ECONOMIC ASPECTS OF HEADER OWNERSHIP IN THE MURRUMBIDGEE IRRIGATION AREAS OF NEW SOUTH WALES

J. G. RYAN*

1. SUMMARY

While a number of the conclusions arising from this study have reference specifically to the irrigated areas of southwestern New South Wales, a substantial part has particular relevance to the study of machinery economics generally. Perusal of the main conclusions listed below will illustrate this.

Evaluation of the economic pros and cons of header ownership versus the employment of contractors for harvesting irrigation crops in southwestern New South Wales is one of the prime purposes of this paper. Definition of break-even crop area combinations is of the utmost importance to prospective header owners, as these days more farmers are buying their own headers and as a result the availability of "off-farm" contract harvesting to offset ownership costs is declining. This aspect is covered in detail in the early part of the study. The effect of taxation allowances on these break-even points is also analysed by measuring the net change in disposable farm income for various harvesting alternatives. This portion of the study will be of particular value not only to extension officers, farmer advisers, accountants, and all farmers growing grain crops in southwestern New South Wales, but also to those in other districts of Australia.

* Economics Research Officer, N.S.W. Department of Agriculture, Leeton.

At the same time, general input-output data on headers are provided to assist decision-making on farms in the area, and with appropriate variations the information could be used for other regions.

An interesting analysis of the relationship between the costs of repairs and maintenance on headers and hours of operation is made. Although not a conclusive examination, this and other data do provide a useful compendium of information for this important and expensive item of farm machinery. Hitherto this information was virtually unavailable in Australia, and while the author hastens to point out that the data has some limitations, these are not sufficient to alter the main conclusions in the paper. The major difficulty was the lack of adequate records of the operating costs of headers which meant reliance had to be placed largely on farmer estimates and recollections.

Of more academic significance is the final section dealing with measurement of the extent of excess capacity in the harvesting industry in the Murrumbidgee Irrigation Area of New South Wales. This has important implications for policy as well as farm management, particularly when viewed in the light of present taxation policy relating to farm machinery.

Main Conclusions Arising from the Study

(i) For harvesting areas of *rice* less than approximately 84 acres, the employment of a contractor is the least expensive method before taxation is taken into account. Header ownership is cheaper for areas in excess of this, and the relevant break-even acreages for each type of header are as follows (assuming no irrigated winter cereals are harvested):

	Acres
10 foot self-propelled petrol (second-hand)	84
12 foot self-propelled petrol (new)	128
8 foot tractor-drawn engine functioned (S/H)	133
10 foot self-propelled petrol (new)[1]	172
13 and 14 foot self-propelled petrol (new)	182
14 foot self-propelled diesel (new)	198

Furthermore, the 10 foot self-propelled second-hand petrol header is the least costly of all these machines up to its maximum physical capacity in 50 per cent of years of about 360 acres of rice annually.

(ii) Economies of scale for the ownership of self-propelled headers become exhausted at about 360 acres of *rice* per year. This occurs at around 180 acres for tractor-drawn headers.

---

[1] The operating costs for this type of header were derived from information obtained from owners of existing 10 foot machines which are now out of production. The overhead costs for a new and different make of header were combined with these operating costs to arrive at the break-even points. This accounts for the apparent anomaly of higher break-even points for the 10 foot new headers compared to some of the larger ones.

(iii) For harvesting *irrigated winter cereals,* break-even points between header ownership and the employment of a contractor, before taxation is taken into account, are as follows (assuming no rice is harvested):

	Acres
10 foot self-propelled petrol (second hand)	360
12 foot self-propelled petrol (new)	560
13 and 14 foot self-propelled petrol (new)	710
10 foot self-propelled petrol (new)[1]	750
14 foot self-propelled diesel (new)	770

At no stage does the ownership of a second-hand 8-foot tractor-drawn engine-functioned header costing $600 become less costly than contract harvesting costs per acre for irrigated winter cereals.

The 10 foot self-propelled second-hand petrol header is the cheapest of all the above machines for harvesting up to approximately 800 acres of irrigated winter cereals annually, which is its maximum physical capacity one year in every two.

(iv) For harvesting *irrigated winter cereals* with self-propelled headers, scale economies almost disappear at around 1,500 acres per annum. For the tractor-drawn header this occurs at about 800 acres of crop.

Break-even acreage combinations for farmers growing *both* rice and winter cereals are defined in section 6 of the paper.

(v) Header replacement every ten years is less expensive than replacement every five years, even after taking into account the relative effects of taxation allowances. Many farmers, advisers and accountants fail to realise that accelerated taxation depreciation allowances do not mean a reduction in depreciation costs of header ownership. The taxation burden may be lightened in the short-run, but because the machine's value at the time of replacement is taxable, the aggregate depreciation allowed over its life is in fact only its real depreciation.

No comparison of the relative merits of retention of headers for periods other than five and ten years was attempted. It may well be that the optimum time for replacement is somewhere between one and ten years, perhaps even longer.

(vi) The comparative financial advantage ten-year ownership has over five-year deceases as the level of taxable income increases, and also as the amount of contract harvesting performed increases.

(vii) The break-even points between contract harvesting and header ownership when taxation effects are taken into consideration vary depending on the level of taxation being paid by the farmer. In general, at higher taxation rates, the purchase of a header becomes desirable for smaller annual crop areas than at lower tax rates.

(viii) In 90 per cent of years there is a surplus of approximately 66 self-propelled and 47 engine-functioned headers on the Murrumbidgee Irrigation Area. That is to say, if header owners were prepared to operate their machines for the full harvest each season, a reduction of 45 per cent in the numbers of serviceable self-propelled and engine-functioned headers would be justified.

(ix) If header numbers were rationalized along the abovementioned lines, savings to the farming community and the economy in general are likely to be of the order of many thousands of dollars. This would be brought about by a reduction in per acre costs of header operation due to increased utilization of machines, thus allowing contract rates to be reduced.

(x) Present header numbers in the Murrumbidgee Irrigation Area could safely harvest *more than* the following *additional areas* nine years in ten:

   (a) 29,000 acres of rice ;

   (b) 63,000 acres of irrigated wheat ;

   (c) 59,000 acres of irrigated oats and barley.

While pertaining only to the M.I.A., these figures, together with an analysis of the situation with three surrounding Shires also included, suggest that excess capacity in the harvesting industry may be prevalent in rather substantial proportions in other cropping areas. The need for similar studies in other districts to answer this question is evident.

2. INTRODUCTION

Headers are an expensive item of farm machinery often involving the investment of thousands of dollars. The trend is towards larger and more complex machines capable of stripping crops in a matter of hours where previously many days were required. This greater capacity and increased capital cost have both allowed and required headers to operate over more acres of crop each year to spread overhead costs, thereby reducing total per acre harvesting expenses.

The growth in harvest capacity as a result of the larger machines has been augmented by a substantial increase in the number of these headers on farms. This is particularly so in the Shires of Carrathool, Leeton, Murrumbidgee, Narrandera and Wade in southwestern New South Wales, where the number of self-propelled headers increased from 11.8 to 22.1 per cent of the total header population in the years 1961–64. In Leeton and Wade Shires alone, the increase in self-propelled headers was from 22.2 to 41.7 per cent.

The main aim of the ensuing study was to obtain and analyse input-output data on the operation of the various types of headers used to harvest irrigation crops in the Murrumbidgee Irrigation Area, and from this to define the relationship between total costs and acres of crop harvested by way of average cost curves. By comparison with the cost of contract harvesting, iso-cost or break-even crop area combinations are established before and after taxation considerations are incorporated into the analysis. An answer to the question—are there too many headers on the Murrumbidgee Irrigation Area?—is attempted in the final section, and a measure of the extent of excess capacity is presented using a model involving rainfall delays, header performance and areas of crops.

All calculations in the paper were originally performed in £ s. d. and have been converted to their nearest equivalent in dollars and cents, except where otherwise indicated. Small discrepancies may therefore appear in some of the tables because of this.

3. HEADER OPERATING COSTS FROM THE SURVEY

A survey of twenty-seven owners of headers which are used to harvest irrigation crops in the Murrumbidgee Irrigation Area was conducted in 1965 to obtain data on operating costs for harvesting both rice and irrigated winter cereals.[2] Each owner was personally interviewed, and as none was able to produce records of machine and labour performance rates, fuel, oil, and grease consumption, and in most cases repair and maintenance costs, reliance had to be placed on their recollections and estimates.

Present "on-farm" prices were used to convert the fuel oil, and grease consumption figures into financial terms. These prices are shown in Appendix 1. Header performance rates were then used to convert these costs from an hourly to a per acre basis. Header performance rates refer to the numbers of acres the machine could harvest in average crops on an average day,[3] assuming there are no holdups due to breakdowns or rainfall and that no travelling to the crop was required. In all cases labour was charged at $1.20 per hour to ensure cost figures were comparable.

The cost of operating the tractor used to draw the bulk auger bin in the case of self-propelled headers, and the bag carrying trailer,[4] for tractor-drawn engine-functioned headers, was made uniform for all headers. That is to say, a standard operating cost per hour of use was applied to estimate per acre costs of tractor operation for hauling bins and trailers. In a number of cases tractors with capacities of up to 80 draw-bar horsepower were being used to haul auger bins which could be easily handled by tractors of almost half this power.

The following was felt to be a fair estimate of the costs which would be incurred in this operation, regardless of tractor size. It is based on the assumption of a 50-hp diesel tractor:

Tractor Operating Costs Per Hour

	Cents (exact equivalent)
Fuel: 2.24 galls. per hour @ 21.25 cents per gall. ..	47.60
Oil and grease	2.50
Repairs and maintenance[5]	14.17
Tyres[5]	9.17
Total	73.44c

---

[2] Wheat, oats, and barley.

[3] An average crop of rice is assumed to be around 2.5 tons per acre in the Murrumbidgee Irrigation Area and average crops of irrigated wheat, oats, and barley approximately 30 bushels per acre.

Owners were asked the number of hours the header would normally be operating on this "average day", to ensure accurate estimates of acres per machine-hour were obtained.

[4] The operation of carting bagged rice from the paddock to waiting trucks is called "snigging out".

[5] The costs of repairs and maintenance and tyre depreciation have been taken from those for a 50 h.p. tractor as contained in D. S. Robertson, "Farm Tractor Costs on the Darling Downs", *Queensland Agricultural Journal* (November, 1962), pp. 685–89.

Cost information was obtained for six major groups of headers, the headers being classified largely on the width of cut. Header owners within each size group were selected on a random basis. Self-propelled headers larger than the 14 foot maximum used in the survey can be operated in winter cereals but generally this is the maximum width that can be used to harvest rice due to the greater yields involved.

