AN EVALUATION OF ANIMAL-FRIENDLY PIG HOUSING IN A MEDITERRANEAN CLIMATE[(1)]

Martin Bent and Wendy Coleman

Muresk Institute of Agriculture, Curtin University

Northam, Western Australia 6401

ABSTRACT

Investment in new buildings is a major decision for intensive livestock producers. Trials into low-cost structures for housing large groups of growing pigs have been conducted in Western Australia. This paper presents a financial evaluation of these structures and concludes that the financial and physical flexibility that these structures offer is a major advantage.

Key words: animal housing, pigs, finance

INTRODUCTION

Changes in world agricultural policy following the Uruguay round of GATT have opened Australian pigmeat markets to competitively-priced imports from Canada, Europe and the USA (WA Pig Industry Taskforce 1996). High value markets for pigmeat products will continue to expand in Asia as populations grow and the socioeconomic status of households rises. Environmental and economic constraints are likely to hamper attempts at increasing pig production in many Asian countries.

Although parts of Australia have the resources and location to competitively supply pigmeat to the domestic and Asian markets, the current systems of production and processing prevent competition on a price basis (WA Pig Industry Taskforce 1996).

To compete, the Australian pig industry must reduce costs of production and processing and produce a more consistent product with the required quality and

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characteristics. Significant expansion is required in some areas to áchieve economies of scale and new production systems need to be implemented.

Another important factor is the rising public awareness of intensive animal production. Pressure groups may hinder attempts to increase production unless more environmentally sustainable and animal friendly systems are developed.

The high levels of capital required to establish or update commercial piggeries often act as a constraint. Low-cost housing option would enable more producers to expand production and exploit economies of scale.

The Australian pig industry is becoming increasingly risky. Investment in production capacity therefore needs to be more flexible with either shorter pay-back periods or a range of alternative uses for new buildings.

Low-cost structures

Low-cost alternative housing systems have been widely used in European breeding herds for many years (Ridgeon 1993). Although there has been some use in breeding herds in Australia, outdoor production of grower/finisher pigs is a relatively recent development (Taylor *et al* 1994, Payne 1995).

Low-cost shelters are considered to have a number of advantages over conventional buildings. They require a lower capital investment per pig space than conventional sheds. Shelters are claimed to be better for the pigs' welfare as they allow pigs freedom to move, forage and socialise in a relatively fresh atmosphere. Shelters are also considered to be more environment-friendly as they produce lower levels of odour and animal excreta is incorporated into manure that can be used as a fertiliser or compost. Finally the shelters are thought to be a more pleasant working environment which should enhance staff morale and retention.

Trials have been conducted by Agriculture Western Australia (AgWA) over the last three years into the performance of low-cost structures for housing groups of around 150 grower/finisher pigs (Payne 1994, 1995, 1996). The structures used in these trials were 9m wide and 22m long. The sides were clad with timber and the roof was a tarpaulin stretched over tubular steel arches. The ends comprised gates which were clad at the end facing the prevailing weather. One version had canvas roller blinds on the sides to allow ventilation. Blinds were also used on the ends for protection from rain and sun. Apart from a solid floor in the feeding area, the floor was bare earth and a deep-litter bedding system was used. Cooling was by thermostatically-controlled sprinklers.

Each shelter was filled with about 150 pigs with an average body weight of 22kg. An all-in all-out system was operated and pigs left the shelters at roughly 95kg after 14 weeks. The performance of the pigs was similar to that observed in commercial operation run by the company supplying the weaners and the feed.

Pig production in Western Australia

Pig production in Western Australia occurs in the agricultural zone in the south-west corner of the state. This zone has a mediterranean climate with a reliable annual rainfall of 200-400mm which falls during the winter months of May to September. Maximum daily temperatures in the summer in this region range from the mid-20°C to the mid-30°C. Temperatures in excess of 40°C do occur. In general, humidity is very low during the summer and spray and fan cooling are effective and cheap. Minimum daily temperatures during winter rarely reach freezing point.

Approximately 600,000 pigs are produced each year from 30,000 sows on 450 farms. Over six million hectares of grain are grown each year in this region.

