Economic assessment of partial adoption of extension programs: the case of the Ricecheck program in Australia

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Abstract. A distinctive feature of the Ricecheck extension program is the identification of 'Key checks' where the adoption of an increased numbers of checks is expected to lead to higher yield. The nature of the program allows full or partial adoption. The main aim of the paper is to estimate the economic importance of partial adoption of the Ricecheck program. Partial adoption, whether on an informal basis through Ricecheck, or through the industry information circulated through awareness programs, is estimated to have been substantial. In this paper the significance of that informal adoption is shown. The estimated Net Present Value of Ricecheck over the period 1986 to 2002 was $64.1 million. The proportion of the total benefits to these full, partial and awareness adopters was 49.6%, 42% and 8.4% respectively, which demonstrates the significant benefits to the partial adopters from the program.

Key words: Rice, extension, economics, partial adoption, cost benefit

Introduction

Ricecheck is an extension program developed in the 1980s by the New South Wales Department of Primary Industries (NSW DPI) to improve productivity through improved crop management in the rice industry (Singh et al. 2005).

In the 1970s, the Australian rice industry experienced a sharp increase in the area sown to rice, and increased production of rice on 'leaky' soils that have led to serious problems of rising water tables, water-logging and soil salinity. To address these issues, restrictions were imposed on further expansion of the area under rice production by local irrigation authorities. Also, a general lack of awareness among growers about the significance of adoption of best management practices resulted in only limited increase in yield during the 1970s and early 1980s.

To assist with identifying the causes for the limited yield increase and to develop a package of best management practices to improve water use efficiency and yield and profitability, a study of commercial rice crops was conducted in the Finley-Jerilderie area of NSW in the mid-1980s. It was found that no single factor consistently influenced rice yields, but that high yields only resulted when the key factors were carried out correctly. Based on the recommendations of that study, a set of eight 'Key checks' called Ricecheck was developed for the Australian rice industry in 1985 (Lacy 1998). The aim was to provide a basis for growers to achieve higher yields (Table 1). A detailed description of all these checks is provided in Lacy et al. (2004).

Table1. The eight key checks included in Ricecheck program

Key checks to be made by farmers
1. Field layout
2. Sowing time
3. Crop establishment
4. Crop protection
5. Pre-flood nitrogen
6. Panicle Initiation nitrogen
7. Panicle Initiation date
8. Water management

Source: 2004 Ricecheck Recommendations

The Ricecheck approach to extension involves direct farmer participation in learning and sharing knowledge with fellow farmers and researchers, and extension workers play a pivotal role in facilitating this learning process. It is an adaptation of the participatory action research approach (Guerin and Guerin 1994) and farming systems research (Petheram and Clark 1998). The Ricecheck program is based on monitoring crops and setting key benchmarks (or 'checks') based on the highest yielding rice crops in farmers' paddocks.

Farmers in the Ricecheck program can adopt the recommendations partially or in full, as in many other extension programs (e.g. Emla 1980). It has been observed by extension agents that partial

adopters have contributed substantially to the success of Ricecheck. The main objective of the present study is to analyse the economic significance of the partial adoption as a component of the overall benefits from the program.

More specifically the objectives of the study were:

- To estimate the degree of adoption of the program (in part and in full);
- To estimate benefits to rice growers from adoption of the Ricecheck program, and
- To measure the contribution of the partial adoption to the total benefits from the Ricecheck program.

Key features of the Ricecheck program

Activities within Ricecheck

The Ricecheck program involves farmers following 'best management practices' (Lacy et al. 2004), monitoring their rice crops and keeping (and submitting) records to determine the number of key checks 'achieved'. These results are also used to update the Ricecheck best management practice recommendations. In aiming to assist farmers to achieve the key checks, extension staff involved in the Ricecheck program used a wide range of methods to help them to improve understanding of rice growing systems and constraints.

A critical element of the operation of Ricecheck is the use of small discussion groups, where farmers can both learn and give feedback on the Ricecheck management package. In the discussion groups, the farmers are encouraged to participate in the program through a series (cycles) of learning steps – observing, measuring, recording, interpreting and changing practices**.** Regular group meetings are held at critical times before and during the cropping season. Through the exchange of experiences within the groups, farmers are assisted and encouraged to meet the key checks. These discussion groups have played a key role in the delivery of the Ricecheck program (Lacy 1998).

