Therapeutic Decision Making in Pig Practice: Economics Made Easy

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Introduction

A predominant part of veterinary pig practice is the provision of advice to clients regarding the inclusion or exclusion of treatments, vaccinations, and procedures into the production system. The basis of this advice comes from a knowledge of the pathogenesis and epidemiology of diseases of concern, the pharmacokinetics of the proposed treatment regimes and their likelihood of success. Typically, there will be a variety of drugs, procedures and combinations thereof which have differing efficacies in achieving the desired objective.

Veterinarians are a resource valued by the pig producer because of the ability to provide concise and accurate information which enables him/her to choose the most efficient and convenient means of achieving production goals. To be effective solution-providers for clients, veterinarians need to be able to estimate the expected profitability of their management suggestions as well give reasonably accurate assessments of the risks involved in choosing one proposed intervention over another.

This paper will outline some of the techniques involved in providing economic justification for the recommendations that veterinarians make to pig producers. This discussion will be illustrated with a case study, and a spreadsheet program illustrating the calculations discussed is available.

Definitions

Diseases within a piggery enterprise fall under one of three categories:

(1) Endemic diseases

These diseases can be expected to occur continuously in most livestock enterprises where susceptible species are kept, unless control measures are undertaken (Morris 1971). Examples of these diseases in commercial piggeries include Enzootic Pneumonia, preweaning diarrhoea and sarcoptic mange.

Losses due to these diseases are reasonably predictable and it is possible, with experimental data, to provide financial estimates of the average adverse effects of these diseases in the long term. Since these conditions are continuously present in the piggery enterprise, it is not necessary to assign a probability to whether they will or will not occur.

When evaluating control programs for these diseases *partial budgets* are well suited for quantifying farm expected returns.

(2) Sporadic diseases

These diseases vary considerably in frequency and severity. They should be viewed as certain to occur at some time in the future, but not certain to occur within the planning period under consideration. Examples of these diseases in commercial piggeries include outbreaks of erysipelas and *Strep. suis*.

Economic assessment of these diseases must take into account the *probability* of the disease occurring, as well as the *severity* of the outbreak, should it occur.

Pay-off tables are suited to evaluate control programs for these conditions.

(3) Rare diseases

These are diseases which are not certain to occur in piggeries at all. Expenditure is directed towards preventing the disease from entering the piggery rather than treating or minimising its effect. Examples include those diseases exotic to a country or district, e.g. Aujeszky's disease and PRRS.

Economic assessment of these diseases is similar to that used for sporadic diseases. It is necessary to take into account the probability of the disease occurring as well as the severity of the outbreak, should it occur. These losses must be weighed against the cost of preventing the disease entering a piggery or region.

Risk analysis and *cost/benefit analysis* are best suited to evaluating control programs for these conditions.

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Budgets

Budgets fit into three main categories:

(1) Whole farm budgets

These budgets are used to assess how a change will affect total farm operation by comparing the revenues generated by the farm at its present level of production with the expenditure required to maintain the farm at that level. Specifically, whole farm budgets identify how easy or difficult it will be financially to implement a proposed program. Good examples of whole farm budgets for Australian and New Zealand pig producers are described by Pointon *et al* (1995).

(2) Farm cash flows

Farm cash flows consider only farm expected incomes and expenses over a specified period of time (see Table 1). When considering different programs for controlling disease, they are only able to determine the farm's ability to institute the proposed procedure. They do not provide information as to whether or not proposed programs are a good investment.

(3) Partial farm budgets

When considering a change to an enterprise that will not affect total farm management, only those costs and returns which are affected by the change need to be included in the analysis. Typically, these costs and returns are laid out under four headings:

A. Additional income as a result of implementing the program (e.g. more pigs sold).

B. Expenses no longer incurred (e.g. the treatment of sick animals).

C. Income no longer obtained once the program is implemented.

D. Cost of implementing the program.

The net change in farm income is given by:

$\Delta\ income = (A + B) - (C + D)$

An example of a partial budget referable to using vaccination and strategic medication with in-feed tetracycline for enzootic pneumonia as aids to control endemic *Actinobacillus* pleuropneumonia (APP) and Enzootic Pneumonia (EP) in a piggery is shown in Table 2.