TOTAL CAPITAL COST OF ACCOMMODATION

The costs of constructing grower-finisher housing varies widely in Australia and particularly in WA because of the small size and geographical distribution of the industry. This means that the price of materials (eg. concrete) can vary widely depending, principally, on location but also on quality. There can also be marked differences in site costs, such as infrastructure. There is a range of designs with variations in feeding, penning and manure handling, and, for a given design, a variety of materials may be used. There can be economies of size, with some unit costs declining as the size of accommodation increases.

Sources of information on building costs were limited and the costs used in this study were therefore based on figures provided by suppliers of some components, figures supplied by two local producers and from costs recorded in the AgWA trials.

A summary of the costs for the two types of shelter and two conventional sheds evaluated are shown in Table 1. An example of the costs of the components and their anticipated lives are given in total and per m^2 in Annex I. The costs per m^2 were calculated from the total costs and the area of pig accommodation.

Table 1 Building construction costs

Building Type	Ecoshelter 21.6m x 9.1m	Clearspan 22m x 9m	Conventional Shed I	Conventional Shed II
Building area	195.6 m^2	198.0 m^2	2592 m^2	1080 m^2
Accommodation	195.6 m^2	198.0 m^2	2007 m^2	826 m^2
Total Cost	$ 12,850	$ 12,250	$ 700,000	$ 236,000
Unit cost	$ 65 /m^2	$ 62 /m^2	$ 349 /m^2	$ 286 /m^2

As only approximately 77% of the area of the conventional sheds is actually used for pig pens, the costs of pig accommodation are much higher than the cost per m^2 of total shed area. The cost of constructing conventional housing is more variable depending on specification and location, and can be four to five times the cost per m^2 of the shelters.

Equivalent annual cost of accommodation capital

Although the initial cost of shelters is much lower than for a conventional shed, the expected useful life is much less. A more meaningful comparison therefore should be based on the costs per year, or equivalent annual costs, of the alternatives.

Three principal categories of costs need to be considered namely depreciation, repairs and maintenance and the opportunity cost of capital. In this study it was practically impossible to obtain meaningful repair costs. It was therefore assumed that replacement of assets would occur more rapidly than may occur in practice and that repair and maintenance costs are capitalised into these replacement costs.

Several techniques are used to convert these costs into annual equivalent costs (Barnard and Nix 1979, Bright 1992). The results of three analytical techniques of differing sophistication are presented below, namely (1) simple partial budgeting using average depreciation and opportunity cost of average capital; (2) pre-tax discounted cash flows (DCF); and, (3) DCF incorporating tax and inflation. In all three approaches, the components of the building were divided into groups depending on their anticipated useful life. An advantage of producing a real, pre-tax cost in partial budgeting (Technique 1) is that it is compatible with budgets that use current prices for other items such as pigs, feed and labour. The mathematical expression of these evaluations is given in Annex II

The results of the analyses are summarised in Table 2. Whilst the initial costs per m^2 of conventional sheds appear to be about four to five times the cost of the shelters, the equivalent annual costs appear to be around three to four times the cost per m^2 p.a. of shelters.

Table 2 Equivalent annual costs ($/m^2 p.a.)

Building Type	Ecoshelter ($/m^2 p.a.)	Clearspan ($/m^2 p.a.)	Conventional shed I ($/m^2 p.a.)	Conventional shed II ($/m^2 p.a.)
Initial capital cost	*65.4*	*61.9*	*348.7*	*285.6*
Technique 1	8.1	7.6	32.1	27.3
Technique 2	11.8	11.0	48.6	41.4
Technique 3	7.1	6.6	27.8	23.8

It is clear that the rankings and the relative magnitudes of the annual costs are similar across all three evaluation techniques. It is interesting that, in spite of marked differences in the cash flows, the costs are of a similar order of magnitude for both the simple partial budgeting approach (Technique 1) and the full post-tax discounted cash flow (Technique 3). The difference between the results from the two discounted cash flows (Techniques 2 and 3) are due to the marginal tax rate which was set at 40%. As the marginal tax rate decreases, the equivalent annual costs will approach those shown for Technique 2.

BUILDING CAPITAL COSTS PER PIG

Although the equivalent annual costs per m^2 p.a. of capital invested in conventional buildings appears to be substantially higher than for shelters (Table 2), these higher costs may be justified if either (a) more pigs are finished per m^2 per year, which would spread the costs, or (b) the operating costs are correspondingly lower.