TABLE 1

Average Header Operating Costs Per Acre in Rice*

Cost Items	14 foot Self-Propelled Diesel	14 foot Self-Propelled Petrol	13 foot Self-Propelled Petrol	12 foot Self-Propelled Petrol	10 foot Self-Propelled Petrol	8 foot Tractor-Drawn Engine-Functioned
	$	$	$	$	$	$
Fuel	0.16	0.45	0.58	0.47	0.70	0.60
Oil and Grease	0.05	0.04	0.02	0.06	0.09	0.11
Repairs and Maintenance†	0.62	0.30	0.23	0.45	0.36	0.91
Labour	1.28	1.30	1.64	2.02	2.13	6.34
Tractor Running	0.31	0.39	0.44	0.55	0.56	0.34
Bags and Twine	....	....	....	....	....	2.30
Track Cutting	....	....	....	....	....	2.11
Total	2.42	2.48	2.91	3.55	3.84	12.71

* These averages include harvesting and handling costs to trucks, assuming no delays in cartage from the farm.

† Includes cash repair costs, labour for repairs and maintenance carried out by the farmer charged a $10 per day, and tyre depreciation using farmer estimates. Repairs during warranty period are excluded

The average operating costs per acre for each type of header are presented in Tables 1 and 2 for harvesting rice and irrigated winter cereals respectively.[6] All harvesting costs are included in the tables, together with handling costs to waiting trucks or on farm storage, assuming there are no delays in off-loading at these points.

TABLE 2

Average Header Operating Costs Per Acre in Irrigated Winter Cereals*

Cost Items	14 foot Self-Propelled Diesel	14 foot Self-Propelled Petrol	13 foot Self-Propelled Petrol	12 foot Self-Propelled Petrol	10 foot Self-Propelled Petrol	8 foot Tractor-Drawn Engine-Functioned
	$	$	$	$	$	$
Fuel	0.07	0.23	0.25	0.25	0.27	0.21
Oil and Grease	0.02	0.02	0.01	0.03	0.04	0.07
Repairs and Maintenance†	0.50	0.30	0.23	0.45	0.36	0.74
Labour	0.39	0.45	0.57	0.82	0.85	1.36
Tractor Running	0.06	0.11	0.13	0.19	0.20	....
Bags and Twine	....	....	....	....	....	0.37
Total	1.04	1.11	1.19	1.74	1.72	2.75

* These averages include harvesting and handling costs to trucks, assuming no delays in cartage from the farm.

† Includes cash repair costs, labour for repairs and maintenance carried out by the farmer charged at $10 per day, and tyre depreciation using farmer estimates. Repairs during warranty period are excluded.

[6] Individual cost details for each header were not included for the sake of brevity. However, the author has copies of these available for those interested, together with individual details of harvest methods, performance rates, and repair costs related to hours of operation.

There was a wide variation amongst headers within each size classification in both the individual items of cost and the total operating costs per acre. This is only to be expected in a survey of this type where reliance is placed on farmer estimates without the assistance of records.

The average operating costs for harvesting rice as shown in Table 1 ranged from $2.42 per acre for the 14 foot self-propelled diesel headers to $3.84 for the 10 foot self-propelled petrol header. The 8 foot tractor-drawn engine-functioned headers had an average operating cost of $12.71 per acre which was by far the most expensive method of harvesting rice.[7] Needless to say there was not a large number of these machines found to be still in operation in the irrigation areas.

Although irrigated oats and barley can be harvested at a slightly faster rate than irrigated wheat, for all intents and purposes their operating costs per acre can be regarded as similar. The 14 foot self-propelled diesel headers had an average operating cost of $1.04 per acre in these irrigated winter cereals while the average for the 10 foot self-propelled petrol headers was $1.72. The 12 foot self-propelled petrol headers had an average cost of $1.74 in irrigated winter cereals, which is some two cents higher than the 10 foot machines. This would tend to indicate the inaccuracy of the data supplied by the owners in general, rather than a significant difference in the operating costs of the two header types. The 8 foot tractor-drawn engine-functioned headers had an average operating cost in irrigated winter cereals of $2.75.

Irrigated winter cereals can be harvested more than twice as fast as rice, due mainly to the lower yields of the former which allow the headers to move at greater speeds. This has the effect of lowering the costs of fuel, oil, grease, labour, and tractor operation per acre, thus explaining the reduced operating costs for the harvest of winter cereals vis-à-vis rice.[8]

4. ESTABLISHING REPRESENTATIVE OPERATING COSTS

One of the main purposes of the study was to establish the most common methods of harvesting crops grown on the irrigation area, so that these could be costed and compared with the contract harvesting alternative. The costs shown in Tables 1 and 2 are based on different harvesting techniques: inter alia some involve two men, others three ; some use two auger bins and others only one.

Invariably the self-propelled headers emptied the grain into a tractor-drawn auger bin on the move when harvesting rice. This generally was not done with irrigated winter cereals because of difficulties this presents with the increased header speeds in these crops. However, there was a tendency to empty on the move in winter cereals with the smaller self-propelled headers. The tractor-drawn headers all stopped to off load grain in both rice and winter cereals as bag handling was involved.

---

[7] These are not the exact equivalents. They are based on the banking and accounting conversion tables of the Decimal Currency Board.

[8] The cost of repairs and maintenance to headers when harvesting irrigated winter cereals is probably not as high as when the machine is harvesting rice. The wear and tear on the internal mechanism used to separate the rice grain from the head and husks would be greater than for winter cereals due to the increased throughput with rice. It was not possible to ascertain this expected difference in repair and maintenance costs between the crops in this study.

The most popular method of harvesting with the self-propelled headers was to operate with two men—one driving the header and one on the tractor which was hauling the auger bin.   This was the case for both rice and the winter cereals, although a number used only one man for winter cereals, driving to a stationary bin in the paddock to discharge the grain, as opposed to having a man on a tractor following with the bin.   The owners of tractor-drawn headers mostly harvested rice using the bag-to-bulk method with three men employed in the harvesting and handling operation.   Winter cereals were also harvested with the bag-to-bulk method, although only two men were required.

TABLE 3

Representative Labour Requirements and Machine Performance

	Header Types					
	14 foot* Self-Propelled Diesel	14 foot* Self-Propelled Petrol	13 foot Self-Propelled Petrol	12 foot Self-Propelled Petrol	10 foot Self-Propelled Petrol	8 foot Engine-Function Tractor-Drawn
Rice—						
Number of Men	2	2	2	2	2	3
Total Man-Hours per Acre ..	0·97	0·97	1·32	1·52	1·78	4·77
Machine-Hours per Acre ..	0·43	0·32	0·58	0·63	0·77	1·21
Irrigated Winter Cereals—						
Number of Men	2	2	2	2	2	2
Total Man-Hours per Acre ..	0·38	0·38	0·53	0·69	0·83	1·36
Machine-Hours per Acre ..	0·14	0·18	0·24	0·31	0·37	0·39

* Labour requirements for the 14 foot diesel and petrol headers have been derived by amalgamating the information from the two-man operations in both types.   This was because there were only two headers in the petrol classification which were operated by two men.

Table 3 shows the average labour requirements and machine performance rates for each type of header.   These have been calculated by averaging labour and machine requirements for the two man operations in each case, except for the harvesting of rice with the tractor-drawn engine-functioned headers, where a three man operation is assumed.   Labour requirements for these headers were calculated using the bag-to-bulk system.   All labour was charged at $1.20 per man-hour.

In the case of repairs and maintenance for the various header types, a simple average of the figures for each header in each particular classification, as shown in Tables 1 and 2, was taken.   There did not seem to be any clear pattern in these costs as explained previously.   For this reason the averages used here *should not* be taken as necessarily implying the relationship between the different headers with respect to these items of expenditure.   Based as they are on the owner's recollections in the majority of cases, they only represent the *general level* of repairs and maintenance costs.   A major research project entailing comprehensive field testing would be necessary before an authoritative statement could be made on the relative costs of the various header types.

Although there were only 27 observations, it appears no definite relationship exists between the age of headers, measured in total machine-hours, and the repair and maintenance costs incurred throughout their life on an hourly basis.   Figure 1 demonstrates this diagrammatically.

$3

$2

COSTS
PER
HOUR

$1

0   500   1000   1500   2000   2500   3000

HOURS OF OPERATION

o 14 FOOT DIESEL
● 14 FOOT PETROL
▲ 13 FOOT PETROL
× 12 FOOT PETROL
+ 10 FOOT PETROL
◻ 8 FOOT PETROL TRACTOR DRAWN
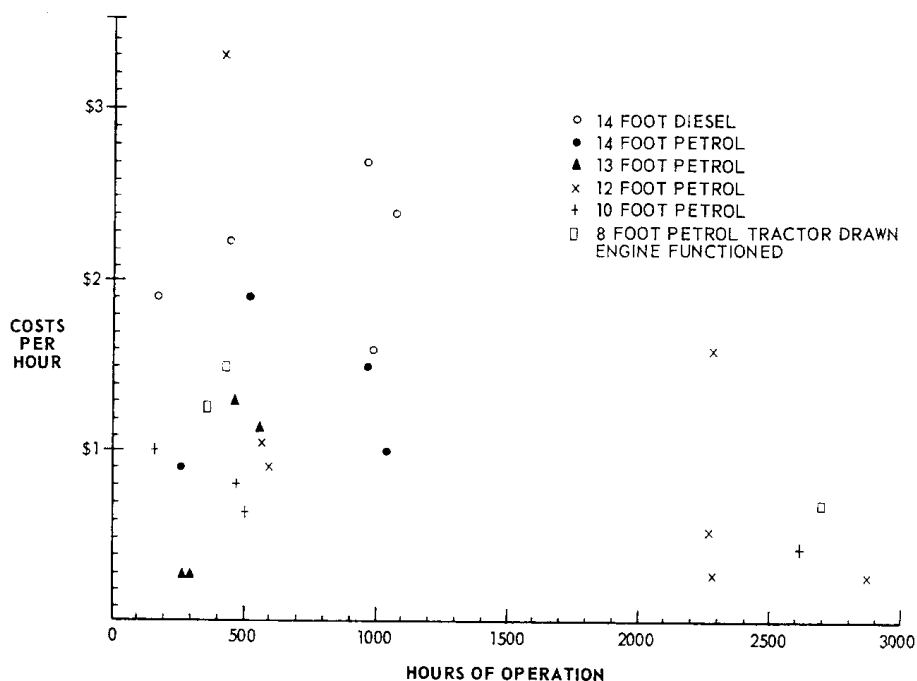   ENGINE FUNCTIONED

Figure 1. Relationship Between Hours of Use and Repair and
Maintenance Costs.