Table 2 illustrates the main advantage of using partial budgets where only those costs (variable costs) that change as a result of the proposed intervention (number of pigs finished per year, amount of feed used, cost of medication, vaccination, and extra labour requirements) need be included in the budget. Overhead costs are ignored as irrelevant to the decision.

A limitation of such a budget is that it is not always possible to estimate the returns and costs associated with the change in question. *Sensitivity analysis* can be used to assess whether the conclusions drawn from the budget are robust enough to withstand errors in these estimates. This is a useful technique to use when outcomes, returns and costs are estimated. An example of sensitivity analysis, as applied to the example cited in Table 2, is shown in Table 3.

In Table 3, sensitivity analysis is performed by varying the expected improvement in growth rate per day and the cost of the ration, and examining the effect of different combinations of these two variables on net change in farm income. A three dimensional surface graph facilitates interpretation (see Figure 1). In this example, net return is sensitive to the expected improvement in weight gain from adopting the program. Compared to changes in weight gain, net return is less sensitive to changes in the cost of the ration. Thus, if advising producers to adopt this control program for APP and EP we need to be confident that our expected improvement in weight gain is likely to be greater than 10%. Based on literature reports of 17% improvement in average daily gain through effective control of respiratory disease (Straw *et al* 1989) we can feel relatively comfortable with our recommendation to adopt the proposed program.

Spreadsheets are a valuable tool for performing partial budgets. In designing the spreadsheet, items which are regarded as fixed in a single budget may be varied. This permits the budget to be quickly recalculated as often as required. In effect, this simplifies sensitivity analysis by facilitating the calculation of 'what if..?' scenarios and can make the same budget applicable to different herds with minimal difficulty.

Pay-off tables

With sporadic and rare diseases, the benefits of a control program centre around defining (a) the *risk* of disease occurring, and (b) how severe an outbreak could be if it does occur. Pay-off tables are a suitable means of defining the economic outcomes for control of these disease types. Also, pay-off tables are useful when we are uncertain as to the degree of effectiveness of a proposed control program.

To select a decision (A_1, A_2, ... A_i), information may be presented in the following mathematical form:

$$A_i = f(A_i, S_1, S_2 \ldots S_j, P_1, P_2 \ldots P_j, V_{i1}, V_{i2} \ldots V_{ij})$$

where:

A_i = the decision made

S_j = the outcome

P_j = probability that the outcome (S_j) occurs

V_{ij} = value of the outcome for each action taken

Using the Expected Monetary Value (EMV) as the decision criteria, then the EMV for each action (A_i) would be:

$$EMV(A_i) = \sum_j (P_i V_{ij})$$

with the highest EMV being the preferred option. Using the data from Table 2 and Table 3, Table 4 presents a pay-off table for three alternatives for controlling APP and EP. Three interventions are defined: (1) medication only, (2) vaccination for Enzootic Pneumonia only, and (3) a combination of vaccination and strategic medication.

Applying the partial budget spreadsheet used in Table 2, the net change in farm income for each of the proposed interventions (medicate, vaccinate, or medicate + vaccinate) is calculated for each of the possible outcomes. In this case, the possible outcomes considered are 0, 5, 10, 15, and 20% improvement in average daily gain (ADG).

The probability of the specified level of response for each intervention has been estimated and assigned to each intervention and outcome. With the medication only and vaccinate only option, we estimate that a 5% increase in ADG is predicted to occur 40% of the time and the medication + vaccination option is predicted to be slightly more efficacious producing a 10% increase in ADG 40% of the time.

Since the choice of intervention rests heavily on the probability of it producing an increase in ADG or not (as shown in Figure 1) it is important that we are conservative in assigning probability estimates. In this case, based on the probabilities assigned above, the decision to medicate and vaccinate yields the highest EMV, and this is the preferred option.