The number of pigs finished per m^2 per year will depend on stocking density, ie the number of pigs per m^2, and the annual throughput, ie the number of batches housed per year. Annual throughput will depend on the time each batch occupies the housing and on down time, ie the time between batches when the accommodation is idle either whilst cleaning or the time between when one batch is sold and the next is housed.

Length of occupation

The time a batch occupies accommodation will depend on the start and finish weights and the daily liveweight gain. Unfortunately not all pigs in a batch start at the same weight or grow at the same rate. This variation in growth and current views on control of disease transmission present a producer with three alternative strategies.

- **Pure all-in, all-out.** In this approach the whole batch of pigs is housed, either in shelters or conventional sheds, on the same day and the whole batch leave together on the same day. Some of the finished pigs will be overweight and some will be underweight. The length of occupancy will be determined by the average daily liveweight gain of the batch and the average finished weight of the group that gives a distribution of carcases weights that balance the advantages of finishing at heavier weights with the disadvantages of penalties for excessive weight (and fat). There will be a wider range of carcase weights, fatscore, and hence price, with this approach than with the other two approaches.
- **Modified all-in, all-out.** In this approach the whole batch of pigs is also housed on the same day. However the pigs are selected and sold over a period in several groups. The selling period and the number of groups will depend on the variation in growth rates, the costs and benefits of selecting pigs and the opportunity cost of unoccupied accommodation. The next batch of pigs is not introduced into the building until the last of the present batch has been sold. In this case the length of occupancy will be strongly influenced by the growth rate of the slower growing pigs rather than the average.
- **Continuous flow.** In this approach pens within a shed are filled with pigs of a similar size. Pigs are sold within a fairly narrow weight band. Pens containing larger and/or faster growing pigs will empty earlier than those containing smaller, slower growing pigs. All pens are repopulated as soon as they have been emptied. Because individual pens are being re-populated, the growth of the slowest pigs is not delaying total repopulation as in the case of the modified all-in, all-out.

system. There is consequently a lower opportunity cost of accommodation associated with retaining slower growing pigs until they achieve a suitable weight and price. However there may be an important cost of lower overall performance associated with not totally clearing a building. It has been suggested (Campbell 1997, *pers comm.*) that the penalty for continuous flow production is a 10% decrease in daily liveweight gain compared to all-in, all-out production.

Growth rate and variation

Growth functions based on Kanis and Koops (1990) were calibrated to fit the growth patterns (a) observed in the AgWA trials, where the whole of life gain was 643g/day, and (b) reported in PigStats (Meo and Cleary 1996), where whole of life gain was 571g/day. These two functions were considered to represent "average" and "better" levels of performance. The growth performance in all-in, all-out systems was assumed to be 10% higher than in continuous flow systems.

In addition to using these standardised functions, the performance of nearly 1200 pigs finished in the AgWA trials was analysed to determine the variability of growth rates within groups of pigs. Pigs within each of eight batches were ranked according to daily liveweight gain observed over the first twelve weeks on trial. The average daily liveweight gain of each decile within each batch was then calculated and expressed as a percentage above or below the average performance of the whole batch (Bent and Coleman 1997).

The variation in growth rates was superimposed on the growth functions to give distributions of weights over time (see example graph in Annex III).

Selling options

The final stage in deciding the length of occupancy was to apply selling rules to the populations of pigs under each scenario. It should be noted that these rules were *ad hoc* with no attempt made to determine the optimum marketing strategy for each system. The selling rules were:

- *Pure all-in, all-out.* The whole batch of pigs was sold when the first decile exceeded the target weight of 95 or 120 kg.

- *Modified all-in, all-out*. Each batch of pigs was sold in three groups. Up to one of the deciles within each group could exceed the target weight.
- *Continuous flow*. Each decile was sold in the week prior to exceeding the target weight.

When these rules had been applied, an average sale weight, an average length of finishing period and the overall length of occupancy of housing by a batch were determined for the two levels of performance and each system of production.

Initial capital cost per pig space

Calculating the initial capital cost per pig space is straightforward where a pig requires the same area throughout the growing/finishing period. However, when there are two phases of growing, the area required in each phase must be weighted by the relative amount of time spent in each phase.

The initial capital costs and the area required per pig space for the different production systems and building options were calculated (see Table 5).