In two out of the six cases the trend in hourly cost of repairs and maintenance as the hours of operation increased was upward. This occurred with the 14 foot self-propelled diesel header and the 13 foot self-propelled petrol. The other four headers demonstrated a downward trend. The results of the analysis are therefore inconclusive and offer no real guide as to the nature of the relationship between the two variables in general.[9] At best all we can say is that a simple *average* hourly figure gives us some indication of the order of magnitude of this item of expenditure.

Oil and grease costs as shown in Tables 1 and 2 were averaged to determine the representative level for each header size and type. Fuel costs were determined by averaging the headers with two-man operations only, except for harvesting rice with tractor-drawn engine-functioned headers where average fuel costs for those with a three-man operation were used. Tractor running costs were also tabulated by averaging machine performance rates for the two-man operations only, with the same exception as for the tractor-drawn headers. These average rates were then multiplied by $0.73, the estimated hourly costs of operating a 50 h.p. diesel tractor. For this reason fuel and tractor running costs do not correspond with the averages shown in Tables 1 and 2, which have been calculated from all headers regardless of their method of operation.

---

[9] Although one would expect old machines would require more repairs at more frequent intervals and therefore that repair and maintenance costs would show an upward trend, this would be offset to an extent by the fact that, as machines age, owners become less inclined to effect repairs unless absolutely necessary. In addition, the cost of repairs of the newer machines would probably be dearer than the older ones because of the added complexity of the more recent models.

A summary of the representative variable costs of harvesting rice and irrigated winter cereals with each type of header is contained in Table 4.

TABLE 4

Representative Harvesting Costs Per Acre*

	Header Types					
	14 foot Self-Propelled Diesel	14 foot Self-Propelled Petrol	13 foot Self-Propelled Petrol	12 foot Self-Propelled Petrol	10 foot Self-Propelled Petrol	8 foot Tractor-Drawn Engine-Functioned (Bag-to-Bulk)
	$	$	$	$	$	$
Rice—						
Fuel	0.16	0.33	0.64	0.49	0.71	0.70
Oil and Grease	0.05	0.04	0.02	0.06	0.09	0.11
Repairs and Maintenance	0.62	0.30	0.23	0.45	0.36	0.91
Labour	1.17	1.17	1.58	1.82	2.13	5.72
Tractor Running	0.32	0.23	0.40	0.46	0.57	0.52
Bags and Twine	....	....	....	....	....	1.00
Track cutting	....	....	....	....	....	2.17
Total	2.32	2.07	2.87	3.28	3.86	11.13
Irrigated Winter Cereals—						
Fuel	0.06	0.23	0.25	0.25	0.31	0.22
Oil and Grease	0.02	0.02	0.01	0.03	0.04	0.07
Repairs and Maintenance	0.50	0.30	0.22	0.45	0.36	0.74
Labour	0.46	0.46	0.64	0.83	1.00	1.63
Tractor Running	0.11	0.13	0.18	0.23	0.28	....
Bags and Twine	....	....	....	....	....	0.30
Track Cutting	....	....	....	....	....	....
Total	1.15	1.14	1.30	1.79	1.99	2.96

* These differ from the averages shown in Tables 1 and 2 as explained in the text. In converting machine and labour performance rates in Table 3 into financial terms for this Table, small discrepancies may be detected due to rounding errors.

5. RELATIONSHIP BETWEEN TOTAL COSTS AND ACREAGE HARVESTED

The variable costs shown in Table 4 include provision for a man on the tractor in addition to the header driver, together with tractor operation costs. They represent the costs per acre for a farmer to harvest his own crops with his own header. If he also engages in contract harvesting off the farm he is not normally required to supply the tractor or the driver. This is the responsibility of the farmer whose crop he is harvesting. As the purpose of this section is to evaluate the relative costs of contract harvesting and header ownership, the cost of header operation is the only consideration. Handling costs for his own crops will be virtually the same to a farmer whether he owns a header or employs a contractor.[10] In both cases he would be required to supply the tractor and driver.

The total variable costs of harvesting together with grain handling costs per acre are shown in Table 5. The costs of header operation per acre are calculated from these in the Table. It is significant to note that although

[10] Handling costs refer to the costs of tractor operation and labour for drawing the auger bins and trailers.

TABLE 5

The Costs of Header Operation and Grain Handling Per Acre

Header Type	Rice Harvesting			Irrigated Winter Cereal Harvesting		
	Total Variable Costs*	Grain Handling Costs	Header Operation Costs†	Total Variable Costs*	Grain Handling Costs	Header Operating Costs †
	$	$	$	$	$	$
14 foot Self-Propelled Diesel ..	2.33	0.90	1.43	1.16	0.33	0.83
14 foot Self-Propelled Petrol ..	2.07	0.82	1.25	1.14	0.36	0.78
13 foot Self-Propelled Petrol ..	2.86	1.19	1.67	1.31	0.49	0.82
12 foot Self-Propelled Petrol ..	3.29	1.37	1.92	1.79	0.65	1.14
10 foot Self-Propelled Petrol ..	3.87	1.63	2.24	2.00	0.78	1.22
8 foot Tractor-Drawn Engine-Functioned.	11.14	2.44	8.70	2.97	....‡	2.97

* From Table 4.

† Total Variable Costs of harvesting minus Grain Handling Costs.

‡ A bag-to-bulk method is assumed here with the truck driver loading the grain in the paddock.

header operation costs in winter cereals for the self-propelled machines averaged 57 per cent of the operation costs for harvesting rice, the contract charge for the former is only 30 per cent of the latter. In other words contractors are either charging too little for harvesting irrigated winter cereals or overcharging for rice, or both. The figures in Table 5 would seem to indicate that, if $3.00 per acre is accepted as a justifiable charge for irrigated winter cereal harvesting (and it is not altogether clear that it is), then $5.26 should, on the basis of the difference in header operating costs in the two crops, be charged for rice harvesting and not $10.00 as at present.

However, considerations other than mere differences in operating costs would influence the relative rates charged by contractors in this area. "Ability of the industry to pay" is no doubt invoked in the case of rice charges, where the contractor's returns from this crop would tend to be used to subsidise those from irrigated winter cereals. Possible higher repair and maintenance costs for rice harvesting as mentioned previously in footnote 8 on page 142, together with slightly greater average harvesting delays as shown in Appendix III, could also partly explain some of the discrepancy. However it is difficult to imagine that these could justify a charge of some $4.74 per acre more than the $5.26 indicated above. Needless to say some serious thought should be given to the relationship between rates charged and the corresponding costs of providing the contract service by the relevant association of contractors. If the rates are continuously above what it costs to harvest the crops (plus of course a reasonable profit margin) more farmers will be induced to purchase their own headers, thus reducing the already declining demand for contract harvesting in this area.

For the purpose of arriving at the overhead costs of owning headers, the purchase prices of all self-propelled headers used to harvest irrigated crops in the area were obtained from machinery agents. The price of the most popular brand in each size classification was chosen to calculate annual overhead costs. This is not entirely satisfactory as there was found to be quite a range of prices for machines of the same type. However, it appears the most feasible solution.

Depreciation was calculated over ten years assuming each header would have a real value of 25 per cent of its original list price less $400 at the end of this time (i.e., real value after 10 years $= 0.25P - 400$). This was determined after discussions with a number of machinery dealers in the area. *Interest* was charged at six per cent on the average value of the headers during their ten year life. *Insurance* against fire was at $3.08 per $200 insurable value, which was based on their average value over the ten years. The cost of *shelter* for headers was calculated by assuming a covering of one square would cost $160 to erect and that this would last 30 years with an interest charge of six per cent per annum and an insurance cost of $0.98 per $200 insurable value. Depreciation on the auger bin was over fifteen years and interest also at six per cent.

As the most popular 10 foot self-propelled model is out of production, overhead costs have been estimated for both a new and an old machine in good condition (of a different make). Tractor-drawn engine-functioned headers are also out of production, so the cost of a second-hand machine in good condition has also been used. Details of the overhead costs are to be found in Table 6.

The total costs of header operation in rice and irrigated winter cereals are shown in Tables 7 and 8 for the six types of headers, over a range of crop areas. They have been derived from Tables 5 and 6 and represent the overhead and operating cost of harvesting, with grain handling costs excluded. For a farmer harvesting his own crops with one of these headers the total costs to him would be as shown in Tables 7 and 8, plus handling costs as in Table 5.

TABLE 6

Overhead Costs of Headers and Ancillary Equipment*

	14 foot Self-Propelled Diesel	14 foot Self-Propelled Petrol	13 foot Self-Propelled Petrol	12 foot Self-Propelled Petrol	10-foot Self-Propelled Petrol		8 foot Tractor Drawn Engine Functioned
					S/H Price	New Price	
	$	$	$	$	$	$	$
HEADER—							
Purchase Price (incl. freight).	12,620	11,780	11,350	7,352	4,000	9,870	600†
Annual Overhead Costs—							
Depreciation	982	924	876	582	360	774	108
Interest	462	430	418	268	132	360	20
Insurance	118	110	108	68	34	92	6
Shelter	26	26	26	24	20	20	16
Sub-Total	1,588	1,490	1,428	942	546	1,246	150
AUGER BIN‡— *Annual Overhead Costs—*							
Depreciation	66.	66	66	66	66	66	16§
Interest	32	32	32	32	32	32	8
Sub-Total	98	98	98	98	98	98	24
Total	1,686	1,588	1,526	1,040	644	1,344	174

* These are based on the present new purchase price of machinery and equipment net of all discounts, etc.
† This is the expected cost of a second hand header in good condition.
‡ The cost of the auger bin in all cases was assumed to be $1,040. The capacity of the bin is approximately 70 bags.
§ These costs are for a hydraulic bag loader costing $240.

TABLE 7

*Total Costs of Header Operation Per Acre in Rice**

	Acres Harvested per Year†									
	60	120	180	240	300	360	420	480	540	600
	$	$	$	$	$	$	$	$	$	$
14 foot Self-Propelled Diesel	29.52	15.48	10.78	8.44	7.04	6.10	5.44	4.94	4.54	4.24
14 foot Self-Propelled Petrol	27.72	14.48	10.06	7.86	6.54	5.66	5.02	4.56	4.18	3.90
13 foot Self-Propelled Petrol	27.12	14.40	10.22	8.04	6.76	5.92	5.32	4.86	4.50	4.22
12 foot Self-Propelled Petrol	19.26	10.60	7.70	6.26	5.40	4.82	4.40	4.10	3.86	3.66
10 foot Self-Propelled Petrol { S/H	12.96	7.58	5.80	4.90	4.36	4.00	3.76	3.56	3.42	3.30
{ New	24.62	13.42	9.68	7.82	6.70	5.96	5.42	3.02	4.70	4.46
8 foot Tractor Drawn Engine Functioned.	11.60	10.16	9.66	9.42	9.28	9.18	9.12	9.06	9.02	9.00

* The costs of grain handling from the paddock to trucks have not been included.

