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EX POST BENEFIT/COST ANALYSIS

PROJECT No: 94/075

Enhancement of yabby production from Western Australian farm dams

Prepared for the FRDC

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NON-TECHNICAL SUMMARY

This report describes the results of an ex-post benefit cost analysis of the FRDC-funded project 'Enhancement of yabby production from Western Australian farm dams' (Project No. 94/075). The project was carried out by the Western Australian Marine Research Laboratories.

The project had three objectives:

To increase harvests from WA farm dams by providing farmers with:

(1) population control method(s) that increase the proportion of yabbies of marketable weights [over 30g].

(2) Quantified methods for reducing dam environmental factors limiting yabby production and causing variation in dam productivity

(3) A manual of methods for stocking and managing farm dams to increase harvest per dam.

The main findings of the project were that stocking density, feeding and male:female ratios were the most important factors which influenced growth rates. A reduction in stocking density from 4.5 to 1 yabby/m^2 was more significant in increasing growth than the standard industry feeding regime. A comparison of different feeds and feeding rates carried out research station showed that 20% higher growth rates were achieved by feeding yabbies with a crayfish reference diet at the same rate (2.5 gm/m^2/week) as the industry standard diet of lupins. When yabbies were fed the crayfish reference diet at a rate of 10 gm/m2/week, growth rates were 84% higher that the industry standard rate. Results of on-farm trials were inconclusive.

The research station trials also showed that growth rates improved when ponds were stocked with males only. The project investigated yabby "varieties" from around Australia to assess the potential of producing a male only strain or hybrid. A number of hybrids were produced which showed preliminary evidence of hybrid sterility. Further research was recommended which was funded by a subsequent FRDC project.

The costs of the project were $470,662, of which FRDC contributed 73% or $354,474). Implementation costs of project recommendations are mainly increased feed costs. These are accounted for in the analysis through consideration of the profit margins of farmers.

Four potential benefits were identified:

(1) increased total production of yabbies;

(2) increased average price of yabbies,

(3) increased profits earned by processors and;

(4) increased rural employment.

Realisation of these potential benefits occurs if project results are disseminated and there is adoption of results by yabby farmers. The results of the project were disseminated through open days, roadshows, Aquainfo leaflets, extension visits and

regular discussions with farmers. In July 2000, a booklet entitled "Yabby Farming: Frequently Asked Questions" was published.

Since the end of the project in 1997, there was little evidence to suggest that research findings have been adopted and led to higher production and an increase in the average size of yabby harvested. Total production has continued to be highly variable, without any clear upward trend. Given the variability in past production and confidentiality or inaccessibility of available data on productivity and average yabby sizes between farmers adopting versus not adopting the project recommendations, informal estimates of project effects had to be used to quantify benefits. Discussions with both processors and farmers suggested that an increase in total production of 10% per annum over the next ten years was a reasonable expectation. Only around half of this potential increase was likely to be attributable to the results of the research, with the remainder attributable to other factors, including existing extension support by processors and greater awareness amongst farmers of the need to produce higher quality product.

With regard to an increase in the average price of farmed yabbies, it appeared that for "serious" yabby farmers, rather than those who harvest yabbies occasionally, the average size of yabbies harvested has increased over the last three years from 30-40g to 50 – 70g. This has led to higher average farm gate prices. Processors anticipate that the trend to produce larger size grades of yabby will continue Based on discussions with industry, it was therefore assumed that increases in the proportions of larger sized animal in annual harvests would lead to an annual increase of 2.5% in average price paid to farmers. After deducting increased operating costs, 80% of this increase in average price represents an increase in farm profits as a result of producing a greater number of larger sized yabbies. Because processors were encouraging farmers to grow larger yabbies through the use of feeding regimes, it was also assumed that around 50% of any increase in farm profits was due to the research findings and extension.

With regard to an increase in profits of processors, it was found unlikely that the increase in production and average prices would lead to an increase in total profits of processors because the benefit to processors of additional volume would probably be counteracted by the continuing profit margin squeeze.

Another potential benefit was an increase in employment. As most yabby farmers are wives of sheep and wheat farmers, their labour generates economic benefits that are realised through higher profit margins rather than an increase in measured rural employment. It was anticipated that the project would be unlikely to increase employment in the harvesting and processing sectors, given the small projected increase in total production.