OPERATION COSTS

The various production systems, performance levels, target finishing weights and housing options will have different operating costs. The total costs of production under each system need to be compared in order to determine the most cost-effective system. Costs included in this analysis were the cost of the weaner, feed, bedding, water for drinking, cleaning and cooling, labour, machinery, veterinary and medicines, power, the opportunity cost of working capital, levies and selling costs and other overhead costs. Assumptions about these cost are presented elsewhere (Bent and Coleman 1997). It should be noted that these are only indicative costs as actual costs will vary widely from farm to farm and the set up and performance of shelters in these trials may not be optimal.

Total costs of production

The cost of production for each target weight, type of housing and production system were calculated. The detailed costs of production of one option are shown in Table 3 to illustrate the main points emerging.

Table 3 Effect of housing type on cost of production (¢/kg)*

	Shelter (1 phase)	Shelter (2 phases)	Conventional shed I	Conventional shed II
Weaner	101.75	101.75	101.75	101.75
Feed	69.48	69.48	69.48	69.48
Bedding	4.74	4.74	0.00	0.00
Water	0.50	0.50	1.38	1.38
Labour	5.04	5.38	3.73	3.73
Machinery	2.57	2.57	0.00	0.00
Selling costs	4.39	4.39	4.39	4.39
Health cost	1.54	1.54	3.08	3.08
Other costs	6.94	6.94	8.02	8.02
Building depreciation	2.56	2.09	4.83	4.18
Building capital opp cost	0.94	0.77	2.80	2.27
Working capital opp cost	2.47	2.48	2.45	2.45
TOTAL	202.92	202.63	201.93	200.74

* target weight = 95kg, better performance

Effects of housing type on cost of production

The type of housing would appear to have relatively little effect on the cost of production (Table 3). Many of the costs are the same per kilogram because of the assumption of similar growth rates, mortality and feed efficiency. The maximum difference of approximately 2.2¢ per kilogram ($1.40 per pig) between housing types cannot be regarded as significant given the margin of error in the assumptions made in this study. Nevertheless some conclusions can be drawn:

- Although using shelters in two phases can reduce initial capital investment by 25 - 30%, there is an almost insignificant reduction in the cost of production (0.3¢/kg), with the small saving in housing costs per pig being largely offset by higher labour costs.

- Shelters appear to involve higher expenditure of about $5.70 per pig on bedding, labour and machinery for manure handling.
- Shelters appear to have lower costs of about $4.70 per pig for water, health, other costs (principally electricity) and buildings.
- The higher costs of the first conventional shed compared to the second shed make a small difference to the overall cost of production (1.2¢/kg).

There would therefore appear to be no significant difference in the cost of production per pig or per kilogram of meat between housing systems. Careful evaluation of costs of bedding, labour and water would appear to be essential before deciding on the most appropriate housing in a particular instance.

Table 4 Effect of system on cost of production (¢/kg)*

	Modified all-in, all-out	Pure all-in, all-out	Continuous flow
Weaner	101.75	109.49	102.57
Feed	69.48	66.34	76.36
Water	1.38	1.29	1.56
Labour	3.73	3.15	3.47
Selling costs	4.39	4.73	4.39
Health cost	3.08	3.32	6.16
Other costs	8.02	8.63	8.01
Building depreciation	4.18	3.72	4.21
Building capital opp cost	2.27	2.02	2.28
Working capital opp cost	2.45	2.16	2.61
TOTAL	200.74	204.85	211.61

* target weight = 95kg, better performance, conventional shed II

Effect of system of production on costs

Example costs for pure all-in, all-out, modified all-in, all-out and continuous flow production are given in Table 4. There is a dramatic difference in cost of production per pig of nearly $14 dollars per head. In part, this is due to the differences in finishing weights.

Differences in costs per kilogram are proportionally much less (Table 4). Lower average finished weight in the pure all-in, all-out system means that costs such as the price of the weaner are spread over a lower finished weight and result in a higher cost per kilogram for this item. Feed efficiency is better at these lower weights and the quicker turnover of batches reduces the building costs per pig and per kilogram.

From these results the modified all-in, all-out system gives the lowest cost of production per kilogram. There will be a narrower range of weights in the modified all-in, all-out system than in the pure all-in, all-out system which should give slightly higher returns. The cost per kilogram in the continuous flow system are substantially higher than in either of the all-in, all-out systems.