Participation in Ricecheck

The Ricecheck approach was first tested on the rice farms in the Finley district of NSW in 1986. By 1987, it had spread to other rice growing regions, i.e. the Murrumbidgee and Coleambally Irrigation Areas. In 2004, approximately 40 Ricecheck discussion groups were being run across all the districts and 780 farmers attended these discussion groups at some time during the year (Table 2). The membership varied from 5 to 50 members per group in a year. The number of times that groups met each year varied from 1 to 4. Each member of a discussion group attended at least one meeting a year.

Table 2. Numbers of Ricecheck discussion groups in rice growing districts, 2004

District	Number of groups	Number of farmers
Murray irrigation area		
Barham	7	140
Finley	8	200
Deniliquin	7	105
Murrumbidgee irrigation area		
Yanco	5	50
Hay	1	15
Griffith	6	120
Coleambally irrigation area		
Coleambally	6	150
Total (all districts)	**40**	**780**

Not all farmers involved in discussion groups are full adopters of Ricecheck (Guerin and Guerin 1994). While participation in Ricecheck involves these group activities, full participation also involves the submission of crop management records to a central database. Farmers mail their records to a central location. Initially records were entered into a spreadsheet, but as numbers built up the records were entered into a database known as the Cropcheck database, which is now

web-based The database is used for entering crop records and analysing data entered for each crop. It generates benchmarking reports that are sent to each participating farmer. The data can be used to compare results between farms and with overall means, and to check adoption trends from season to season.

Based on the analysis of records from the Ricecheck database, the number of crops and checks achieved in the Ricecheck system each year since 1986 is shown in Table 3. From an initial level of 30 rice crops in 1986, the number of crops grown by farmers using the Ricecheck system had grown to 823 by 2001.

Table 3. Number of crops and Key checks achieved by participating farmers 1986 to 2002

	Number of checks achieved*										Total
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Av.***	**crops**
1986	1	2	4	5	7	6	3	1	0	*3.8*	30
1987	1	3	9	11	13	8	5	2	0	*3.7*	53
1988	2	6	17	22	25	17	10	4	0	*3.7*	105
1989	3	11	29	39	42	28	17	7	1	*3.7*	178
1990	5	16	42	55	59	38	24	10	1	*3.7*	251
1991	6	21	51	69	76	50	32	14	2	*3.7*	319
1992	7	25	60	82	93	61	39	17	2	*3.7*	387
1993	8	31	73	99	112	74	48	20	3	*3.7*	466
1994	9	36	85	116	131	86	56	24	3	*3.7*	546
1995	2	10	50	98	188	164	163	61	10	*4.6*	746
1996	2	12	58	120	150	167	102	39	9	*4.4*	659
1997	0	22	61	125	156	149	100	23	0	*4.2*	636
1998	0	1	13	55	122	163	145	63	11	*5.1*	573
1999	0	4	25	69	154	166	129	49	7	*4.8*	603
2000	2	8	49	129	163	199	128	42	9	*4.5*	729
2001	0	6	19	87	188	254	174	82	13	*4.9*	823
2002	0	4	61	85	175	147	71	23	5	*4.3*	571

*Achieved means items checked by farmers and found to conform with Ricecheck criteria

Although crop numbers increased, over 50% of the farmers attending rice discussion groups did not submit crop records to the database. These farmers adopted the same Ricecheck practices as the other farmers but did not complete these records.

The information given in Table 3 and the results of a separate study by Singh et al (2005) suggest that even with good management and knowledge, the checks proved difficult to achieve. For example in 2002, 11% of crops in Ricecheck successfully 'achieved' only 1 or 2 checks, and only 0.9% achieved all 8 checks (Table 3). On average, the number of checks achieved for crops in Ricecheck between 1986 and 2002 was 4.1 checks, or 52% of the 8 checks. The reasons for difficulty in achieving these key checks were determined by Singh et al. (2005) to include:

- *'Black and white' adoption criteria:* There is no allowance for any error or blurring at each end of the adoption 'window'. For example, the sowing date window for the variety Amaroo for the Murrumbidgee Valley is 1 to 20 October, and if a crop is sown on 21 October it fails the check. Yet in most years no significant yield difference would result from a one day delay.
- *Factors outside farmer control:* Some factors are outside the control of the farmer. For example, seasonal temperature differences up to panicle initiation can alter nitrogen mineralisation and resultant nitrogen uptake by 30-40 kg N/ha. Hence a hotter season can increase nitrogen uptake by 40 kg N/ha, producing a crop outside the nitrogen uptake check window, while an average season for the same crop would result in lower nitrogen uptake and hence achievement of the check.
- *Checks changed over time so harder to achieve:* Adoption of some checks has become more difficult over time. For example, the optimum nitrogen plant level check was initially

based on shoot numbers/m^2 at panicle initiation. Hence only one parameter needed to be satisfied. In the late 1980s, the NIR nitrogen test was developed to provide more objective ratings, and made the check harder to achieve. In the late 1990s, shoot nitrogen was replaced by fresh weight and NIR analysis, again making the check harder to achieve.

- *Reliance on the NIR tissue test:* Although the change from shoot nitrogen to fresh weight is a more accurate measure of crop nitrogen, extra labour is needed to measure fresh weight, and so is a barrier to many farmers carrying out the test. The NIR tissue test crop data form has been designed to record information for crop nitrogen and Ricecheck. Hence any issues or advancements in technology leading to reduced use of the NIR test automatically reduce the potential number of Ricecheck records captured. Local agribusiness agronomists are being encouraged to increase the number of crops NIR tissue tested.
- *Some checks difficult to achieve:* Farmer surveys conducted in the Finley district from 1995 to 2000 showed there were 25 different factors affecting rice establishment, i.e. the plant number check. A number of these related to seasonal weather conditions. In a warm, no-wind start to a season, adoption of this check is relatively easy, but in colder windy starts check plant numbers are difficult to achieve.
- *Linked checks:* Sowing date is linked to panicle initiation date. Hence if a farmer chooses to sow late and not adopt the check it is likely that the panicle initiation check will also not be adopted either. Although bank height check adoption is generally good, crops with lower banks are unlikely to be able to achieve the early pollen microspore check. Crops with poor establishment are more likely to have poorer weed control since the rice crop biomass provides less competition to weeds and there is more reliance on chemical weed control.
- *Check importance:* Temperatures in the Murrumbidgee Valley are higher than in the Murray Valley. Cold affects rice yields 4 years out of 10 in the former compared to 6 years out of 10 in the latter. Hence microspore water depth adoption to reduce cold damage tends to be better in the Murray Valley than Murrumbidgee Valley because it is a more important check to them.

An annual booklet is published to update the Ricecheck recommendations (see Lacy et al. 2004) and a copy is sent to every rice grower (whether a Ricecheck participant or not). Grower feedback indicates that some growers follow those recommendations without necessarily becoming part of a Ricecheck discussion group or recording detailed information for their crops. District Agronomists also promote the recommendations of the Ricecheck program with farmers through the media and field days.

In addition, since the Ricecheck program and the discussion groups began in 1986, many farmers who were regular members of these discussion groups have left the program after a few years. Based on feedback to District Agronomists, many of these former members are likely to be still using the Ricecheck approach, though they are not current members of the program.

While past participation helps them to improve their skills and knowledge for achieving higher yields, the Ricecheck program continually updates the regular members about changes in management and other technologies over time. Thus past or irregular members or those who have never joined any discussion group may not be able to take advantage of improvements in the key check recommendations and other technologies, and this may result in them achieving lower yields than the regular attendees.

Levels of adoption of Ricecheck

Because of the range of methods for getting information to farmers, the benefits of the Ricecheck recommendations to individual farmers varied depending upon their involvement and access to the different sources (McIntosh and Schipp 2002). In this study, farmers were divided into four categories depending upon their level of participation in the Ricecheck program:

- *Full adopters*: This group are full participants of the Ricecheck program. As members, they keep records, monitor crops and grow rice following the Ricecheck recommendations, regularly attend discussion group meetings, other farmers meetings, field days, read the Ricecheck booklet and submit the crop production records.
- *Partial ('Informal') adopters*: This group have developed their skills and knowledge and are aware of the importance of adoption of the Ricecheck recommendations. They attend meetings and field days and follow Ricecheck recommendations by reading the booklet and joining discussions with other farmers. This group includes former members who no longer provide records of their crops, and other farmers who have never been formal members of Ricecheck.
- *Partial ('Awareness') adopters*: These farmers have never joined any Ricecheck discussion group but either regularly attend other farmer meetings and field days organised by

advisory staff of NSW DPI, or try to follow the recommendations given in the Ricecheck booklet.