An alternative to using pay-off tables is *decision-tree analysis* where the decision process is represented graphically. A typical decision tree, using the same data as that used in Table 4 is shown in Figure 2. Software packages are available to conduct decision tree analyses (eg. Arbor™ and Smalltree™)

As with partial budgets, these basic techniques can be modelled very well using computer spreadsheet programs. This gives the decision maker the additional advantage of performing sensitivity analyses in which the input variables (the assumptions) of the model are systematically varied over a range in order to determine whether and how far the outcomes change.

If required, more sophisticated techniques such as dynamic programming, Markov chains, and Monte Carlo simulation may applied to more complex problems.

Further reading

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Table 1: Example of a cash flow budget for a typical piggery. Adapted from Pointon *et al* (1995).

CASH FLOW	Jan	Feb	Mar	Apr	TOTAL
FARM INCOME					
Pig sales	$31,740	$33,360	$31,785	$28,980	**$397,095**
Sheep and wool	-				**$6,200**
Agistment	-	$2,100	$380	$1,260	**$8,190**
Crops					**$7,100**
Other income			$2,250		**$9,000**
Capital income		$10,000		$15,000	**$45,000**
REVENUE	**$31,740**	**$45,460**	**$34,415**	**$45,240**	**$472,585**
FARM COSTS					
Accountancy					**$1,750**
Adminstration	$35	$35	$35	$35	**$420**
Animal health		$1,500	$1,500	$1,500	**$16,500**
Artificial breeding			$150		**$565**
Bank fees	$333	$762	$42	$106	**$2,217**
Cartage	$1,219	$1,281	$1,221	$1,113	**$15,249**
Consultancy			$600		**$2,400**
Dog upkeep	$50	$20	$20	$20	**$270**
Feed ingredients	$7,935	$8,340	$7,946	$7,245	**$99,273**
Fuel and oil	$771	$397	$413	$415	**$5,255**
Gas	$75			$75	**$300**
Grain/pellets	$8,252	$8,674	$8,264	$5,357	**$101,066**
Herd recording	$130	$130	$130	$130	**$1,560**
Insurances	$2,300				**$4,700**
Labour	$1,250	$1,250	$1,250	$1,250	**$15,000**
Levies/selling	$543	$570	$544	$496	**$6,792**
Licences and permits	$200				**$300**
Postage	$45	$45	$65	$120	**$850**
Power and heating	$1,100			$1,150	**$4,400**
Protective clothing			$80		**$210**
Rates and water	$3,035				**$3,820**
R and M (imprs)		$1,320		$1,050	**$5,250**
R and M (plant)		$660		$120	**$2,230**
R and M (vehicles)	$230	$415	$225	$25	**$2,325**
Stock requisites	$30	$30	$30	$30	**$360**
Superannuation	$145	$145	$145	$145	**$1,740**
Telephone			$250		**$1,100**
Transfers		$400	$200		**$600**
Travel and seminars		$150			**$150**
Vehicle registration			$373	$925	**$2,153**
Weeds and pests	$750	$250			**$1,000**
Workshop and tools				$100	**$350**
COSTS	**$28,428**	**$26,374**	**$23,483**	**$21,407**	**$300,155**
NET INCOME	**$3,312**	**$19,086**	**$10,932**	**$23,833**	**$172,430**

Table 2: Partial budget to assess yearly net change in farm income as a result of controlling Actinobacillus pleuropneumonia and Enzootic Pleuropneumonia using a combination of strategic medication and vaccination.