FURTHER CONSIDERATIONS AND CONCLUSIONS

Based on measures of cost and profitability per pig finished or per kilogram of carcase, there would appear to be no advantage in using shelters compared to conventional sheds *per se*. However, using shelters (or conventional sheds) for all-in, all-out production is clearly more profitable than using conventional sheds for continuous flow production.

The decision to invest in a particular system of production will not necessarily involve choosing the system that gives the highest profit per pig or per kilogram. A number of further considerations will affect the choice.

Return on capital

Calculation of return on capital (ROC) is straightforward where there are unambiguous statements of 'return' and 'capital'. However, in many circumstances, calculation and interpretation of ROC is complicated because there are several alternative ways of calculating both 'return' and 'capital'.

Average and initial fixed capital

The initial capital costs per pig space calculated for producing pigs with a target weight of 95kg were approximately $55 for shelters operating in two phases, $70 for single phase shelters and $160 - $200 for the two conventional sheds.

The capital invested per pig space will vary over the years as the buildings and fittings depreciate and are replaced. This is clearly demonstrated in Figure 1 which shows the nominal value per m^2 of the Ecoshelter and the two conventional sheds over 35 years. Clearly if a constant profit margin is obtained the return on capital will vary over the years as the value of the assets varies.

As the investment per pig space in conventional housing is approximately three times the investment in shelters, the return on fixed capital (ie the capital invested in accommodation only) will be three times as great from shelters as from conventional sheds.

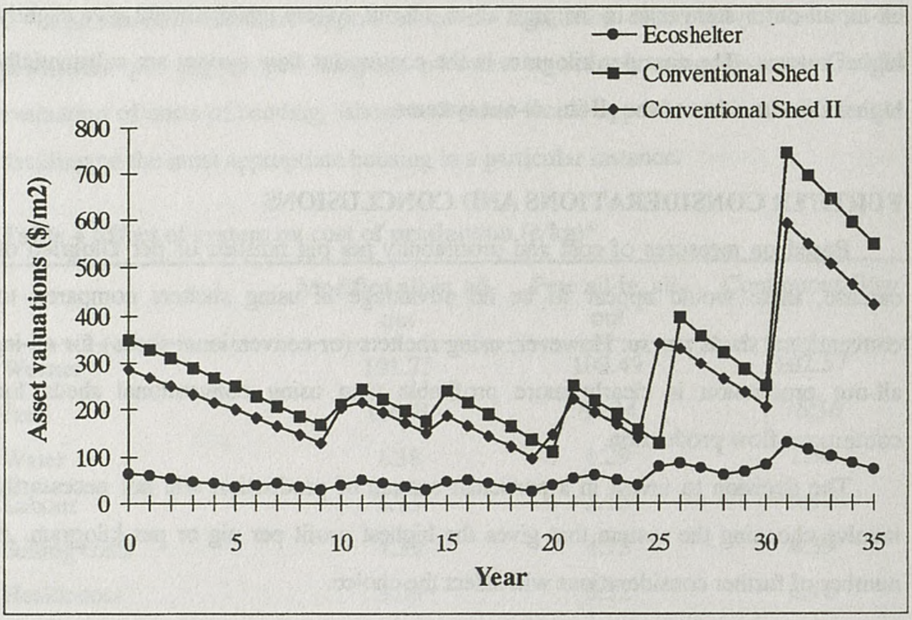

Figure 1 Nominal capital value of accommodation ($/m²)

Working and total capital

The average working capital invested in a grower/finisher pig is between $90 and $100 per head. Thus the total capital per pig in a new facility will be between $150 and $170 for shelters and $260 to $300 for conventional sheds.

If the profit margin per pig is the same for both types of housing, then the return on total capital will be roughly twice as high for shelters as for conventional sheds.

Even if the profit margin per pig in shelters is lower than in conventional sheds the return on total and fixed capital can still be higher from shelters than from conventional sheds.

Scale of operation

Shelters require only a third of the fixed capital and half the total capital of conventional sheds. Therefore a grower can purchase twice or three times the production capacity in shelters for the same investment. This means that a slightly lower margin per pig can be accepted in shelters. Alternatively, an acceptable income may be generated from the holding in times when profit margins are reduced.

Financial feasibility

Lending institutions will be interested in the potential profitability of an investment but will also wish to see appropriate collateral offered for any borrowing. Buildings for pig production do not usually increase the value of a property by the amount they cost to erect>

A farmer with assets valued at, say, $1.5 million and little debt should find it relatively easy to borrow the $55,000 - $70,000 to put up shelters to accommodate 1000 growers compared to borrowing the $160,000 - $200,000 required to house the same number of pigs in a conventional shed.

