Multiply the paddy requirements by 1.25 (the conversion factor) and the figure obtained for surplus paddy by 1, then add the two results.
5. Multiply the expected yield by 1.25 to obtain the **maximum possible adjusted yield**.
6. Take the lesser of the results from steps 4 and 5 as the **adjusted yield**.

[a] These calculations are for households that presently do not have any land (e.g., resettlers). Information on rice requirements and losses in converting paddy rice to milled rice is from: Government of Lao PDR, Ministry of Agriculture and Forestry, 1999:17, Table 8: Rice Balance Sheet for 1995-2000

In many situations, such debates will raise other "special cases". Quite often however, debate might show that just about every group is a "special case". Either there is no justifiable reason for privileging one group over others equally impoverished, or the question of equity might best be dealt with by making a explicit policy decision to exclude services to well-defined groups that are relatively well off.[22]

Figure 10: Cut-Off Line for UXO Clearance



[22] In Lao PDR, this might be commercial farmers and/or farmers growing export crops who have more than, say, five hectares. These people might use commercial UXO firms as their decision to expand the cropping area is, essentially, a commercial proposition. Alternatively, UXO LAO could provide services on a cost recovery basis.

Evaluating the entire clearance programme

The models developed allow an assessment of whether to clear a particular area of land in the future The clearance cost per hectare is a "full-cost" figure including both direct labour, materials, fuel, etc., plus overheads for UXO LAO management, equipment depreciation and maintenance, local training costs, and similar items, based on 1999 cost and productivity figures. However, very significant sums were invested since late 1995 in building UXO LAO's capacity, and in the early years its clearance productivity was far lower. Can we say anything about the likely return on investment to these "start-up and capacity-building costs"?[23]

First, it must be emphasised that these historic costs have already been incurred. Economists refer to these as "sunk costs" and sunk costs should not influence future decisions. Significant capacity in UXO LAO has already been paid for and should be used as the NPV of future benefits promises to exceed that of future costs. The following exercise, therefore, is more relevant for donors when considering how best to establish new programmes in the future for mine contaminated countries.

To evaluate the entire clearance programme in Lao PDR, we need to start from its beginning in 1995 and compare the total costs against the benefits accruing from all clearance operations to this point in time We then need to forecast total clearance costs and total clearance benefits into the future.

Estimating total clearance costs from 1995

UXO LAO and its implementing partners perform both clearance and risk reduction (roving clearance and community awareness), so total costs must be apportioned among these functions. In 1999, an estimated 62 per cent of field staff time was spent on clearance, with the rest going to risk reduction. Detailed figures are not available for prior years, but we know risk reduction – particularly roving clearance – was given higher priority in earlier years, while there is pressure to shift more resources to clearance in the future. The following table gives our estimates for total costs (including international salaries) plus the percentages allocated to clearance

	1995	1996	1997	1998	1999	2000 (est.)
Total costs (US$000s)	1,091	4,371	8,206	10,031	10,293	10,615
% Clearance	45	50	55	60	62	64
Clearance costs	491	2,186	4,514	6,019	6,382	6,794

We project total costs will decline over a number of years to US$6 million in 2006 as international staff are withdrawn, and the proportion of total field staff (i.e., deminers and community awareness personnel) allocated to clearance to increase gradually until it reaches 80 per cent.

[23] As well, the cost figures per hectare used earlier do not include the continuing capacity-building costs (i e , the salaries and benefits of international technical advisors and trainers)

Estimating how many hectares will be cleared

An estimate for total benefits requires (1) the number of hectares cleared and (2) the estimated NPV from the average hectare cleared. For the first item, figures for 1996 to 2000[24] are:

Year and hectares cleared	Index (1996 = 100)	% increase (year-on-year)
1996 - 24	100	
1997 - 159	663	553
1998 - 292	1,217	84
1999 - 578	2,404	98
2000 - 1000 (projection)	4,167	73

We need a projection for the hectares likely to be cleared in future years, but cannot simply extrapolate from earlier years as UXO LAO was growing rapidly from 1995-2000, and this will not continue in the future. Total growth in clearance operations since 1996 stemmed from increases in (1) the number of deminers, (2) the percentage of time each deminer works on clearance (as opposed to roving), and (3) the average productivity of a deminer. For the first two items, we project UXO LAO will stop expanding in 2001 and that it will gradually reallocate from roving to clearance until 86 per cent of total deminers' time is spent on clearance by 2004. But how can we estimate future productivity increases?

As a basis for this, we first need to understand the reasons behind the rapid increase in clearance to date. The following table gives our estimates for three sources of increase.