- *Non adopters*: Even though all rice growers would be aware of the Ricecheck program, some growers are unable or unwilling to adopt Ricecheck recommendations because of a lack of skills, knowledge, resources, poor infrastructure, location of the farm, and/or social factors.

Value of Ricecheck to growers

When growers participate in Ricecheck, for each check achieved the expected level of yield increases. Although there are seasonal and regional differences, the accumulated data from the Ricecheck database provides a measure of the yield benefits from the adoption of a different number of checks. On average, for the leading variety, rice yields increased from 8.7 t/ha progressively as checks were achieved to 10.1 t/ha when all the 8 checks are achieved, with each additional check giving an average additional yield of 0.175 t/ha. In addition, potential rice yields have increased in recent years for a number of reasons other than the Ricecheck program, including the use of higher-yielding varieties. The analysis undertaken for this report indicates that the benefit from adopting additional checks has remained constant throughout the period.

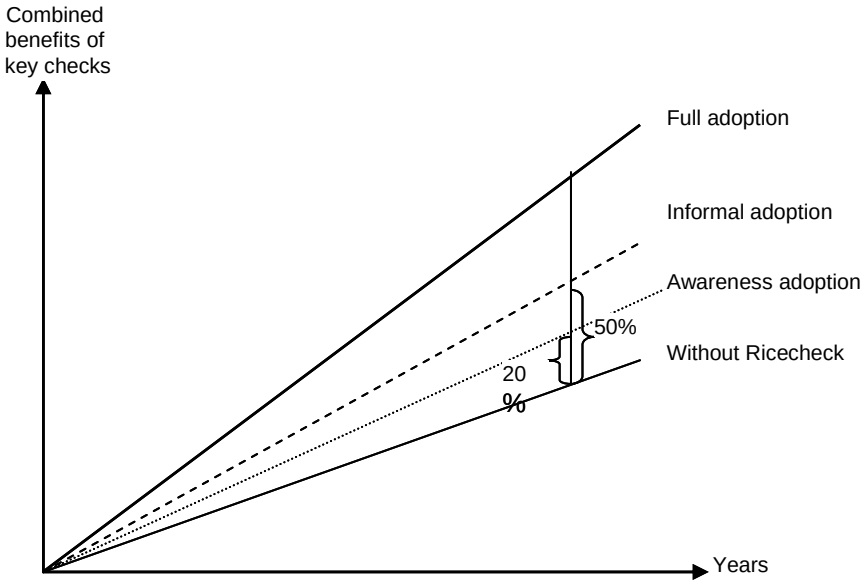
The Ricecheck approach of considering the total number of checks achieved, rather than the achievement of particular individual checks, implies that each of the checks is equally important in determining yield levels. Therefore, in the analysis presented here, the implicit assumption is that each of the checks has equal weight, and any combinations of, say three, checks would give the same expected yield level. Although this assumption may not be valid, no analysis has yet been conducted to determine the different influence of each of the 8 individual checks, on rice yield.

Benefits of adopting Ricecheck

The level of benefits received from Ricecheck is affected by the level of adoption. The benefits of adoption are expressed as a proportion of the additional benefits obtained from the adoption of

Ricecheck over and above those that would have been received without Ricecheck. 'Full adopters' are assumed to receive 100% of the benefits of Ricecheck since they have fully participated and utilised all the learning methods provided. 'Informal adopters' are assumed to receive about 50% of the unit benefits of Ricecheck. This is the biggest group, as rice farmers generally appear to prefer personal communication and interaction with other farmers and advisors to writing down records. Writing tasks are usually left to last and compete with essential farm business administrative writing tasks. Given the level of information that they are known to receive, the 'Awareness group' is assumed to receive 20% of the unit benefits of Ricecheck. Although they do not formally participate and never contribute to Ricecheck, they probably accept the results and practices of other farmers who use Ricecheck and results from researchers or extension officers they find credible. The basis for the combined yield benefits of achieving key checks is illustrated in Figure 1.

Figure 1. Basis for determination of benefits of key checks



In estimating the number of rice crops that fall in each category of adopters, the following assumptions are made, on the basis of analysis of the records and the experience of advisory officers of the NSW DPI District (extension) Agronomists:

- 'Full' adopters: The percentage of farmers in this group reached a maximum of 17% in 2000, and averaged 10% over the period 1986 to 2002.
- 'Partial' adopters were assumed to be twice as numerous as the group of full adopters, given they participated in discussion group meetings and other extension activities.
- 'Awareness' adopters were also assumed to be twice as numerous as the group of full adopters.
- 'Non-adopters' represent all other rice crops in each year, ranging from close to 100% in early years to 14% of crops in 2000.