Net present values and benefit cost ratios for the FRDC research were calculated at three discount rates. The results are shown in the table below.

Net present values and benefit cost ratios

Discount Rate	**6%**	**8%**	**10%**
NPV of economic benefits	$372,204	$242,360	$143,257
Benefit/cost ratio	2.2:1	1.8: 1	1.5: 1

EX POST BENEFIT/COST ANALYSIS OF PROJECT No: 94/075

Enhancement of yabby production from Western Australian farm dams

Agency: WA Marine Research Laboratories, Waterman

1 Objectives

To increase harvests from WA farm dams by providing farmers with:

- Population control method(s) that increase the proportion of yabbies of marketable weights.
- Quantified methods for reducing dam environmental factors limiting yabby production and causing variation in dam productivity
- A manual of methods for stocking and managing farm dams to increase harvest per dam.

2 Background

In inland southwestern Western Australia, some farmers have diversified their traditional cropping and sheep enterprises to include yabby farming in their farm dams. At the time the project was conceived, the industry had experienced rapid growth rates from a production level of 1.7 tonnes in 1987 to 127 tonnes in 1993. At least half of the product was exported live to markets in Europe and Asia.

One of the main problems facing yabby producers during harvesting was the low proportion of yabbies of marketable weight (over 30g). This was attributed to the high fecundity of yabbies and their uncontrolled reproduction in farm dams. Farmers had also observed that there was a substantial variation in yabby harvests between dams. This was attributed to erratic feeding practices, inadequacy of the feed (lupin) and the fact that many yabby dams were chronically deficient in calcium, which is needed for shell formation.

This project was aimed at removing these constraints to yabby production to realise a perceived potential to expand annual production to 5,000 tonnes, valued in 1994 at $50 million.

3 Research Findings

There were two main components to the research: increasing the productivity of dams and the proportion of marketable size yabbies; and assessing the relative aquaculture potential of different species of yabby. To carry out this research twenty-five ponds were constructed at Waterman Research Station to run replicated random and reproducible experiments in an environment that simulated farm dams. A logbook system for farmers was also initiated to record management practices and yabby harvests.

1.1 Increasing the productivity of dams and the proportion of marketable size yabbies

The research found that a number of factors influenced growth rates of yabbies. In particular, stocking density and type and quantity of feed were important. Over a 105-day grow-out period, yabbies at low stocking densities gained more weight than those farmed at higher densities. A reduction in stocking density from 4.5 yabbies/m^2 to 1 yabby/m^2 was more significant in increasing growth than adopting the standard industry feeding regime of lupins (2.5g/m^2/week). Specifically, 79% of growth could be attributed to density and 21% to feeding.

Table 1 summarises the main results from research station feeding trials. Significantly higher growth rates were achieved by feeding yabbies with a crayfish reference diet rather than the current industry standard diet of lupins. Increasing the amount of feed per week also improved growth rates, with the crayfish reference diet producing higher growth rates than the lupin diet. The crayfish reference diet was therefore recommended as a control diet for future evaluation of yabby feeding and management regimes.

Trials carried out in farm dams yielded slightly different results. The replacement of lupins with the crayfish reference diet led to improved growth of yabbies in some of the dams participating in the trial – but not all. This was attributed to highly variable farm dam environments and the use of lower than planned feed rates. It was concluded that further on-farm trials were required to replicate the research station experiments.

Table 1 Comparative growth rates on different feeds with a stocking density of one yabby/m^2

Feeding regime	Growth rates (% increase in weight)
Industry standard rate of lupins 2.5g/m^2/week	45% higher than no feeding
Lupins at 10g/m^2/week	28% higher than industry standard rate
Crayfish reference diet of 2.5g/m^2/week	20% higher than industry standard rate
Crayfish reference diet of 10g/m^2/week	84% higher than industry standard rate

The project investigated the effect on growth rates of mono-sex culture compared to mixed-sex culture. Ponds stocked with male-only yabbies produced a greater proportion of animals in the larger size classes (over 30g). Growth rates were 53% higher than ponds with mixed sex populations and 68% higher than ponds stocked with females only. Furthermore, males in mono-sex culture grew 17% faster than males in mixed-sex populations, whilst females in mono-sex culture grew 31% faster than females in mixed sex populations.