Flexibility and risk

Lower-cost, shorter-life shelters allow a greater deal of financial flexibility than that associated with conventional buildings. Quitting production if trading conditions deteriorate becomes a more realistic option when sunk costs are kept to a minimum. As smaller amounts of money need to be located for building replacement, less money needs to be sourced externally at any one time and risk is reduced.

Synergies

The use of straw-based housing systems, particularly for contract growing can fit in well with other activities on a mixed enterprise farm with machinery already present, low opportunity cost straw and slack labour at various times of the year.

Manure

The costs of disposing of manure beyond stockpiling were not included in the estimated costs of production. Payne (1996) calculated that the value of nutrients in

40 tonnes of manure removed from a shelter at AgWA to be approximately $750 which should more than cover the cost of spreading.

It has been suggested that the manure may have a higher value when sold to worm farmers or garden compost manufacturers. However similar benefits might be obtained from treated effluent from conventional sheds and the benefits may be more to do with the entrepreneurial skills of the producer and the local opportunities rather than significant differences in waste products from the two systems of housing.

Working conditions

Odour appears to be kept to a minimum in shelter systems. Pig vices such as tailbitting are reported as less common in shelters and the incidence of respiratory problems in pigs is lower (Honeyman, 1995). These factors make working conditions more pleasant for farm staff which should make recruitment and retention of well motivated staff easier.

Environmental impact

A possible environmental cost associated with the operation of the shelters is the seepage of nutrients from the manure pack into the subsoil beneath the housing. Soil Management Consultants Pty Ltd (1995) collected and analysed soil samples throughout the operation of the AgWA trials to assess the environmental impact of the alternative housing system.

Results from these samples indicated an increase in soil nitrogen with the introduction of the first batch of pigs. Levels stabilise and very little change in soil nitrogen levels were recorded between the end of the first batch and the end of the second. Soil phosphorus levels remained unchanged throughout the trials. On the basis of these findings there appears to be a minimal external cost associated with the operation of the shelters.

CONCLUSIONS

Several conclusions emerge from this study:

- The cost per m^2 of pig accommodation in conventional sheds is approximately five times the cost in shelters (Table 5). This greater cost is, in part, due to the lower proportion of space within conventional sheds which is used to actually accommodate pigs.

- The equivalent annual cost per m^2 of accommodation (depreciation and interest) in shelters is about a quarter of the cost of conventional sheds (Table 5).
- The initial capital cost per pig space will depend on stocking density, finishing weights and growth rates. In general, the initial cost per pig space in shelters is 30% - 40% of the cost of conventional sheds (Table 5).
- Housing pigs in shelters in two phases with higher stocking rates at younger ages can reduce the initial capital investment per pig space by 20% - 25% depending on production system (Table 5). Greater initial savings will be possible from this practice if pigs are finished at higher weights and/or weaned directly into shelters.

Table 5 Alternative housing costs ($)

	Shelter (one phase)	Shelter (two phases)	Conventional shed
Cost per m^2 of accommodation ($/$m^2$)	65	65	280 -350
Equivalent annual cost ($/ m^2 p.a.)	8	8	27 - 32
Initial capital cost per pig space* ($/pig)	72	57	160 - 200

* Better performance pig, target finish weight 95kg, modified all-in, all-out production

- When all costs of production are included, there would appear to be an insignificant difference in the cost of production per pig or per kilogram of carcase weight between shelters and conventional sheds.
- Although two phase housing reduces the initial capital investment compared to one phase of housing in shelters, there is effectively no difference in the cost of production per pig.
- Substantial reductions in total costs of up to 11¢/kg may be obtained from all-in, all-out production compared to continuous flow production.
- Although profit margins per pig from shelters would appear to be similar or slightly lower than in conventional sheds, returns on initial and fixed capital would appear to be up to three times as great in shelters compared to conventional sheds.
- The returns on total capital (ie including investment in weaner, feed, etc.) would appear to be twice as great in shelters than in conventional sheds.