† See Appendix II for estimates of the physical capacity of each header per year.
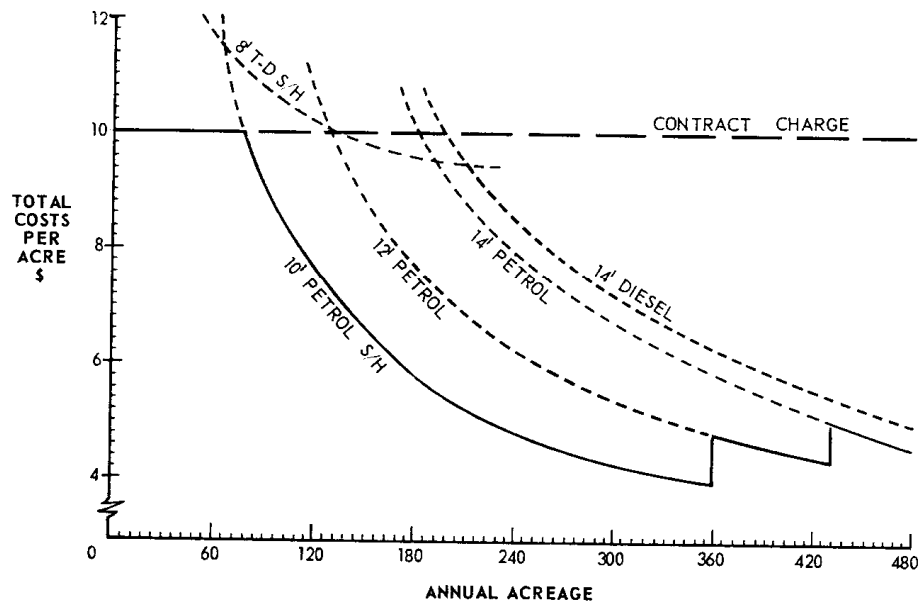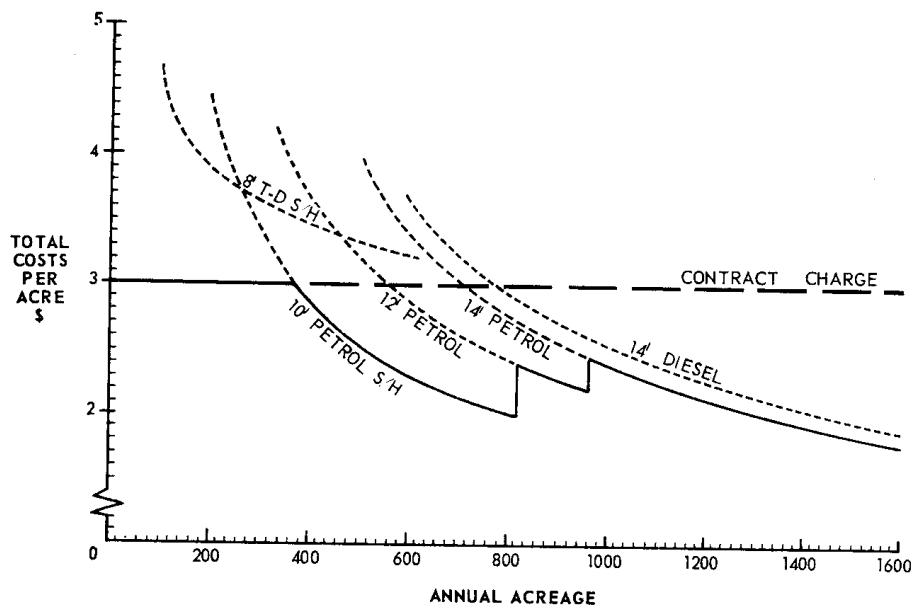
Figure 2.   Least Cost Curves for Rice Harvesting.

Figure 3.   Least Cost Curves for Irrigated Winter Cereal Harvesting.

TABLE 8

Total Costs of Header Operation Per Acre in Irrigated Winter Cereals*

	Acres Harvested per Year†																			
	100	200	300	400	500	600	700	800	900	1000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,000
	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
14-foot Self-Propelled Diesel	17.68	9.26	6.44	5.04	4.20	3.64	3.22	2.92	2.70	2.50	2.36	2.22	2.12	2.02	1.94	1.88	1.81	1.76	1.70	1.66
14-foot Self-Propelled Petrol	16.66	8.72	6.08	4.74	3.96	3.42	3.04	2.76	2.54	2.36	2.22	2.10	2.00	1.92	1.84	1.78	1.72	1.66	1.62	1.58
13-foot Self-Propelled Petrol	16.08	8.46	5.90	4.64	3.88	3.36	3.00	2.72	2.52	2.34	2.20	2.10	2.00	1.92	1.84	1.78	1.72	1.66	1.62	1.58
12-foot Self-Propelled Petrol	11.54	6.34	4.60	3.74	3.22	2.88	2.62	2.44	2.30	2.18	2.08	2.00	1.94	1.84	1.84	1.80	1.76	1.72	1.68	1.66
10-foot Self-Propelled Petrol S/H	7.66	4.44	3.36	2.84	2.50	2.30	2.14	2.02	1.94	1.86	1.80	1.76	1.72	1.68	1.64	1.62	1.60	1.58	1.56	1.54
10-foot Self-Propelled Petrol New	14.66	7.94	5.70	4.58	3.90	3.46	3.14	2.90	2.72	2.56	2.44	2.34	2.26	2.18	2.12	2.06	2.02	1.96	1.92	1.90
8-foot Tractor-Drawn Engine-Functioned.	4.70	3.84	3.54	3.40	3.30	3.26	3.20	3.18	3.16	3.14	3.12	3.10	3.10	3.08	3.08	3.06	3.06	3.06	3.06	3.04

* The costs of grain handling from the paddock to trucks have not been included.

† See Appendix II for estimates of the physical capacity of each header per year.

Figures 2 and 3 have been drawn to illustrate Tables 7 and 8 diagrammatically. Only those cost curves involved in tracing a least cost path have been drawn, together with the relevant contract rates of $10 and $3 for rice and irrigated winter cereals respectively.[11] Each curve has been terminated at the acreage representing the median annual area of crop the headers could harvest as shown in Appendix II.[12]

Figure 2 shows that for harvesting areas of *rice* less than approximately 84 acres, the employment of a contractor is the least costly method. Thereafter the purchase of a second-hand 10 foot self-propelled petrol header is the cheapest alternative up to its maximum physical capacity, which is estimated to be 360 acres of rice per annum in 50 per cent of years (Appendix II), providing the header can be bought at a price of $4,000 or less. This is the approximate current second-hand value of this type of machine. The cost of a new 10 foot self-propelled machine is $9,870 and, using the same operating costs per acre as with the second-hand header, its average total cost curve lies close to that for the 13 and 14 foot headers. However, as this new 10 foot machine is a recently released model and none of the farmers interviewed owned one, one may expect its operating costs to be slightly lower than for the older model. The costs shown in Tables 7 and 8 for the new 10 foot header should therefore be regarded as tentative.

It appears that a second-hand tractor-drawn 8 foot header costing about $600 is uneconomical *vis-à-vis* other harvesting alternatives for all rice crop areas. The cost of harvesting 60 acres of rice using this method is approximately $11.60 per acre compared with $10 for the employment of a contractor. In addition, the contractor would harvest the crop at least twice as fast as a farmer using the 8 foot machine, thus entailing a reduced cost of grain handling for the latter. For areas in excess of 133 acres of rice per year (the break-even point of the engine-functioned header with contract harvesting) the self-propelled headers are less expensive than either contract or the tractor-drawn header.

The approximate break-even points where header ownership becomes less costly than contract harvesting of *rice* for each type of header from Table 7 and the graph are as follows:

	Break-even Points (acres)
10 foot self-propelled petrol (second hand)	83
12 foot self-propelled petrol (new)	129
8 foot tractor-drawn engine-functioned (S/H)	134
10 foot self-propelled petrol (new)[13]	173
13 and 14 foot self-propelled petrol (new)	182
14 foot self-propelled diesel (new)	197

[11] An average crop of rice is about 2.5 tons per acre and about 30 bushels for irrigated winter cereals. Contractors charge more if the crops are lodged, especially with winter cereals. Growers with yields in excess of 2.5 tons of rice per acre are charged an additional $0.10 per bag for harvesting by contract. The same applies to cereal crops in excess of 30 bushels per acre.
Contractors are often criticised for causing grain losses due to the speed with which they harvest the crops and lack of timely harvesting. Account can be taken of this here by adding a figure to the contract rate sufficient to cover any expected loss of yield or quality so caused.

[12] This is discussed in detail in Section 8.

[13] See footnote 1.

Economies of scale for the ownership of self-propelled headers become exhausted at about 360 acres of rice per year. After this there are only marginal cost reductions as a result of the spreading of overhead costs. For the tractor-drawn header this occurs at around 180 acres of rice per annum.

For areas of *irrigated winter cereals* up to 370 acres per year, contract harvesting is the most inexpensive alternative as shown in Figure 3. For areas in excess of this the 10 foot second-hand self-propelled petrol header has a cost advantage over all other possibilities up to its estimated physical capacity, in 50 per cent of years, of about 800 acres per annum (Appendix II).

The approximate break-even points between header ownership and the employment of a contractor for irrigated winter cereal harvesting occur at the following levels for each header, as read from Figure 3 and Table 8:

	Break-even Points (acres)
10 foot self-propelled petrol (second-hand)	358
12 foot self-propelled petrol (new)	559
13 and 14 foot self-propelled petrol (new)	710
10 foot self-propelled petrol (new)[13]	747
14 foot self-propelled diesel (new)	773
8 foot tractor-drawn engine-functioned	no break-even

To the extent that $1.20 does not represent the true opportunity costs of labour per hour at harvest times, the cost curves in Figures 2 and 3 require alteration. If the header driver's time is in fact worth more than $1.20 the curves will be raised and break-even acreages increased. Interpretation of the cost curves in individual cases is therefore best handled by consideration of actual farm labour opportunity cost in relation to the figure applied here.

With the exception of the tractor-drawn header, scale economies almost disappear at around 1,500 acres of winter cereals per annum. For the tractor-drawn header this occurs at about 800 acres of crop, which in fact exceeds the maximum area of winter cereals this header could harvest one year in every two.

6. ISO-COST CROP AREA COMBINATIONS

The break-even points specified in the previous section refer to the annual harvested area of *either* rice or irrigated winter cereals, before ownership of each particular type of header becomes justified on cost grounds, in preference to employment of a contractor.