Trapping selectivity also had an effect on male:female ratios. Results showed that the proportion of males above 20g caught in traps was significantly higher than of females. This was because the traps used by industry to harvest yabbies were selectively removing the faster growing male yabbies, leaving behind the berried females capable of producing large numbers of juveniles. This resulted in an increase in yabby density and lower growth rates.

Other environmental factors that affect yabby production were found to be inadequate aeration (for example, due to low wind exposure from high banks) and water chemistry parameters; both of which are location and dam dependent. Calcium nitrate was found to increase dissolved oxygen levels in ponds and oxidise anaerobic sediments, potentially permitting higher feeding levels compared to non-aerated ponds.

1.2 Aquaculture potential of various yabby species

The research showed that highest growth rates occur from the culture of male only yabbies. Using a strain or hybrid that did not breed would, therefore, have the greatest aquaculture potential. The project investigated yabby varieties from around Australia to assess their potential for strain selection and population control.

Laboratory experiments were carried out on these varieties to assess their relative aquaculture potential (size, growth, size/age at sexual maturity, sex ratio) under identical controlled conditions.

A number of strains failed to grow to the 30g minimum marketable size and were therefore excluded. The introduced Western Australian *albidus* strain was considered to be as good as or superior to most of the Australian strains evaluated. A number of hybrids were produced by this study which showed preliminary evidence of hybrid sterility and or heterosis (single sex offspring). More research to confirm fecundity and age/size of sexual maturity of these hybrids was recommended. This research was subsequently funded by FRDC.

4 Benefit/Cost Analysis

There are two major components of net economic benefit in cost/benefit analysis - producer's surplus and consumer's surplus. Producer's surplus is a measure of net economic benefits created in the harvesting and processing sector from a specific research project. Although a simplified explanation, producer's surplus can be thought of as additional profits generated. In addition, if the research findings induce increases in production and employment, then to the extent that previously unemployed labour is employed, the associated wages would also be included as a benefit in producer's surplus.

Consumer's surplus is a measure of net economic benefits to consumers. For example, if a research project induces an increase in product supply that in turn results in a decrease in prices on the domestic market, then domestic consumers would be better off. Consumer surplus is simply a measure of this improvement in consumer well-being.

In simple terms, to undertake the benefit/cost analysis, it is necessary to estimate all economic benefits that flow from the research findings. Benefits are then compared to the financial cost of research, plus any economic costs that are required to capture the benefits.

1.3 Costs

The total project cost was $479,662 of which FRDC contributed 75% ($254,474). In addition there are implementation costs of project recommendations, particularly increased feed costs. These are accounted for in the analysis through consideration of the profit margins of farmers.

1.4 Potential Benefits

There are four potential benefits arising from this research programme:

(1) An increase in the total production of yabbies.

(2) An increase in the average price of yabbies

(3) An increase in the profits earned by processors

(4) An increase in rural employment

An increase in total production of yabbies

Increased production of yabbies per dam may occur if farmers changed their practices with respect to stocking density, feeding and aeration. Also, improved production and profitability per dam may lead to an increase in the number of dams under production. With only around 25% of the total number of dams in Western Australia currently used for farming yabbies, there is clearly plenty of scope to increase production.

An increase in the average price of yabbies

The second potential benefit is an increase in the average price paid for yabbies as a result of an increase in the proportion of large sized yabbies in the harvest as a consequence of reduced stocking densities, improved feeding regimes and mono-sex culture.

An increase in processor profits

An increase in yabby production will lead to higher throughput for processors. It could be expected that processors would benefit from this additional throughput by earning increased profits.

An increase in rural employment

The third potential benefit of the project arises from any increase in employment in rural areas in both the harvesting and processing industries as a result of increased yabby production. Wages paid to labour represent economic benefits, provided the labour would otherwise have been unemployed.

1.5 Realisation of benefits

Economic benefits from the research will only occur if the research results are disseminated effectively and adopted by industry. The results of the project were disseminated through open days, roadshows, Aquainfo leaflets, extension visits and regular discussions with farmers. In July 2000, a booklet entitled "Yabby Farming: Frequently Asked Questions" was published.