The estimates for the two partial forms of adoption - Informal and Awareness - were consistent with records and experience of extension staff. The total number of rice growers in each rice growing district in Australia varies between 50 to 400 farmers. The District Agronomists involved in the program are working closely with those farmers and are very familiar with the attitude of different farmers and their involvement in the program since 1986.

Costs of adopting Ricecheck

In adopting Ricecheck, farmers have to make various commitments of their time and resources. The input of farmers' time was estimated at 8.7 hours per crop, comprising time spent at group meetings and field days related to Ricecheck, crop monitoring activities and formal record-keeping (Singh et al. 2005). Farmers who adopted Ricecheck informally (i.e. without keeping formal records) were assumed to also spend time at meetings and field days and the same time on crop monitoring, but not on record-keeping (Table 4). Those defined as 'awareness adopters' were

estimated to spend time gaining awareness only. The farmers' time was valued at a rate of $25 per hour, and therefore at $218, $143 and $75 per crop for full adopters, informal adopters and awareness adopters, respectively. In all, farmers contributed a total of $5.0 million worth of their time (an annual average of $294,000) to the Ricecheck program since 1986.

Table 4. Estimates of farmers' labour in adoption and checking of Ricecheck recommendations

	Hours per crop		
	Full adopters	**Informal adopters**	**Awareness adopters**
Discussions groups	2.7	2.7	0.0
Crop monitoring	2.0	2.0	2.0
Meetings	1.0	1.0	0.0

Record-keeping	3.0	0.0	0.0
Reading Ricecheck Booklet	0.0	0.0	1.0
Total hours	***8.7***	***5.7***	***3.0***

In addition, the adoption of key checks involved extra expenditure on inputs such as seed, fertilisers, harvesting of additional rice yield or farm improvements like land-forming or raising bank height. These costs were estimated to be $5.02 per hectare for each check achieved (Singh et al. 2005).

Methodology for economic analysis

To evaluate returns to the investment in the Ricecheck program, the study first measured the crop scale benefits and costs from the adoption of the Ricecheck recommendations for full adopters, partial and awareness groups. Then, drawing these impacts into a benefit-cost framework, returns to the research, development and extension investments on the program were measured. Ricecheck is essentially an extension program but we have included the time spent by research staff in developing and improving the program over many years.

The crop level benefits are estimated for three different levels of adoption of Ricecheck, taking into account the lags involved in the development and rate and extent of adoption of the program over the accounting period. The study measured the returns to the investment in research, development and extension, taking into account both in-kind and cash expenditure on the program.

Key assumptions and data used in the analysis

The key assumptions in our analysis of Ricecheck are discussed under subheadings below.

Area sown to rice

The area sown to rice in NSW generally increased throughout the period 1986 to 2002, with an average area sown of 128,000 ha. There have been considerable annual fluctuations in the area sown to rice due mainly to water allocations and seasonal conditions (see Singh et al. 2005 for more details).

Rice prices

The price of rice used for each year was the average unit value of rice across all grades. The prices were converted to constant 2002 dollars for the analysis, using the Consumer Price Index. In 2002 dollars, rice prices fluctuated between $205 per tonne and $340 per tonne, with a mean price of $263 per tonne (see Singh et al. 2005 for more details).

Accounting period

In an on-going program, it is always difficult to determine the period chosen to estimate the benefits and costs, since both will continue into the future. Because of issues related to the availability of unambiguous data, the stream of investments analysed relates to the period 1986 to 2002. That is, the evaluation being carried out is on the basis of 'What if the program had been stopped at the end of the 2002 season?' It is clear that, given the participatory nature of the program, benefits would continue to accrue even after the cessation of the formal investment in the program by NSW DPI and Rural Industries Research and Development Corporation (RIRDC). We assumed that the benefits would decline linearly to zero over the next ten years after the program funding was ceased.

Thus, in this analysis, the period over which benefits of the program were accounted for was from 1986 to 2012, a total of 27 years. After 2012, it was anticipated that either this program would be replaced by a new program from future research and development, or that the rest of the industry would be achieving the same productivity as those who have adopted Ricecheck. While measuring benefits from 2002 to 2012, no research and extension costs were charged against the project over this period.