These acreage combinations represent only two of the many which lie on an iso-cost curve for contract harvesting and header ownership.

---

[13] See footnote 1.

The derivation of each iso-cost curve is best achieved by employing some simple algebra:

If X = Area of rice harvested per annum.

    Y = Area of irrigated winter cereals harvested per annum.

    R = Cost of header operation in rice.

    W = Cost of header operation in irrigated winter cereals.

    A = Overhead costs of header and ancillary equipment per annum.

Then if it is assumed the contract charges for rice and irrigated winter cereals are $10 and $3 respectively, the iso-cost or break-even equation is defined as that point where:—

Cost of Contract Harvesting of X and Y = Cost of harvesting X and Y with a farmer-owner header.

i.e., Where
$$10X + 3Y = A + RX + WY$$
or
$$X(10-R) + Y(3-W) = A$$

The equation is linear, and by substituting the relevant values of A, R, and W for each header into it, the linear relationships can be established and graphed. The results of this analysis are found in Table 9. Figure 4 has been drawn to represent the iso-cost combinations graphically for a number of headers. The qualification about valuation of labour opportunity cost mentioned at the end of the previous section also applies to the interpretation of Figure 4.

Farmers who are facing a decision whether or not to purchase a header instead of hiring a contractor to do the job need only refer to Figure 4 to decide whether it is desirable before taxation allowances are considered. By plotting a point on the graph which represents the areas of rice and irrigated cereals they intend to harvest each year an indication of the least costly method of harvesting can be established. Crop area combinations to the right of the iso-cost lines signify that header purchase is justified and those to the left that contract harvesting is the less expensive method. Some idea of the type of header which minimises the cost of harvesting specified crop areas can also be gleaned from Figure 4. For example, a farmer with 60 acres of rice and 100 acres of irrigated winter cereals to strip each year should be indifferent between contract harvesting and the purchase of a second-hand ten foot self-propelled petrol header to do the work. If he harvested more than this area each year he would benefit financially if he bought the header. However, if he harvested 120 acres of rice and 150 of irrigated winter cereals, he would be justified in purchasing either the ten foot second-hand machine or a new 12 foot self-propelled petrol header. The former would be less costly than the latter and would be preferred, providing it could safely handle the area of crops to be harvested each year (see Appendix II).

An iso-cost curve for the purchase of a 12 foot self-propelled petrol header every five years instead of ten years is also included in Figure 4 to illustrate the effect of the higher annual depreciation, interest and insurance charges that this involves, on break-even points. The real values of the header after five and ten years were estimated to be $2,050 and

TABLE 9

*Iso-Cost Combinations**

Header Type	Break-even Area of Rice with No Irrigated Winter Cereals Harvested Each Year (i.e., $Y = 0$)	Break-even Area of Irrigated Winter Cereals with No Rice Harvested Each Year (i.e., $X = 0$)
	acres	acres
14-foot Self-Propelled Diesel	197	773
14-foot Self-Propelled Petrol	182	715
13-foot Self-Propelled Petrol	183	694
12-foot Self-Propelled Petrol	129	559
10-foot Self-Propelled Petrol ⌠ S/H ..	83	358
⌡ New ..	173	747
8-foot Tractor-Drawn Engine-Functioned	134	5,800†

* For replacement every 10 years.

† As explained in the text this virtually means it is always better to employ contractors to harvest these crops if rice is not harvested.

$1,540 respectively. It can be seen that the curve is moved significantly to the right, suggesting that header ownership for a ten year period is preferable to replacement every five years.

Just what effect taxation considerations have on this and the iso-cost combinations in general will be discussed in the next section. Taxation effects have not been taken into account in the construction of the above-mentioned iso-cost curves and the curves therefore do not provide a sufficiently comprehensive model to enable sound decisions to be made.
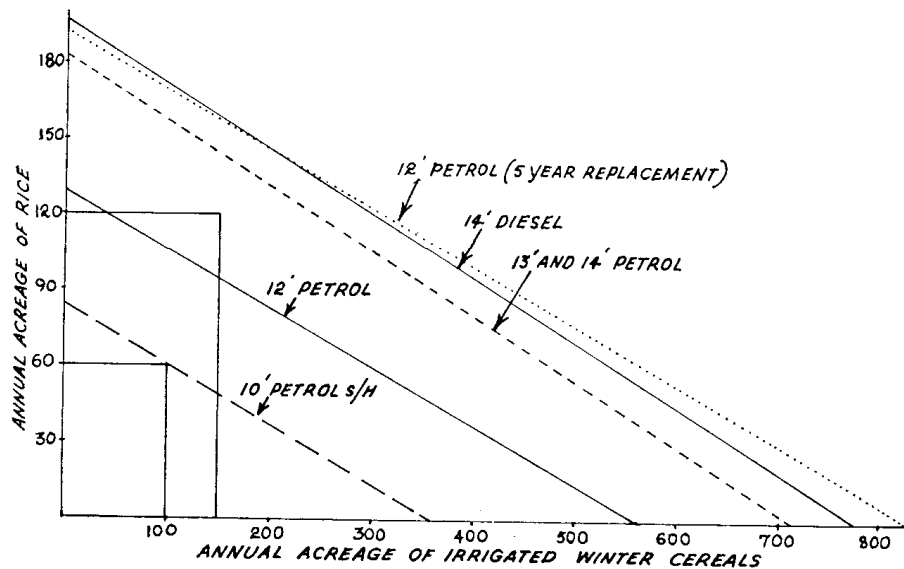

Figure 4. Iso-cost Acreage Combinations for Rice and Irrigated Winter Cereals (Header Replacement Every 10 years Except Where Indicated).

7. EFFECT OF TAXATION ALLOWANCES

There are two alternative methods open to primary producers for the calculation of depreciation allowances on newly acquired farm machinery where old equipment is traded-in or sold in the same year. The first is where the annual 20 per cent depreciation allowance is charged on the full price of the new item for five years, and the cash value of the replaced item in excess of the taxation book value is included as income in the first year. The other alternative primary producers can elect to use is called the "balancing charge method".[14] Here the full price of the new machine less the trade-in value of the old one is used to calculate depreciation allowances for the five years. Any positive difference between the book value of the old machine and its trade-in or cash value is not taxed as with the other method. The investment allowance is given on the full price of the machines regardless of which method of calculating depreciation is chosen.

The value of the taxation deductions for both methods over the five years is exactly the same. The balancing charge method does however have the advantage of a larger tax saving (deduction) in the year of purchase which will have particular advantages to farmers expecting a high level of taxation in any one year. This of course would be offset by reduced deductions in later years. Accelerated taxation depreciation allowances do not, as some believe, have the effect of reducing the depreciation costs of owning the machine. Taxation burdens may be lightened in the short-run, but because the machine's value at the time of replacement is taxable, the aggregate depreciation allowed over its life is in fact only its real depreciation.

Using this balancing charge method the net affect of purchasing a new 12 foot self-propelled header every 5 and 10 years on disposable net farm income was examined for four crop area combinations and five levels of taxable income.[15] The intention was to evaluate the following, taking taxation into account:

(i)   the effect of increased areas of contract harvesting with a farmer-owned header on disposable net farm income ;

(ii) for given annual crop harvest areas using a farmer-owned header, the effect of increased taxation rates on disposable net farm income ;

(iii) the effect of employment of a contractor to harvest the normal crop combination on farms in the Murrumbidgee Irrigation Area on disposable net farm income for a range of taxation rates ;

(iv) the relative net benefits of header replacement every five years versus every ten.

---

[14] For a discussion of these points see sections 59 (1), 59 (2), and 59 (2A) of the *Income Tax and Social Services Contribution Assessment Act*, 1936–1964.

[15] The calculations involved in achieving the four aims listed below were so tedious and time consuming that the analysis had to be restricted to one type of header.

The four crop area combinations chosen for the examination of aims (i) and (ii) were as follows:

	Area of Rice Harvested Per Year (acres)	Area of Irrigated Winter Cereals Harvested Per Year (acres)
Case 1	60	60
Case 2	60	299
Case 3	120	307
Case 4	296	768

Case 1 was selected to represent the most common combination of the two crops found on large area farms in the Murrumbidgee Irrigation Area. Case 2 is a point on the iso-cost curve in Figure 4 for the 12 foot header replaced every 10 years. Case 3 is a point on the iso-cost curve for a 12 foot header replaced every five years. Case 4 represents the minimum areas of the two crops a 12 foot self-propelled header could physically handle allowing for rainfall delays, breakdowns and travelling time between crops nine years in ten. In other words, except for one year in 10, the 12 foot header could harvest *at least* 296 acres of rice and 768 of winter cereals, without any undue loss in grain quality or yield. Only one year in ten would it not be possible to harvest these areas. The calculation of this is shown in Appendix II, and the data from which it was derived is discussed in the next section.

The range of taxable incomes considered were two, four, eight, twelve and twenty thousand dollars. These were all assumed to represent the taxable incomes *before* the costs of harvesting are deducted.

The change in disposable net farm income was used to measure the relative effects of header purchase on a farmer's financial position. It was calculated as follows:

$$D = Y + T + R + S - (C + V)$$

Where

D = Change in disposable net farm income per annum.

Y = Increase in gross income per annum.

T = Tax savings per annum.

R = Value of old header in year of replacement.[16]

S = Value of auger bin and shelter in year 10.[16]

C = Capital costs of header, auger bin and shelter in year of purchase.[16]

V = Header operation costs and insurance per annum.

Increases in gross income as a result of header purchase were assumed to occur in Cases 2, 3 and 4 only. This resulted from contract harvesting returns for areas harvested in excess of the header owner's own farm crops of 60 acres of both rice and irrigated winter cereals.

---

[16] These three variables do not enter the calculations except in the years specified.

Tax savings were found by tabulating for each of the four cases and five levels of taxable income, the annual taxation deductions allowable as a result of header purchase (including a $1,040 auger bin) and operation, less any increase in taxable income from contracting where this applied. Tax payable on the "post-harvest" taxable income so calculated was then subtracted from that for the "pre-harvest" taxable income to ascertain the value of tax savings each year. This was done for a ten year period in the case of header replacement each five and ten years to enable a comparison to be made between the two alternatives.

To gauge the real effect of all alternatives on disposable income each year, the capital costs of the header, auger bin and shelter were debited in the year of purchase—year 1. To offset this the depreciated real value of the header was credited as income in the year of replacement and that of the auger bin and shelter as income in year 10. By so doing the cost of depreciation over the period is handled on a cash value basis at two points in time. The real value of the header after five and ten years respectively was $2,050 and $1,540. These were based on estimates supplied by machinery dealers in the area, and although one would expect a larger difference between the two figures, this is the value placed on them by the trade.