Source of increase	1997	1998	1999	2000 (est.)
Additional deminers	309%	17%	7%	22%
Reallocation to clearance	8%	8%	7%	4%
Productivity increase	50%	46%	72%	36%
Total year-on-year increase[25]	563%	84%	98%	73%

About 54 per cent of the total increase in production (i.e., hectares cleared) from 1996 to 2000 is due to expansion of the programme (more deminers), with about 3 per cent due to reallocation of deminers from roving to clearance. A substantial increase in labour productivity[26] (i.e., the number of hectares cleared per deminer working on clearance) accounts for the rest. The pattern of labour productivity growth in the past gives some basis for estimating future productivity growth. Labour productivity increases peaked in 1999.[27] Following the peak (a 72 per cent year-on-year increase), it appears the rate of labour productivity growth will fall by half in 2000. We therefore project future productivity increases will decline by half each year. Based on these assumptions, the number of hectares cleared in future years is depicted in Figure 11

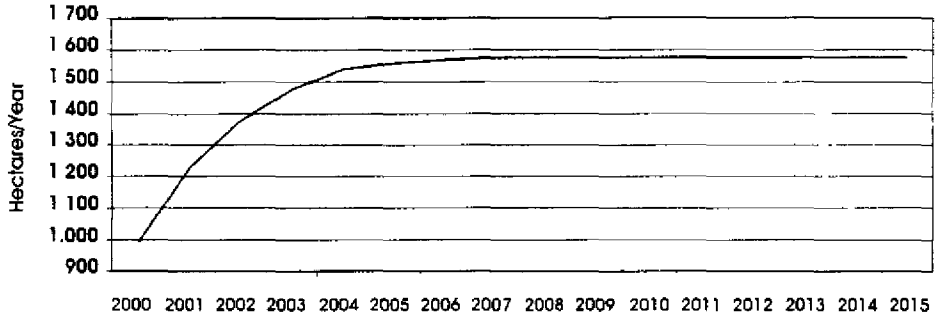
[24] Based on clearance rates for the first four months of 2000 relative to the comparable period in 1999

[25] Note, these columns do not add to the total – productivity increases are multiplicative. Using 1997 as an example, the formula is Total Increase = (100%+309%) x (100%+8%) x (100%+50%) - 100%. In this case, we know the Total Increase and the increases in both the number of deminers and the reallocation from roving to clearance, so we calculate the productivity increase as a residual

[26] Note, some of the increase in "labour productivity" may be due to better use of equipment, in which case this term could be called "total factor productivity"

[27] We assume the peak in productivity growth did not occur earlier because managers were new and busy expanding the programme (both numbers of personnel and provinces covered) until late 1998

Figure 11: Projected Hectares Cleared



Estimating NPV of benefits

We already have developed a model suggesting the NPV of clearing a hectare of rain fed rice land, at a 12 per cent discount rate (the baseline case), was about US$3,540 in 1999. Agricultural productivity is increasing at about 2 per cent per year, so the NPV of clearing the same hectare will be higher next year.[28] This pattern will continue as agricultural productivity increases over time.[29] We also know the NPV of clearing irrigated land is significantly higher, and will increase faster over time because of higher rates of productivity increases. It is hard to estimate average values for other clearance tasks (intensively farmed vegetable plots, roads, schools, health clinics, etc.), but these are likely to be significantly higher on average than that for rain-fed agricultural land.[30]

The basic model

Based on the above discussion, we will use the following parameters to build a model:

- Clearance costs = total costs x percentage attributable to clearance;[31]
- Hectares cleared = actual figures to 1999, then increased by projected changes in numbers of deminers, percentage of deminers' time spent on clearance, and labour productivity increases;
- Labour productivity increases = calculated at 72 per cent for 1999 and projected to decline by half each year thereafter,
- NPV of cleared rain-fed agricultural land = US$3,540 in 1999, adjusted for prior and future years for growth in agricultural productivity (estimated at 2 per cent per year);
- Average NPV of land cleared = 125 per cent of rain-fed agricultural land (as portions of the land cleared will have higher NPVs than rain-fed rice land).

[28] It will increase to almost US$3,620 for 2000.

[29] Similarly, the NPV of wet season rice land cleared in earlier years would be slightly lower than in 1999

[30] For example, the cost of replacing rural roads averages US$30,000/km (World Bank, 1997a iii) Clearing the entire length of the road to a width of 20 metres means a maximum area clearance of two hectares for every kilometre of road Bids for this type of clearance range up to US$2,000/ha (because the road is not in fact mined for its entire length). Therefore, total costs of perhaps US$4,000 provide an immediate benefit of US$30,000 – a net benefit of US$26,000 and an IRR (assuming the clearance is done fully six months before the road is reopened) of 5,525 per cent. Even if the road has deteriorated and requires reconstruction at, say, US$15,000/km, the internal rate of return for clearance six months prior to the road reopening would be over 1,300 per cent

[31] Calculated in this manner, average clearance costs per hectare were about US$11,040 in 1999, rather than the US$4,400 estimated in UXO LAO's *Cost Capture Study* (unpublished) This gives an idea of the scale of how dramatically international salaries and benefits push costs up