Discounting and discount rate

Discounting and compounding was applied to ensure that people's time preference for money is appropriately accounted for in the analysis. All benefits and costs are expressed in 2002 dollars, which required past expenditures to be converted to real 2002 dollars by the GDP deflator, then compounded forward at the discount rate. All future returns and costs were discounted to 2002. These benefits and costs were discounted at a real rate of 4% per annum.

R&D Investments in Ricecheck

The R&D investment in Ricecheck included the direct expenditure by RIRDC and the in-kind contributions from the extension and research staff of the NSW DPI in the development and promotion of the Ricecheck program over the study period. All costs were considered in estimating the total costs, and are expressed in 2002 dollars, using the GDP deflator.

The labour input was estimated on the basis of days per year for Departmental officers and the labour costs (including salary and on-costs) in 2002 were then applied to those inputs to give the cost of those inputs in constant 2002 dollars. The total labour input from Departmental staff was estimated to average 461 person-weeks per year. The value of the average labour input since 1986 was $317,000 per year (in 2002 dollars), ranging from $44,000 in 1986 to $477,000 in 2001 (see Singh et al. 2005 for more details

Operating costs incurred by Ricecheck other than labour costs, involved the costs of printing the Ricecheck forms, printing the annual *Ricecheck Recommendations* booklet (Lacy et al. 2004), and travel costs for the extension officers and an annual fee of $5,000 required for programming to establish and maintain the database for Ricecheck (see Singh et al. 2005 for more details)

Results of the economic analysis

The benefits from Ricecheck were estimated by first estimating the unit impacts of Ricecheck per hectare, compared to the baseline without Ricecheck, then determining the impact per crop of rice, then aggregating to impact for the industry. The detailed steps in the estimates are outlined in Singh et al. (2005).

After the costs of involvement in Ricecheck recommendations and the direct costs of adopting different numbers of checks each year were deducted, the net benefits averaged from $31 to $54 per check 'achieved' over and above the equivalent checks that would have been 'achieved' in the absence of the Ricecheck program (Singh et al. 2005).

The total benefits in each year were estimated by summing over all crops for which one to eight checks were 'achieved' by farmers. The total net benefits from this group of farmers adopting Ricecheck were estimated to have been $114,000 in 1986, rising to a peak of $3.38 million in 1995 (Table 5). As the area sown to rice, the price of rice and the number of crops in Ricecheck varied from year to year, the total benefits varied annually.

Table 5. Total benefits from achieving key checks in Ricecheck: Full adoption
($'000, 2002 dollars)

	Number of checks achieved*										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Total***	**Farmer time**	**Net benefit**
1986	2	9	17	31	30	20	10	0	*119*	4	**114**
1987	3	17	33	50	42	31	15	2	*194*	7	**187**
1988	9	49	96	143	120	88	44	5	*554*	23	**531**
1989	13	70	139	202	165	123	61	8	*782*	39	**743**
1990	16	82	162	232	187	141	70	10	*898*	55	**844**
1991	0	47	127	211	184	147	75	11	*802*	69	**733**
1992	0	57	156	265	233	187	96	14	*1,009*	84	**925**
1993	0	85	233	396	347	281	144	21	*1,507*	101	**1,406**
1994	0	135	368	624	546	444	228	33	*2,379*	119	**2,260**
1995	0	65	256	736	856	1063	477	91	*3,544*	162	**3,382**
1996	0	0	170	424	708	576	276	76	*2,230*	143	**2,086**
1997	0	0	166	414	593	531	153	0	*1,856*	138	**1,718**
1998	0	0	65	289	580	688	373	78	*2,073*	125	**1,949**
1999	0	0	86	385	622	645	306	52	*2,097*	131	**1,966**
2000	0	0	164	415	760	651	267	69	*2,326*	159	**2,167**
2001	0	0	0	214	579	595	374	74	*1,838*	179	**1,658**
2002	0	0	0	220	370	268	116	31	*1,006*	124	**882**

*Achieved means items checked by farmers and found to conform with Ricecheck criteria Insert

The total benefits to each of the two groups of partial adopters ('Informal' and 'Awareness') were estimated using the number of crops achieving the various numbers of key checks in Ricecheck each year, adjusted by the size of the group of partial adopters. The informal adopters accounted for twice as many rice farmers and receive 50% of the unit benefits. Because the direct adoption costs for each check were the same as for the full adopters and the labour inputs also varied, the total net benefits for informal adopters were lower than the full adopters (Table 6). The number of awareness adopters was the same as for full adopters, and received 20% of the unit benefits. The total benefits to these two groups of partial adopters of Ricecheck were estimated to have been $116,000 in 1986, rising to a peak of $3.64 million in 1995.