The effect on disposable net farm income of employing a contractor to harvest the farm's crops instead of purchasing a header was measured by subtracting the reduction in taxation as a result of deducting contract costs from the "pre-harvest" level of taxable income, from the annual cash cost of engaging the contractor.

The change in disposable net farm income for all the abovementioned options was discounted at 6 per cent over the ten year period for which each was calculated, to enable them to be compared on a present value basis. The end result of all these voluminous calculations is found in Table 10.

By far the most significant finding was that in all four cases, replacement of the header every ten years was preferable to replacement every five years. This appears to dissipate the widely held view of many farmers that it isn't wise to keep headers for more than five years because one's taxation increases due to the expiration of depreciation and investment allowances. This attitude fails to take cognizance of the fact that, as previously mentioned, they are taxed on the excess value of the replaced machine over and above its book value, and secondly that real depreciation in later years is substantially less than earlier in the life of the machine. Furthermore, from the survey, there is no reason to believe that repairs and maintenance costs per acre vastly increase with age over this period of time as discussed in Section 4.

The comparative financial advantage ten year ownership has over five year decreases as the level of taxable income paid increases and also as the amount of contract harvesting performed increases. For example, a farmer harvesting his own crops (Case 1, Table 10) and having a "pre-harvest" taxable income of $4,000 would be better off by the present value equivalent of some $2,156 over ten years if he kept the 12 foot header for this length of time instead of replacing it at five years and again at ten years. On the other hand, if he is paying tax on a "pre-harvest" taxable

TABLE 10

Comparison of Header Ownership Costs at Various Levels of Annual Use and Contract Harvesting Costs for a Range of Taxable Incomes*

Taxable Income per Year Before Deduction of Harvest Costs	Present Value of Change in Disposable Net Farm Income Over 10 Years†							
	Case 1 (60 acres Rice, 60 acres Irrigated Winter Cereals)		Case 2 (60 acres Rice, 299 acres Irrigated Winter Cereals)		Case 3 (120 acres Rice, 307 acres Irrigated Winter Cereals)		Case 4 (296 acres Rice, 768 acres Irrigated Winter Cereals)	
	Header Purchase Every 5 Years	Header Purchase Every 10 Years	Header Purchase Every 5 Years	Header Purchase Every 10 Years	Header Purchase Every 5 Years	Header Purchase Every 10 Years	Header Purchase Every 5 Years	Header Purchase Every 10 Years
$	$	$	$	$	$	$	$	$
2,000	− 6,124	− 3,214	− 3,050	− 308	+ 260	+ 2,798	+ 13,490	+ 15,158
4,000	− 4,744	− 2,588	− 2,206	− 194	+ 516	+ 2,384	+ 11,534	+ 12,780
8,000	− 3,122	− 1,832	− 1,270	− 48	+ 766	+ 2,092	+ 9,280	+ 9,898
12,000	− 2,150	− 1,374	− 696	+ 54	+ 942	+ 1,632	+ 7,987	+ 8,366
20,000	− 1,632	− 1,138	− 378	+ 98	+ 1,022	+ 1,454	+ 7,102	+ 7,224

* This table is for a new 12-foot self-propelled petrol header costing $7,352.

† To enable easy comparison, the present value of the change in disposable net farm income for employing a contractor to harvest farm crops of 60 acres of rice and 60 acres of winter cereals was taken as a zero base. Only the differences between the values for this case and the computed values for cases 1 to 4 are therefore shown in the table.

income of $20,000, he would only be better off to the extent of $494 over the period on a present value basis. Alternatively, if that farmer intended to harvest a total of 296 acres of rice and 768 acres of irrigated winter cereals each year with the header (Case 4, Table 10), the ten year ownership would be superior to the extent of only $1,246 and $122 for "pre-harvest" taxable income levels of $4,000 and $20,000 respectively.

It can be seen from column 5 of the table, that for "pre-harvest" taxable income levels in excess of $8,000, the present value of the reduction in disposable net farm income for header replacement every ten years is positive, signifying that it becomes more attractive than employing a contractor for harvesting only farm crops at this point. For taxable income levels of 8,000 dollars or less the position in reversed. In other words, when "pre-harvest" taxable income is more than about 8,000 dollars, the effect of taxation allowances in this particular example is to shift the break-even or iso-cost crop combinations downwards, suggesting that header purchase becomes justified at smaller crop areas than indicated in the previous section[17] (i.e., somewhere between Case 1 and Case 2). However, at "pre-harvest" taxable income levels of 8,000 dollars or less, the "after tax" analysis in Table 10 suggests iso-cost combinations lie somewhere between Case 2 and Case 3, signifying larger crop areas are required to justify header purchase.

This "crossing over" effect at higher taxation rates means that no general rule can be given regarding the effect of taxation on the break-even combinations calculated in Figure 4. Each situation has to be budgeted out individually, remembering that the outcome will depend on the farmer's level of "pre-harvest" taxable income. Accountants, farm advisers, and farmers should not forget to measure the absolute effect of header purchase on disposable net farm income for a range of possible harvest areas involving contract harvesting. The results should then be compared with the alternative of employing a contractor to harvest the farm's crops. It is feared in many cases this is not done and the farmer is advised without a complete analysis being made. No doubt, in a great number of instances it is not fully realized that expenditure for engaging contract harvesters on the farm is fully tax deductible in the year it is incurred. Every time a decision is to be made regarding header purchase or replacement, the net cost of the contract alternative "after tax" should be introduced for comparison. This may provide a few surprises.

Turning to header replacement every five years, the point at which this "breaks even" with the employment of contractors occurs somewhere between Cases 2 and 3. That is, the iso-cost combination is less than the areas indicated in Figure 4 for replacement of the 12 foot header every five years without taxation effects taken into account (i.e., 120 acres of rice, 307 acres of irrigated winter cereals). This also illustrates the fact that, at higher tax rates, the purchase of a header becomes desirable for smaller annual crop areas than at lower tax rates. However, to reiterate, it appears that replacement of the header each ten years is always preferable to doing so every five years.

---

[17] It will be remembered that Case 2 represents a break-even combination for the 12 foot header replaced every 10 years, when taxation considerations are not included in the analysis.

A comparison of the "after-tax" consequences of purchasing second-hand as opposed to new headers was not attempted here, due largely to insufficient data about the former and secondly the immensity of the arithmetical task involved. For the same reason no comparison of the relative merits of retention of headers for periods other than five and ten years was tried, although the need for such an analysis is fully realized. However, the second-hand comparison was partly covered in the previous section and is certainly something which should also occupy the attention of farm management research workers in the future. It would be expected that second-hand machines would retain their comparative advantage over new ones after taxation was incorporated, although the advantage may be reduced as the investment allowance is applicable only to new machinery.

8. EXTENT OF EXCESS CAPACITY IN THE HARVESTING INDUSTRY

The proportion of self-propelled headers in the five Shires of Carrathool, Leeton, Murrumbidgee, Narrandera, and Wade, increased from 11.8 to 22.1 per cent in the period 31st March, 1961, to 31st March, 1964.[18] In the Leeton and Wade Shires over the period the proportion increased from 22.2 to 41.7 per cent. This trend can be expected to continue as farmers tend to replace old power-take off, engine-functioned and ground-driven headers with their generally more expensive, self-propelled counterparts. A continual expansion of harvest capacity can therefore be anticipated in the future.

To attempt to measure the number of headers actually required to harvest the main irrigation crops in the Murrumbidgee Irrigation Area, and hence obtain some idea of the extent of excess capacity, the statistics for the Shires of Leeton and Wade were chosen. The boundaries of the Shires coincide very nearly with the boundaries of the M.I.A., and virtually all crops are grown under irrigation. The performance rates of headers previously derived on the basis of harvesting irrigation crops can therefore be used with confidence on crop statistics from these Shires.

After discussions with research and extension Agronomists, the Rice Marketing Board, Grain Elevators Board and farmers in the area, it was decided the *safe* harvest period for the four main crops grown in the M.I.A. were as follows:

Rice	.. ..	..	.. March 14 to April 21
Oats and Barley		..	.. November 7 to November 21
Wheat ..	..	..	.. November 22 to December 20

That is to say, these are the periods within which each crop should come off, based on the dates when the majority of crops mature in the area, and the length of time available after this for harvesting without undue loss of grain quality or yield. In actual fact a large number of crops are harvested well after the dates specified according to the two Boards, with no apparent ill effects on the grain. The periods chosen above to calculate header requirements therefore appear to allow a much greater safety margin than would appear to be necessary in practice.

[18] Private communication, Commonwealth Bureau of Census and Statistics, Sydney.

The delays caused at harvest time by rainfall were calculated by consulting the meteorological records at the Agricultural College and Research Station, Yanco and the CSIRO Irrigation Research Laboratories, Griffith. Records were available for the 24 years from 1942-65 for Yanco and 41 years from 1925-65 for Griffith. Table 11 shows the delays assigned to varying rainfall intensities for the two harvest periods.

TABLE 11

Days Lost at Harvest Due to Rainfall

Rainfall	Irrigated Winter Cereals	Rice
10 points	....	....
10— 20 points	0·50	1·00
20— 30 points	0·75	1·50
30— 50 points	0·75—1·50	1·50—2·50
50—100 points	1·50—4·00	2·50—3·50
100—150 points	4·00—5·00	3·50—4·00
150—200 points	5·00—6·00	4·00—4·50
>200 points	6·00—8·00	5·00—7·00

These delays are founded largely on information from header operators, and relate to physical delays caused by both soil conditions and excessive grain moisture unacceptable to the respective Boards. The Rice Marketing Board now has facilities for handling grain with a moisture content up to 23 per cent, and once the crop attains this level, rainfall will not materially affect its acceptability providing it is not allowed to dry in the paddock below 16.5 per cent moisture beforehand. Wheat is not similarly placed and excessive and prolonged rainfall at harvest can result in rejection by the Grain Elevator's Board, due to high moisture content. This is the main reason for the greater delays assumed for winter cereals at high rainfall intensities.

In addition to the abovementioned delays a further day was allowed for the number of days, in excess of one, on which the rain fell. The results of the rainfall analysis are contained in Appendix III. The highest *median* number of days lost of the two meteorological stations for both harvests was at Griffith. This was also the case with the ninth *decile* number of days lost. The respective values of these from Appendix III were:

	Winter Cereals	*Rice*
Median Days Lost	7.75	7.5
Ninth Decile Days Lost	17.50	20.0

The *median* refers to the maximum delay that can be expected one year in every two and the *ninth decile* is the maximum delay that can be expected to occur nine years in ten. In other words, nine years in ten the delays would be less than those specified for the ninth decile year.