- The lower capital requirement per pig space for shelters should allow a two - three times larger scale of operation for the same investment.
- The lower capital requirements of shelters will make raising finance for grower facilities easier and the payback period shorter. This will reduce the financial risks associated with long-term investment.
- Shelters appear to have significant advantages in terms of animal welfare and staff working conditions.

Conditions

The above conclusions are based on some significant assumptions.

- The growth rate, feed efficiency and backfat thickness of pigs in shelters and conventional sheds are similar.
- Details of labour requirements of conventional sheds and shelters are scarce. The details of handling of pigs in shelters are still being refined.
- The cost and availability of straw and the costs and options for manure disposal will vary from farm to farm and will affect the financial advantages of shelters.
- The number of pigs required to fill a shelter for all-in, all-out production may be difficult to produce in one batch on small- to medium-sized farms. Collaboration within producer groups may be one way to provide the necessary volume. Alternatively producers may have to move to batch farrowing every two, three or four weeks to generate large enough groups. Batch farrowing may have further advantages. Smaller shelters than those used at AgWA are available, although there will be slight dis-economies associated with smaller shelters. Partitioning within shelters is being used in some instances. However the health status and performance of multiple groups within a single shelter may be reduced. Further research is required into this option.

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AUTHORS

Dr Martin Bent is Senior Lecturer in Agribusiness Management at Muresk Institute of Agriculture, Curtin University, Western Australia. He is currently seconded as CEO to the. *Wendy Coleman* is a researcher at Muresk Institute of Agriculture working on projects for the WA Pig Industry Investment Board.

ANNEX I

Building Type	Clearspan 22m x 9m		
Building area (m^2)	198.0		
Accommodation (m^2)	198.0		
Component Description	***Total cost ($)***	***Unit cost ($/m^2)***	***Expected life (years)***
1 Kit -steel frame	4500	22.7	25
2 Kit -tarpaulin	1000	5.1	5
3 Timber for walls (posts and cladding)	1400	7.1	7
4 Concreted feeding pad (3m x 9m x 0.1m)	400	2.0	15
5 Gates, partitions, fencing	800	4.0	15
6 Feeders (1 Maxifeeders)	2200	11.1	10
7 Drinkers (10 drinkers plus piping)	150	0.8	10
8 Cooling system	250	1.3	5
9 Miscellaneous hardware	50	0.3	10
10 Siteworks (leveling, footings, etc)	500	2.5	15
11 Labour (2 men x 5 days)	1000	5.1	10
Total	12250	62.4	

Building Type	Conventional Shed II		
Building area (m^2)	1080		
Accommodation (m^2)	826		
Component Description	***Total cost ($)***	***Unit cost ($/m^2)***	***Expected life (years)***
1 Sheds - erected	70000	84.7	25
2 Concrete (on-site batching)	33000	39.9	30
3 Concrete slats	16000	19.4	25
4 Blinds	11000	13.3	10
5 Penning	33000	39.9	10
6 Feed system	25000	30.2	10
7 Drinking system	7000	8.5	10
8 Electrical fitting	25000	30.2	15
9 Effluent handling, ponds	5000	6.0	15
10 Siteworks (leveling, footings, etc)	9000	10.9	25
11 Plans, surveys, licences	2000	2.4	25
Total	236000	285.6	

ANNEX II

Technique 1: Simple partial budget

$$\textit{Average annual ownership cost} = \frac{(C_0 - R_t)}{t} + \frac{(C_0 + R_t)\ I}{2}$$

Where:

C_0 = capital cost at time 0
R_t = resale value at time t (terminal/salvage value)
t = anticipated life in years
I = opportunity cost of capital (%) (interest rate)

Technique 2: Simple discounted cash flow

$$\textit{Equivalent annual cost} = \frac{(H_t)}{A_t}$$

Where:

H_t = holding cost to year t
A_t = annuity factor for t years

$$\textit{Holding cost to year t } (H_t) = \sum C_i - R_t$$

Where

C_i = present value of capital purchases at time i, where 0>i<t
R_t = present value of resale at time t (terminal/salvage value)

and all costs and discount and annuity factors are real, pre-tax.