The total benefits (in constant 2002 dollars) were estimated to have averaged $2.79 million per year over period 1986 to 2002. The benefits to partial adopters account for 50% of the total estimated benefits. Although the area under rice increased over time, there were fewer benefits from the project in later years because an increased number of checks would have been achieved without the program.

Combining the flows of research and extension costs (Singh et al. 2005) with these estimated benefits, the Net Present Value of the Ricecheck program was $64.0 million and the benefit-cost ratio was 18.0:1.

These results are sensitive to the assumptions about the level and benefits of partial adoption. If only those formally and fully adopting Ricecheck obtained any benefits, then the benefit-cost ratio would have been 9.2 rather than 18.0. However, given the strong evidence that partial adoption is occurring at a significant level, the process of being involved in Ricecheck both informally and at the level of awareness means that these groups of farmers capture almost 50% of the total benefits from Ricecheck even though they achieve fewer benefits than if they were full adopters.

Table 6: Benefits from full and partial adoption of Ricecheck
($'000, 2002 dollars)

		Partial adoption			
	Full adopters	**Informal adopters**	**Awareness adopters**	**Total**	**Total benefits**
1986	$114	$96	$20	$116	**$230**
1987	$187	$154	$30	$184	**$371**
1988	$531	$469	$118	$588	**$1,119**
1989	$743	$642	$143	$784	**$1,528**
1990	$844	$693	$107	$800	**$1,643**
1991	$733	$610	$111	$721	**$1,453**
1992	$925	$745	$101	$846	**$1,771**
1993	$1,406	$1,189	$237	$1,426	**$2,832**
1994	$2,260	$2,004	$519	$2,523	**$4,783**
1995	$3,382	$2,947	$691	$3,638	**$7,020**
1996	$2,086	$1,794	$396	$2,190	**$4,277**
1997	$1,718	$1,442	$274	$1,715	**$3,433**
1998	$1,949	$1,642	$315	$1,957	**$3,906**
1999	$1,966	$1,654	$315	$1,969	**$3,935**
2000	$2,167	$1,834	$366	$2,200	**$4,367**
2001	$1,658	$1,305	$135	$1,440	**$3,098**
2002	$882	$713	$108	$821	**$1,703**

Discussion

Ricecheck, an extension program developed in the 1980s by the New South Wales Department of Primary Industries (NSW DPI), aimed to improve productivity through improved crop management in the rice industry (Singh et al. 2005).The Ricecheck program is based on monitoring crops and setting key benchmarks (or 'checks') based on the highest yielding rice crops in farmers' paddocks. Thus, a distinctive feature of the Ricecheck program is the identification of 'Key checks', the achievement of which is expected to lead to higher yield.

In this study, the Ricecheck program has been evaluated starting from 1986, when it was first introduced to farmers in the Finley district. To ensure that available data could be obtained, and to avoid the recent difficulties facing the rice industry in more recent seasons with the lack of irrigation water entitlements, the analysis was restricted to the investment up to 2002, by which time it was being used by growers across the entire rice industry. Because of the extent to which knowledge and management were influenced by Ricecheck, the benefits were estimated to continue to flow from that investment up to 2012, a further ten years. Beyond that time, it is assumed that other extension efforts would have replaced those in Ricecheck if funding was not extended beyond 2002. However, given that Ricecheck has continued since that time, the total benefits (and the total costs) will be greater than those measured in this analysis.

The Ricecheck program, requiring adoption of key checks, close monitoring and record-keeping of rice crops, has increased the extent to which farmers closely monitor their crops. The benefits that have been measured were the improved yields that followed from meeting the key checks of the Ricecheck program. Yield increases were evident from the thousands of crops in the Ricecheck database.

The nature of the Ricecheck program is such that farmers can adopt the recommendations partially or in full. The awareness of the Ricecheck program is known to be very strong, as every rice-grower receives a copy of the Ricecheck recommendations booklet each year, with the latest results and most up-to-date information and recommendations. Further, the significance of the key checks and monitoring of the crops is also highlighted and reinforced to farmers at discussion group meetings, pre-season meetings, field days and informal discussions with NSW DPI extension staff.