The average number of machine-hours worked each day in the two harvest periods from the survey of header owners was 8 in rice and 10 in winter cereals. Using these, the number of machine-hours actually available for harvesting in both the median and ninth decile years net of rainfall delays were calculated as follows:

	Oats and Barley	Wheat	Rice
Median Hours of Machine Time ..	123.6	238.9	316.0
Ninth Decile Hours of Machine Time	115.5	174.6	216.0

Self-propelled and tractor-drawn engine-functioned headers are the only two types capable of harvesting all kinds of irrigated crops as mentioned previously. The power take-off headers are not generally used for harvesting irrigation crops and there are virtually no ground driven machines in operation. The Statistician does not compile details of headers by size and type, so it is impossible to weight the performance rates derived earlier in the study for each type of self-propelled header according to their relative proportions in the total population. The next best alternative is to use simple average performance rates. These worked out to be 0.56 machine-hours per acre for rice and 0.25 for winter cereals in the case of self-propelled headers. Tractor-drawn engine-functioned machine performance was set at 1.21 hours per acre in rice and 0.39 in winter cereals. These were derived from Table 3.

Assuming the average crops of rice and irrigated winter cereals are both 60 acres on farms in the M.I.A., and allowing 2 hours per crop for travelling and general machine adjustments, together with a loss of 1 hour in 10 for breakdowns with self-propelled headers and 1 hour in 8 for the engine-functioned machines, the net average performance rates in acres per machine-hour are:

	Rice	Winter Cereals
Self-propelled	1.542	3.231
Tractor-drawn Engine Functioned	0.717	2.109

At March 31, 1964, there were approximately 147 self-propelled and 105 engine-functioned headers under 15 years of age as far as can be ascertained from the statistics. Headers over 15 years of age are considered to be obsolete and probably not in serviceable condition.

To calculate the number of headers required to harvest the M.I.A. annual grain harvest, assuming the proportion of engine-functioned and self-propelled headers to be the same as that above for the whole population under 15 years of age, we can establish two equalities for each crop. These two equalities are:

$$Y = 0.714X \tag{1}$$
$$\text{and} \quad aX + bY = A \tag{2}$$

where Y = Number of Engine-functioned headers required.

X = Number of self-propelled headers required.

0.714 = Proportion of engine-functioned headers to self-propelled under 15 years of age in the whole population.

a = Acres of crop one self-propelled machine could harvest in the median and ninth decile year (acres per machine-hour by hours available for harvest).

b = Acres of crop one engine-functioned header could harvest in the median and ninth decile year (acres per machine-hour by hours available for harvest).

A = Area of crop in Leeton and Wade Shires in 1963–64.

The coefficients a and b in equation (2) for each harvest period in the median and ninth decile years were as shown in Table 12.

TABLE 12

Physical Capacities of Headers

Using Delays Caused by Rainfall in the—	Acres of Crop One Self-Propelled Header Could Harvest per Season (Coefficients a)			Acres of Crop One Engine-Functioned Header Could Harvest per Season (Coefficients b)		
	Rice	Irrigated Wheat	Irrigated Oats and Barley	Rice	Irrigated Wheat	Irrigated Oats and Barley
Median Year*	487	772	399	227	504	261
Ninth Decile Year†	333	564	373	155	368	243

* One year in every two, harvesting would be restricted to these areas, due to delays caused by rainfall. In all other years areas in excess of these could be harvested.

† Except for 1 year in 10, these and oftentime larger crop areas could be harvested.

When equations (1) and (2) were solved for each crop harvest period, the number of headers required to safely complete harvest was found. Basic to this was the assumption that the number of headers required had the same proportion of engine-functioned to self-propelled headers under 15 years of age, as in the total population. The results of the analysis are to be found in Tables 13 and 14. These show present numbers, header requirements and the size of the surplus in both the median and ninth decile years, assuming all crops are harvested within the safe period after maturity.

The most surprising fact emanating from the tables is that, nine years in ten, there is a surplus of approximately 66 self-propelled and 47 engine-functioned headers on the Murrumbidgee Irrigation Area as shown in Table 14. That is to say, if header owners were prepared to operate their machines for the full harvest each season, a reduction of 45 per cent in the numbers of serviceable self-propelled and engine-functioned headers would be justified. With these reduced numbers, only one year in ten is it likely that portion of the crops will be harvested outside the periods specified as desirable earlier in this section, due to insufficient capacity in the harvesting industry. For the other nine years the surplus of headers would actually be greater than the above figures. As these harvest periods were made fairly restrictive, it is almost certain that major damage would never occur to unharvested crops due to delays so caused.

TABLE 13

*Estimated Header Requirements and Excess Capacity in 1963-64 Using Median Delays Due to Rainfall—Leeton and Wade Shires**

Type of Header	Approximate Number of Headers on Farms at March 31, 1964 Under 15 Years of age	Number of Headers Required to Harvest 1963-64 Area of—			Number of Surplus Headers on Farms in 1963-64 to Harvest—		
		Rice	Irrigated Wheat	Irrigated Oats and Barley	Rice	Irrigated Wheat	Irrigated Oats and Barley
Self-Propelled	147	55	48	37	92	99	110
Engine-Functioned	105	40	34	26	65	71	79
Total	252	95	82	63	157	170	189

* The *median delay* refers to the maximum number of days delay at harvest that can be expected one year in every two (i.e., 50 per cent of years) due to rainfall.

TABLE 14

*Estimated Header Requirements and Excess Capacity in 1963–64 Using Ninth Decile Delays Due to Rainfall—Leeton and Wade Shires**

Type of Header	Approximate Number of Headers on Farms at March 31, 1964 Under 15 Years of Age	Number of Headers Required to Harvest 1963–64 Area of—			Number of Surplus Headers on Farms in 1963–64 to Harvest—		
		Rice	Irrigated Wheat	Irrigated Oats and Barley	Rice	Irrigated Wheat	Irrigated Oats and Barley
Self-Propelled	147	81	66	39	66	81	108
Engine-Functioned	105	58	47	28	47	48	77
Total	252	139	113	67	113	129	185

* The *ninth decile* delay refers to the maximum number of days delay at harvest that can be expected nine years in every ten (i.e., 90 per cent of years) due to rainfall.

It may be said by some that the headers in Leeton and Wade Shires are not used solely to harvest crops in the M.I.A., and so the above conclusions are incorrect. A similar analysis performed on the five Shires in and around the M.I.A. on the basis of the data derived for irrigation crops, shows the following numbers of headers to be required to safely harvest all crops nine years in ten:

	Rice	Wheat	Oats and Barley
Self-Propelled	105	182	66
Engine-Functioned	63	} 507	} 183
Other	..		

These were derived by assuming the area of wheat, oats and barley each header could harvest per year in the five shires was 40 per cent more than the areas shown for the ninth decile year in Table 12. Information obtained from header owners suggest that this is a reasonable figure, especially when it is realised that most of the winter cereals in the five Shires are not grown in the Irrigation Areas. The larger paddock sizes and crop areas per farm outside the Irrigation Areas would entail less turns and less travelling between crops. The performance rates for harvesting in the Irrigation Areas, as shown on page 162, were calculated allowing 2 hours travelling per 60 acres of crop. This represented about 14 per cent of operating time in a 60 acre crop of winter cereals.

Furthermore, all except approximately 82,000 of the 501,427 acres of winter cereals grown in the five Shires is not irrigated. This 82,000 is made up of the area of winter cereals in Leeton and Wade Shires, which cover Benerembah and Tabbita Irrigation Districts, plus the area of cereals grown under irrigation in the Wah Wah Irrigation District.[19] Yields under irrigation are usually three to nine bushels per acre more than dry area crops and this would again allow headers to harvest the latter at increased speeds with less stops for discharging the grain.

It has also been assumed that the performance rates of power take-off and ground drive headers in the five Shires were the same as that derived for the engine-functioned headers, and that the number of headers estimated to be required have the same proportion of header types as that in the whole population under 15 years of age.

At 31st March, 1964, there were approximately 234 self-propelled and 652 other headers under fifteen years of age in the five Shires. When compared with the requirements for safe wheat harvesting presented in the table above of 182 and 507 respectively, the extent of excess capacity is such that, nine years in ten the number of self-propelled headers could be reduced by *at least* 52 and others by at least 145. In other words, if header owners in the Shires of Carrathool, Leeton, Murrumbidgee, Narrandera, and Wade were prepared to operate their headers for the full harvest season, a reduction of at least 23 per cent in the number of headers would be justified nine years in ten. The extent of excess capacity would in fact be greater than 23 per cent in most of these nine years, as this is based on the maximum harvest delay expected nine years in ten.

[19] *Annual Report of the Water Conservation and Irrigation Commission of New South Wales* 1963–64, Victor C. N. Blight, Government Printer, Sydney, New South Wales (1965), p. 46.

Although the apparent requirement of headers as a percentage of present numbers in the five Shires is higher than for Leeton and Wade Shires alone, the amount of excess capacity is still quite substantial in the former area. The above analysis for the five Shires is by no means a completely rigorous one as differences in rainfall intensities between Shires has not been taken into account. However, as a first approximation it gives some idea of the extent of excess capacity in the M.I.A. and surrounding districts.

Translating the apparent surplus of 66 self-propelled and 47 engine-functioned headers in the M.I.A. into effective acres of crop in each season, we find the present header numbers could safely harvest *more than* the following *additional areas* nine years in ten:

	Acres
Rice	29,000
Irrigated Wheat	63,000
Irrigated Oats and Barley	59,000

Only one year in ten would they not be able to harvest these additional areas. If the number of headers in operation in this and other areas was rationalized to more closely correspond with requirements, it appears the cost both to the nation and to individual farmers could be substantially reduced. This would be brought about by a reduction in per acre costs of header operation due to increased utilization of machines, thus allowing contract rates to be reduced. Some further algebra will give an idea of the possible savings that would occur.

Substituting the approximate number of headers under 15 years of age in Leeton and Wade Shires at 31st March, 1964, into equation (2) established earlier in this section, we obtain the equation:

$$147a + 105b = A \qquad (3)$$

Now using the proportionate relationships between the coefficients a and b for the ninth decile year for each crop, shown in Table 12, we can derive a second equation:

$$a = Kb \qquad (4)$$

Where $K = \dfrac{a}{b}$ for each crop in the ninth decile year.

Solving these simultaneous equations for each crop, the approximate average area harvested per serviceable header under 15 years of age in the 1963–64 harvest seasons is found. These are shown in Table 15.

TABLE 15

Approximate Average Area Harvested Per Header in M.I.A. in 1963–64*

Header Types	Rice	Irrigated Wheat	Irrigated Oats and Barley
	acres	acres	acres
Self-propelled Headers	181	250	98
Engine-functioned Headers	84	163	64

* These refer to the area harvested by serviceable headers under 15 years of age.