An increase in total production of yabbies

It would be expected that, since the end of the project in 1997, there would be some adoption of project results, leading to higher production and an increase in the average size of yabby harvested. However, there is little evidence to support this. Total production has continued to be highly variable, without any clear upward trend, as shown in Table 2. According to processors and research staff, participation in yabby farming is related to the profitability of wheat and sheep farming, the main economic activities of farms in the areas where yabbies can be grown. When wheat and sheep prices are high, there is less need for alternative income sources and participation in yabby farming wanes. Low production in 1995/96 was apparently due to drought in yabby farming areas, while the 1998/99 crop was adversely affected by an outbreak of a muscle-wasting disease (*Thelohania).*

Table 2 Production and Value of Yabbies (Western Australia)

Year	Quantity (tonnes)	Value	Average value/tonne (based on processor returns)
1994/95	210	$2,100,000	$10,000
1995/96	112	$1,230,000	$10,982
1996/97	124	$1,152,000	$ 9,290
1997/98	230	$2,252,600	$ 9,794
1998/99	166	$1,590,900	$ 9,584

Source: ABARE

Anecdotal evidence from processors and farmers indicate that some dams have improved their productivity as a result of increased feeding and improved management, but the extent of this increase in productivity is not known. In addition, there is no clear evidence to indicate that an increased number of farm dams have been brought into production in recent years.

Looking ahead, opinions of processors were mixed as to the likely impacts of the project results. Some indicated that the results will have a positive impact on yabby farming practices and that productivity would increase significantly, while others thought that farmers have done little to change their practices and that, in any case, feeding and mono-sex culture have always been known to improve growth rates. Given the variability in past production and confidentiality or inaccessibility of available data on productivity and average yabby size between farmers adopting versus not adopting the project recommendations, informal estimates of project effects have to be used to quantify benefits. Discussions with both processors and farmers suggest that an increase in total production of 10% per annum over the next ten years would be a reasonable expectation. However, discussions also indicated only around half of this potential increase is likely to be attributable to the results of the research, with the remainder attributable to other factors, including existing extension support by processors and greater awareness amongst farmers of the need to produce higher quality product (see Table 4).

An increase in the average price of yabbies

It appears that for "serious" yabby farmers, rather than those who harvest yabbies occasionally, the average size of yabbies harvested has increased over the last three years, leading to higher average farm gate prices. This is confirmed by processors who indicated that there has been an increase in the average size of yabbies produced from 30-40 g to 50-70 g. Processors anticipate that the trend to produce larger size grades of yabby will continue. The average prices for various size grades of yabbies are given in Table 3.

Table 3: Average yabby prices to farmers in 1999/2000

Size grade	**Average price (per kg)**
30-50 g	$6.50 – $7.50
50-90 g	$9.00 – $9.50
More than 90g	$10.00 – $10.50

Based on discussions with industry, it is assumed that increases in the proportions of larger sized animal in annual harvests will lead to an annual increase of 2.5% in

average price paid to farmers. Part of this increase will be accounted for by an increase in operating costs, as larger sized animals require improved management and more feeding. Previous estimates of the costs of production (Farming Yabbies, Aquaculture WA 1999) show that average operating costs account for just over 30% of average revenues (price), when improved management and feeding practices are carried out. All the feed and probably half the fuel costs (for feeding) are likely to be additional costs to the farmer of following project recommendations. These account for 65% of total operating costs or 20% of average revenues. Assuming that these estimates are still valid, then 20% of average price should be deducted to cover any increase in costs of feeding. Therefore 80% of the increase in average price represents an increase in farm profits as a result of producing a greater number of larger sized yabbies (see Table 4). But not all these extra profits are attributable to the research results. Before the project started, processors were encouraging farmers to grow larger yabbies through the use of feeding regimes, so it may be realistic to assume that around half of any increase in farm profits is due to the research findings and extension.

An increase in processor profits

Table 2, which is based on processor returns, shows the average value of a tonne of yabbies before further processing and packing. Processors have explained the decline in average values by observing that the competition between processors for export markets has led some processors to undercut their competitors, squeezing margins in order to maintain or gain access to markets. Given this situation, it appears unlikely that the increase in production and average prices to farmers will lead to an increase in total profits of processors because increasing competition between processors will squeeze their profits, i.e. the benefit to processors of additional volume will probably be counteracted by the continuing profit margin squeeze.