A. ADDITIONAL INCOME	**SUB TOTAL**	**TOTAL**
Decreased mortalities: 159 extra pigs finished at a weight of 60 kg @ $2.05 per kg	$19526	A. $19526
B. SAVINGS FROM REDUCED LOSSES		
Saved feed: 448 tonnes feed @ $400 per tonne	$179111	
Fewer dead pigs: 0.25 hours per day x 159 @ $9.00 per hour	$357	B. $179468
C. INCOME NO LONGER OBTAINED	nil	C. nil
D. COST OF PROGRAM		
Medication: 235 tonnes medicated feed @ $140 per tonne	$32960	
Record keeping: $50 flat fee per month + 2 hours per week @ $9.00 per hour	$1536	
Vaccination: 26061 doses @ $1.50 + cost of labour	$41900	
Extra labour units required: 1.5 @ $25000 per year	$37500	D. $113896
NET CHANGE IN FARM INCOME (A + B) - (C + D)		**$85098**

Table 3: Sensitivity analysis. Effect of expected improvement in growth rate and cost of ration fed on yearly net change in farm income. In this example, net change in income is more sensitive to change in weight gain from adopting the program compared to changes in the cost of the ration fed.

	Cost of ration ($ per tonne)				
Expected improvement in weight gain (%)	$300	$350	$400	$450	$500
0%	-$94013	-$94013	-$94013	-$94013	-$94013
5%	-$55632	-$49235	-$42838	-$36441	-$30044
10%	-$20740	-$8528	$3684	$15896	$28108
15%	$11118	$28639	$46161	$63383	$81205
20%	$40321	$62709	$85098	$107487	$129876

Table 4: Pay-off table for controlling Actinobacillus pleuropneumonia and Enzootic Pneumonia in a commercial piggery.

OUTCOME	NET CHANGE IN FARM INCOME					
	A_1 Medicate only	P_1 Probability of effect	A_2 Vaccinate only	P_2 Probability of effect	A_3 Medicate + vaccinate	P_3 Probability of effect
S_1: 0.0% increase ADG*	-$79 996	0.2	-$59 517	0.2	-$94 013	0
S_2: 5% increase ADG*	-$28 822	0.4	-$8 342	0.4	-$42 838	0.2
S_3: 10% increase ADG*	$17 701	0.2	$38 180	0.2	$3 684	0.4
S_4: 15% increase ADG*	$60 178	0	$80 657	0	$46 161	0.1
S_5: 20% increase ADG*	$99 115	0	$119 595	0	$85 098	0.1
EXPECTED MONETARY VALUE	-$23 988		-$931		$6032	

*ADG: Average Daily Gain

Figure 1: Graphical interpretation of data presented in Table 3.