When these figures are compared with those in Table 12 for the areas which each type of machine is *capable* of harvesting, it can be seen once again that, on the average, headers in the Murrumbidgee Irrigation Area are substantially underutilized.

The existing surplus of harvest capacity is evidence of either the importance attached by farmers to non-economic factors or, alternatively, the high opportunity cost of labour involved in operating headers over larger areas than those specified in Table 15 precludes greater machine utilization.[20] However, contract harvesting only required the header owner to supply one man to drive the machine, and most large area farmers on the M.I.A. who have headers appear to have at least two men on hand at both harvest periods.[21]

If we assume from this that the $1.20 per hour used in costing the labour input for the construction of Figures 2 and 3 is a reasonably accurate reflection of the opportunity cost of labour at harvest times, this underutilization can be roughly trans'ated into financial terms by reference to these graphs.[22]

Taking the 12 foot self-propelled petrol and the 8 foot tractor-drawn headers as representing the "average" headers of these types in the M.I.A., as defined earlier, we can read off from figures 2 and 3 the total per acre costs of harvesting the areas of rice and irrigated winter cereals specified in Tables 12 and 15, the difference between them measuring the expected savings upon rationalization. Table 16 shows the savings in harvest costs that would result.

TABLE 16

Approximate Cost Savings Per Acre From Rationalization of Excess Capacity

Header Types	Rice	Irrigated Winter Cereals
	$	$
Self-Propelled Headers	2.65	1.85
Engine-Functioned Headers	1.00	0.45

[20] It is probably true to say that many farmers buy headers on what appear to them to be logical grounds, being prepared to incur increased costs for the non-monetary advantage of mitigating the fear of crop losses due to harvest delays and employment of contractors. Pride of ownership, conservatism, and ignorance of the economics of the situation could also be cited as reasons for this behaviour. It is to be hoped the information contained in this paper will in future enable farmers to make a more informed decision on such matters.

[21] In a survey of a stratified random sample of large area farms in the M.I.A. at present in progress, 15 of the 31 farmers interviewed to date were owners or part owners of serviceable self-propelled headers. All but one of the 15 had at least two men available at both harvests, mostly representing the permanent farm labour force. Thirteen of the 15 owners engaged in contract harvesting off their farm, and in all cases managed to operate their farms with one man plus occasional casual labour during the harvest periods.

[22] A model for evaluating least-cost harvesting methods for various labour rates and acreages has been developed by E. J. Smith in "Buying Versus Renting a Combine: A Suggested Basis for Decision Making", *Agricultural Economics Research*, Vol. XIII, No. 4 (October, 1961), pp. 109–117.

When these possible savings are spread over the total area of the two types of crop grown in the Murrumbidgee Irrigation Area, it could amount to many thousands of dollars. The difficulty of measuring accurately the opportunity cost of labour and inability to weight overall machine performance according to the proportion of the different header types in the total population must however render the above estimation a rather tentative one. Further research aimed at precisely quantifying the assumptions made is certainly called for before any dogmatic statement can be made on this. However any positive bias that may have been introduced as a result of the assumptions used would be offset to a large extent by the fact that, in most years, the headers required to safely harvest crops in 90 per cent of years could in fact harvest more than the areas shown in Table 12.

9. CONCLUSION

The foregoing study emphasises the need for careful evaluation before decisions are made about header purchase. There is already a substantial amount of excess capacity evident in the harvesting industry of the Murrumbidgee Irrigation Area which, if reduced, could benefit both header owners and non-owners alike. Numerous headers must now rest in the shed for most of the harvest season, either because of the owner's dislike of contracting or simply that the work is not available. The former attitude is not business-like and possible income from contracting is foregone in these cases. Some who have a header to harvest only their own crops may find this an extremely expensive way of providing insurance against possible losses from untimely harvesting when using contractors. Until some rationalization of the position occurs, the excess capacity in the harvesting industry could continue to cost the owners and the nation dearly.

A lot more work on mechanisation economics is required in Australia, as at present there is a dearth of factual data. Furthermore, the present paper has not touched on important considerations such as:

(i) optimum machine combinations for different farm types and sizes ;[23]

(ii) the optimum time to trade-in old machines on new ones, taking account of second-hand values over time, interest, depreciation and repair costs ;[24]

---

[23] See E. O. Heady and R. D. Krenz, *Farm Size and Cost Relationships in Relation to Recent Machine Technology: An Analysis of Potential Farm Change By Static and Game Theoretic Methods* (Agricultural and Home Economics Experiment Station, Iowa State University, Bulletin No. 504, May, 1962), and E. L. Walker, *Machinery Combinations for Oklahoma Panhandle Grain Farms* (Oklahoma State University Experiment Station, Bulletin B–630, November, 1964.).

[24] Some studies relating to the optimum time for tractor replacement have been attempted in the U.K. and New Zealand. See W. J. Dunford and R. C. Rickard, "The Timing of Farm Machinery Replacement," *Journal of Agricultural Economics*, Vol. XIV, No. 4 (May, 1961) p. 348 and Wilfred Candler, "The Rate of Interest and the Second Hand Market for Farm Machinery", *Journal of Agricultural Economics*, Vol. XV, No. 3 (June, 1963) p. 461.

(iii) evaluation of the additional cost of providing sufficient machinery to perform jobs at the correct time in *all* years, compared with the expected production losses when sufficient machinery is provided only for the average, median or some other specified decile year.[25, 26]

These studies should be undertaken with taxation aspects incorporated in order to yield data to assist farm management decision making. The foregoing investigation has partly answered some of these questions for only one item of machinery in one particular area of Australia. It is felt however that it is a start in the right direction.

---

[25] Heady and Krenz, *op. cit.*

[26] Walker, *op. cit.*

APPENDIX I

On-Farm Prices of Fuel, Oil and Grease[27]

Petrol
    Standard .... 3s. 3d. per gall. (32.50 cents)
    Super .... 3s. 6d. per gall. (35.00 cents)

Power Kerosene   2s. 6d. per gall. (25.00 cents)

Distillate   2s. 1½d. per gall. (21.25 cents)

Engine Oil
    SAE 30 .... 10s. 10d. per gall. (1 dollar 8.33 cents)
    SAE 90 .... 15s. 7d. per gall. (1 dollar 5.84 cents)

Hydraulic Oil   10s. 1d. per gall. (1 dollar 0.84 cents)

Transmission Oil   12s. 3d. per gall. (1 dollar 22.50 cents)

Grease
    Multi-purpose .... 2s. 4½d. per lb (23.75 cents)

[27] Prices quoted as at November, 1965 and net of discounts for payment within 30 days. All calculations were performed in £ s. d. and that is the reason they are shown in this currency here. Dollar and cent amounts shown represent the exact equivalents.

APPENDIX II

Calculation of the Physical Capacity of Headers

The calculation for a 12 foot self-propelled petrol header is shown as an example.

Performance Rate in:

Rice .... 0.63 machine-hours per acre

Irrigated Winter Cereals .... 0.31 machine-hours per acre

∴ To harvest 60 acres would take 37.8 machine-hours for rice and 18.6 for winter cereals. Assuming 2 hours are lost per 60 acres due to travelling and machine adjustments, together with 1 hour in 10 due to breakdowns, the total time per 60 acres is:

Rice .... 43.78 hours

Irrigated Winter Cereals .... 22.66 hours

Minimum time available for rice harvest nine years in ten

(Section 8) .... 216 hours.

Minimum time available for winter crop harvest nine years in ten

(Section 8) .... 290 hours.

∴ Minimum possible areas one machine could handle *nine years in ten* (or the *maximum area* it could harvest one year in ten):

Rice .... 296 acres

Irrigated Winter Cereals .... 768 acres

The minimum capacity of the other five headers nine years in ten, or alternatively their *maximum capacity* one year out of every ten is as follows:

Header Type	Rice	Irrigated Winter Cereals
	acres	acres
14 foot self-propelled diesel and petrol	453	1,364
13 foot self-propelled petrol	320	965
10 foot self-propelled petrol	244	654
8 foot tractor-drawn engine-functioned	155	612

Performing the same calculations using the time available in the *median* wet year for harvesting rice and winter cereals, the maximum areas of crop each header could safely handle one year in every two are as follows:

Header Type	Rice	Irrigated Winter Cereals
	acres	acres
14 foot self-propelled diesel and petrol	663	1,705
13 foot self-propelled petrol	468	1,206
12 foot self-propelled petrol	433	960
10 foot self-propelled petrol	358	817
8 foot tractor-drawn engine-functioned	227	764

APPENDIX III

Days Lost at Harvest Due to Rainfall

Year	Rice (March 14—April 21)		Winter Cereals (Nov. 7—Dec. 20)	
	Yanco	Griffith	Yanco	Griffith
1925	n.a.	1·50	n.a.	4·33
1926	n.a.	15·00	n.a.	1·50
1927	n.a.	nil	n.a.	2·75
1928	n.a.	14·50	n.a.	1·50
1929	n.a.	14·00	n.a.	5·00
1930	n.a.	1·00	n.a.	20·50
1931	n.a.	17·00	n.a.	11·25
1932	n.a.	20·00	n.a.	7·25
1933	n.a.	4·00	n.a.	19·00
1934	n.a.	16·50	n.a.	14·75
1935	n.a.	17·00	n.a.	4·00
1936	n.a.	13·00	n.a.	16·50
1937	n.a.	2·50	n.a.	4·50
1938	n.a.	nil	n.a.	nil
1939	n.a.	33·00	n.a.	9·50
1940	n.a.	9·50	n.a.	11·50
1941	n.a.	2·50	n.a.	1·50
1942	5·00	4·50	6·00	9·75
1943	6·00	10·50	9·00	11·00
1944	5·50	10·00	5·50	4·00
1945	3·50	7·00	2·75	4·00
1946	7·00	6·00	7·50	12·50
1947	12·50	13·50	18·00	13·75
1948	6·00	5·50	3·00	7·25
1949	10·50	8·50	4·00	9·50
1950	20·00	21·50	5·50	5·00
1951	7·00	4·50	2·00	1·50
1952	18·50	21·00	12·25	12·00
1953	8·50	4·50	7·00	9·00
1954	2·50	2·50	16·50	21·00
1955	5·50	6·00	7·25	7·75
1956	25·00	23·00	2·00	3·50
1957	6·00	5·00	1·50	1·00
1958	10·00	9·00	16·50	13·75
1959	6·00	8·50	nil	0·50
1960	8·00	2·00	11·75	9·25
1961	14·00	13·00	16·50	22·00
1962	7·00	6·00	3·00	2·00
1963	4·50	7·50	10·20	9·50
1964	6·00	5·00	1·50	3·25
1965	8·00	7·00	13·50	17·50
Average	8·89	9·57	7·60	8·43