Ricecheck has also helped to improve the knowledge and skills of many farmers who have left the program after joining it for a few years. As a result, many growers utilise its approach without being formally involved in the Ricecheck program. It is estimated that the actual formal participation in Ricecheck accounts for about 20% of the rice crops grown; about 60% of the farmers have received benefits from the program, through partial adoption both on an informal basis and through the awareness programs. It was assumed that the full adopters receive 100% of the benefits of Ricecheck, whereas, the informal and awareness groups received only 50% and 20% respectively of the benefits of Ricecheck, given the level of information they are known to have received.

A key difference between Ricecheck and many research and extension programs is that the cost of the farmers' time in adopting those key checks is a significant input into the process. Farmers are required to contribute 8.7 hours (valued at $218) per crop for full adoption of Ricecheck. In addition, once they moved to achieve the key checks, they had a further investment, averaging $5.02 per hectare, to meet some of those checks such as laser levelling, increasing bank height and soil suitability testing. Thus, farmer resources are a key input to the process.

The present value of the investment in Ricecheck over the period from 1986 to 2002 is $3.7 million (in real 2002 dollars). Over two-thirds of this has been in kind contribution from NSW DPI staff, with 30% cash investment by RIRDC. The estimated present value of the benefits flowing from that investment, after allowing for adoption costs for key checks, is $67.8 million. Thus, the estimated Net Present Value of Ricecheck over the period 1986 to 2002 is $64.1 million. The proportion of the total benefits to these full, partial and awareness adopters was 49.6%, 42% and 8.4% respectively. This demonstrates the significant benefits to the partial adopters from the program.

The results of the benefit cost analysis also revealed that a benefit cost ratio of 18.5 was achieved even with less than 20% of the farmers formally adopting the Ricecheck program in any given year. If only those formally and fully adopting the Ricecheck obtained any benefits, then the benefit cost ratio would have been 8.9 rather than 18.0. The results further indicated that half of the potential benefits from the program estimated to flow from Ricecheck were those captured by the group of farmers who only utilised Ricecheck information in an informal way. It is also apparent that any efforts to increase formal adoption of the Ricecheck program will lead to significant benefits to farmers, and industry.

References

Elma M 2004,'Community initiatives on sustainable agriculture: Towards food security of the Erumanen Ne Menuvus in Palacat, Aleosan, Cotabato', Paper resented to the National Conference on Food Security,Agrobiodiversity, and Indigenous Knowledge of Indigenous People. Quezon City, Philippines, March 25-26.

Guerin LJ and Guerin TK 1994, 'Constraints to the adoption of innovations in agricultural research and environmental management: a review', *Australian Journal of Experimental Agriculture*, 43: 549-71

Lacy J 1998, 'Learning from farmers – the check approach', in *Proceedings of the 9th Agronomy Conference*, Charles Sturt University, Wagga Wagga, pp. 58-65

Lacy J, Beecher, G, Fleming, M, Fox, K, Lattimore, M, Lewin, L, McRae, M, Murray, A, O'Keeffe, K, Reinke, R, Schipp, A, Snell, P, Subasinghe, R, Whitworth, R and Steel, F 2004, '*2004 Ricecheck Recommendations'*, NSW Department of Primary Industries and Rural Industry Research and Development Corporation, Yanco.

Lyon N 1996. 'Adopt best practices', *Australian Farm Journal*, January, pp. 26 - 27.

McIntosh G and Schipp A 2002, 'The focus paddock method as used in the Mallee in the Dareton and Hay districts (South west NSW)'. District Agronomists Conference - Extension Techniques, 5-7 February.

Petheram RJ and Clark RA 1998, 'Farming systems research: relevance to Australia'. *Australian Journal of Experimental Agriculture*, 38: 101-15

Singh RP, Brennan JP, Lacy J and Steel F 2005, '*An assessment of the economic, environmental and social impacts of the Ricecheck program'*, Economic Research Report No. 28, NSW Department of Primary Industries, Yanco. (Available at http://www.dpi.nsw.gov.au/reader/10550)

Szmedra PI, Wetzstein ME, and McClendon RW 1990,'Partial adoption of divisible technologies in agriculture', *Journal of Agricultural Economic Research*, 42(3): 20-26.

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