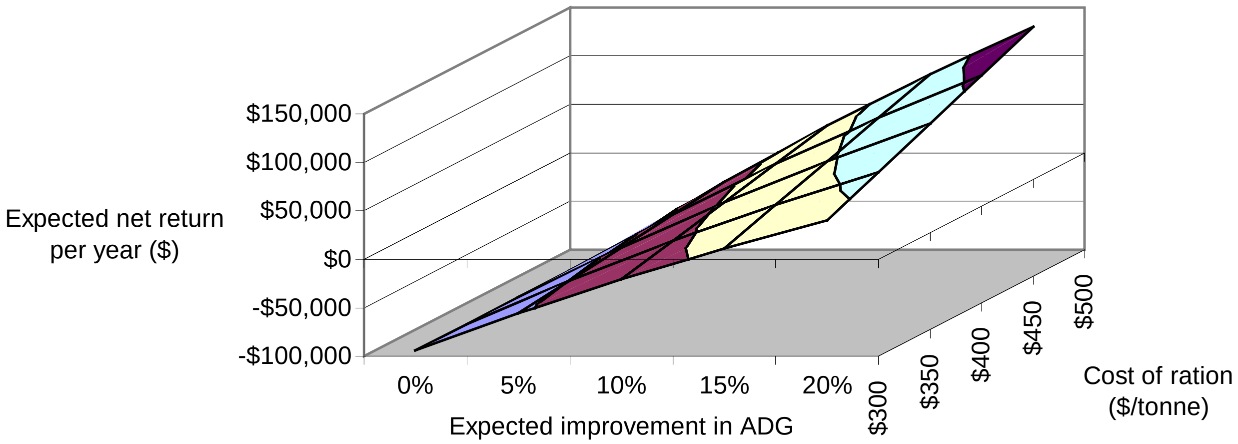
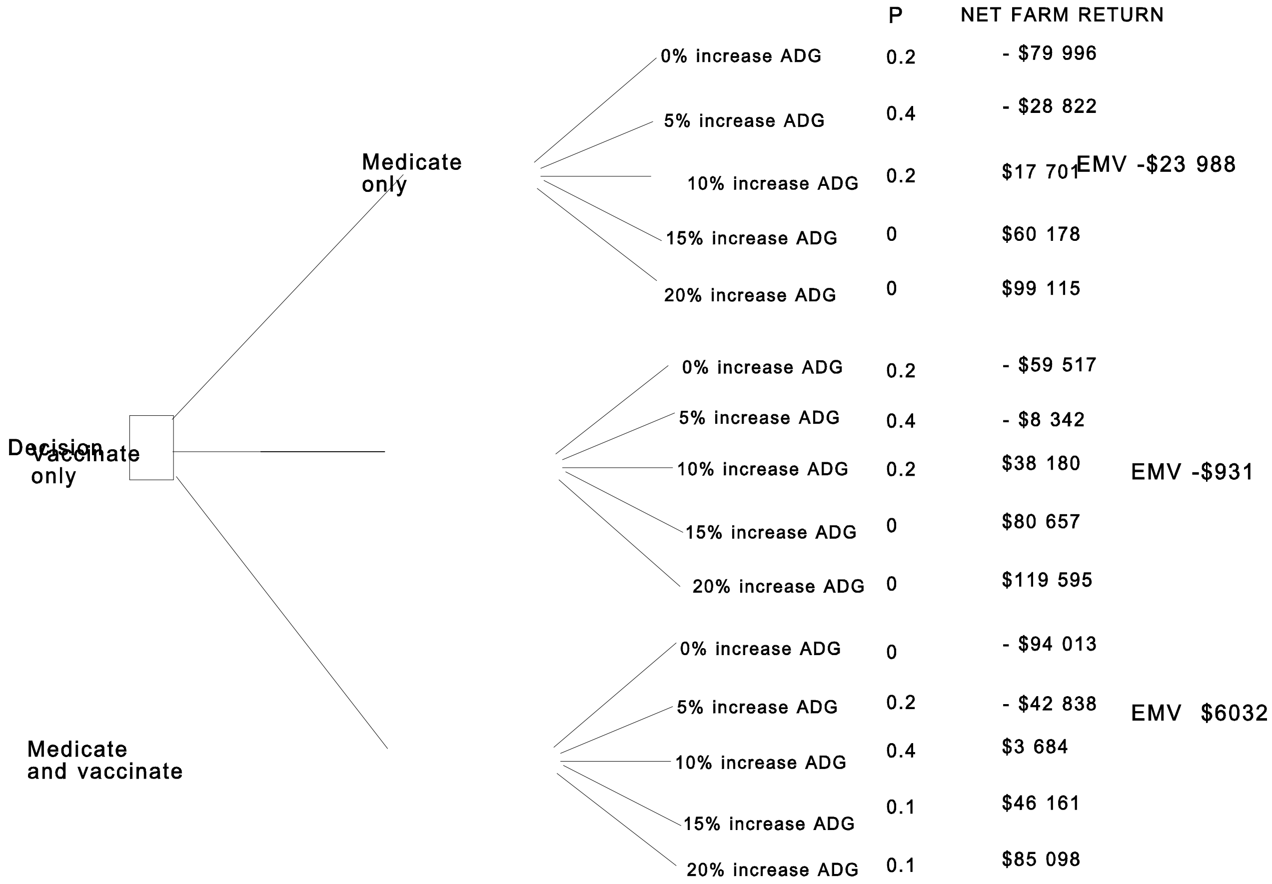


Figure 2:Decision tree analysis for controlling Actinobacillus pleuropneumonia and Enzootic Pneumonia in a commercial piggery.



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