An increase in rural employment

Yabby farming provides employment for farmers, harvesters and processors. In yabby farming, the majority of yabby producers are women, wives of sheep and wheat farmers. Most of them are looking for income-generating work on-farm and, as such, are not part of the labour force actively seeking employment. Therefore their labour generates economic benefits that are realised through higher profit margins

rather than an increase in measured rural employment. A few of these farmers do not harvest the yabbies themselves but use "harvesters" (professionals who harvest yabbies on behalf of a group of farmers). Given the relatively small projected increases in production in terms of total tonnage it is unlikely that there will be an increase in the number of harvesters.

The increase in production attributed to the project is unlikely to increase employment in the processing sector, as processors are currently able to handle larger quantities of yabbies than currently produced, without increasing their labour force.

Table 4 Net Benefits of Project 94/075

		1994/5	1995/6	1996/7	1997/8	1998/9	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2004/05	2006/07	2007/08	2008/09	2009/10
Costs																	
FRDC	$	143,216	103,504	107,754													
Other	$	47,934	55,202	36,417													
TOTAL COSTS	$	$191,150	$158,706	$144,171	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits																	
Annual Production (tonnes)					*230*	*166*	*230*	*250*	*275*	*302.5*	*333*	*366*	*403*	*443*	*487*	*536*	*589*
10% Increase in production (tonnes)					*0*	*0*	*64*	*20*	*25*	*27.5*	*30*	*33*	*37*	*40*	*44*	*49*	*54*
Increase in production attributed to project (tonnes)	0.5				*0*	*0*		*10*	*13*	*14*	*15*	*17*	*18*	*20*	*22*	*24*	*27*
Average price/tonne received by farmer ($)	$				*0*	*7500*	*7500*	*7688*	*7880*	*8077*	*8279*	*8486*	*8698*	*8915*	*9138*	*9366*	*9601*
A. Value of increase in production attributed to project ($)	$	$0	$0	$0	$0	$0		$76,875	$98,496	$111,054	$125,214	$141,179	$159,179	$179,474	$202,357	$228,158	$257,248
Increase in average price/tonne $	$							*187*	*192*	*197*	*202*	*207*	*212*	*217*	*223*	*228*	*234*
Increase in operating costs/tonne $	0.2							*37*	*38*	*39*	*40*	*41*	*42*	*43*	*45*	*46*	*47*
Increase in profits/ $	$						-	*150*	*154*	*158*	*162*	*166*	*170*	*174*	*178*	*183*	*187*
B. Increase in farm/harvester profits attributed to project on existing production	0.5	$0	$0	$0	$0	$0	$0	$18,000	$21,141	$23,836	$26,875	$30,302	$34,165	$38,521	$43,433	$48,970	$55,214
TOTAL BENEFITS (A + B)	$	$0	$0	$0	$0	$0	$0	$94,875	$119,637	$134,890	$152,089	$171,480	$193,344	$217,995	$245,790	$277,128	$312,462
NET BENEFITS	$	-$191,150	-$158,706	-$144,171	$0	$0	$0	$94,875	$119,637	$134,890	$152,089	$171,480	$193,344	$217,995	$245,790	$277,128	$312,462

1.6 Net Benefits

The discounted present values of research costs and estimated benefits are shown in Table 5 using three different discount rates. The net present value of economic benefits (after accounting for research costs) ranges from around $372,000 using a discount rate of 6%, to $143,000 at a discount rate of 10%. The associated benefit/cost ratios range from 2.2:1 to 1.5:1. Sensitivity analysis on benefit cost ratios at an 8% discount rate if there is a 100% increase in one of three key parameters (production, benefits from research and average farm gate price) is given in Appendix 1.

Table 5: Estimated net present values of research benefits

Discount Rate	**6%**	**8%**	**10%**
NPV of economic benefits	$372,204	$242,360	$143,257
Benefit/cost ratio	2.2:1	1.8: 1	1.5: 1

Appendix 1: Sensitivity Analysis

Table 5 shows the result of sensitivity analysis on benefit cost ratios at an 8 % discount rate, if there is a 100% increase in one of the three key parameters. The analysis shows that the benefit:cost ratios are most sensitive to changes in an increase in production resulting in just over a 170% improvement in the ratio, if yabby production grows at 20% per year.

Table 5 Sensitivity Analysis at 8% discount rate

	Annual production increases by 20% p.a.	Benefits attributed to research account for 100% of total increases in production	Average farm gate price/tonne increase to 5% p.a.
Benefit/cost ratio	4.8:1	3.7:1	2.5:1