Technique 3: Full discounted cash flow

$$\textit{Equivalent annual cost} = \frac{(H_t)}{A_t}$$

Where:

H_t = holding cost to year t
A_t = annuity factor for t years

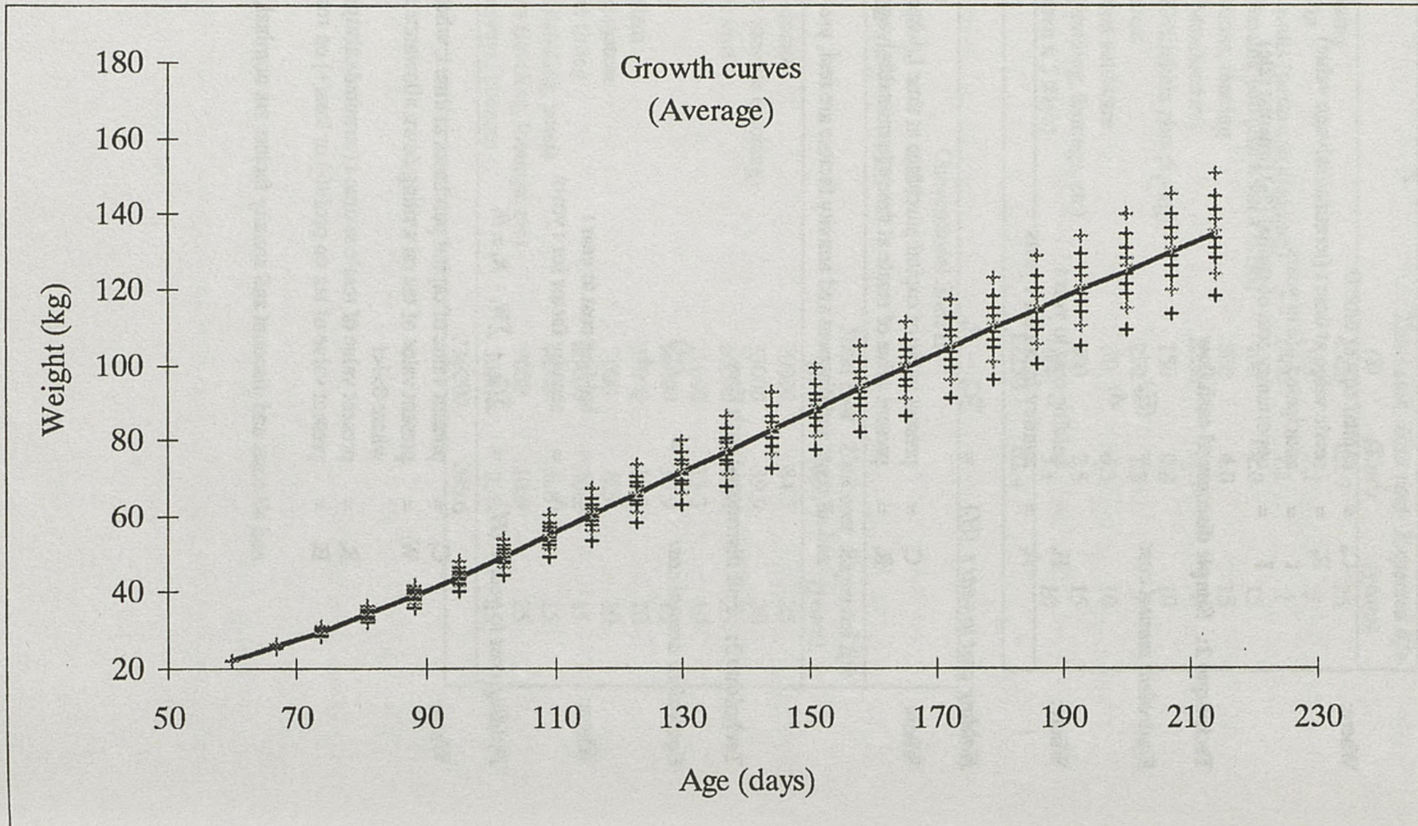
$$\textit{Holding cost to year t } (H_t) = \sum C_i + \sum W_i - R_t \pm B_t$$

Where

C_i = present value of capital purchases at time i, where 0>i<t
W_i = present value of tax on writing down allowance at time i, where 0>i<t
R_t = present value of resale at time t (terminal/salvage value)
B_t = present value of tax on profit(-) or loss(+) on resale at time t

and all costs and discount and annuity factors are nominal, post-tax.

ANNEX III


Growth curves
(Average)
Weight (kg)
180
160
140
120
100
80
60
40
20
50
70
90
110
130
150
170
190
210
230
Age (days)