Australian Government
Australian Centre for
International Agricultural Research

ACIAR's activities in Africa: a review

ACIAR IMPACT ASSESSMENT SERIES 82

Research that works for developing countries and Australia

ACIAR's activities in Africa: a review

Hayden Fisher and Laura Hohnen
Centre for International Economics

ACIAR
Research that works for developing countries and Australia

aciar.gov.au

2012

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

Where trade names are used this constitutes neither endorsement of nor discrimination against any product by the Centre.

ACIAR IMPACT ASSESSMENT SERIES

ACIAR seeks to ensure that the outputs of the research it funds are adopted by farmers, policymakers, quarantine officers and other beneficiaries. In order to monitor the effects of its projects, ACIAR commissions independent assessments of selected projects. This series of publications reports the results of these independent studies. Numbers in this series are distributed internationally to selected individuals and scientific institutions, and are also available from ACIAR's website at <aciar.gov.au>.

Fisher H. and Hohnen L. 2012. *ACIAR's activities in Africa: a review*. ACIAR Impact Assessment Series Report No. 82. Australian Centre for International Agricultural Research: Canberra. 81 pp.

ACIAR Impact Assessment Series – ISSN 1832-1879 (print); ISSN 1839-6097 (online)

ISBN 978 1 922137 12 8 (print)
ISBN 978 1 922137 13 5 (online)

Editing and design by Clarus Design
Printing by Elect Printing

Cover: A women and her child on a farm near Mount Kenya where they are growing a number of crops including mango. (Photo: M. Gyles)

Foreword

Africa is emerging as a more significant research focus for the Australian Centre for International Agricultural Research (ACIAR). This is a reflection of changing priorities in Australia's aid program, culminating in the establishment of the Australian International Food Security Centre (AIFSC) within ACIAR. While AIFSC has a broad international focus, it is starting with a particular emphasis in Africa.

ACIAR has a long history of working with countries in Africa, starting in 1983, and has funded 85 projects that contain an African component. With a fresh focus on Africa it is important to develop initiatives that will contribute to greater food security and better nutrition, and to invest scarce research funds in ways that optimise the benefits accruing to the target countries and Australia.

Reviewing past projects can help guide future investment decisions by highlighting the types of projects that deliver the best returns and by identifying some of the barriers faced in different countries. This report gives a retrospective assessment of 44 ACIAR-funded projects, and is a timely contribution to the process of new project development.

The assessment has revealed mixed results in delivering benefits to African smallholders. Some of the successful projects developed new technologies such as vaccines for tick-borne diseases and Newcastle disease, tick-resistance diagnostic testing, selection of Australian trees for reforestation and agroforestry, and introduction of annual and perennial legume species suitable for arable lands.

Even where evidence of adoption is limited, the project reviewers pointed to significant lessons learned, and highlighted some common elements when successful adoption took place. Projects that engaged final users in the research tended to report significant levels of adoption. There was also evidence of adoption spreading through farmer-to-farmer contact when farmers were actively involved in the project. Other projects that achieved significant levels of adoption also tended to have clear strategies for disseminating final outputs to final users.

The reviewers found many instances of capacity building that raised the levels of expertise in international and national institutions, and trained extension personnel and farmers. Key to successful capacity building are essential underlying skills, the allocation of sufficient time and opportunity for learning to take place, and the retention of trained personnel.

Nick Austin
Chief Executive Officer, ACIAR

Contents

Figures

Tables

Executive summary

Since 1982 the Australian Centre for International Agricultural Research (ACIAR) has funded more than 80 projects with activities in Africa. Given the increasing attention to food security in Africa, leading to the establishment of the Australian International Food Security Centre, it is timely to review ACIAR's experiences in that region to date.

This report reviews a selection of ACIAR-funded projects and grants involving African countries. The review was primarily undertaken as a desk study.

Overview

Since 1983, ACIAR has provided more than $101.8 million (in 2012 Australian dollars) to projects focused either entirely or partly on Africa. ACIAR-funded research has been directed mainly to southern and eastern Africa.

ACIAR has funded a broad range of projects in Africa. The program area that has provided the largest proportion of that funding is cropping systems and economics, owing mainly to a large current project with a budget of around $20 million (in 2012 dollars). Other program areas that have provided significant funding include forestry, and soil management and crop nutrition.

Key findings

The key findings from this review of ACIAR-funded research in Africa and some lessons for the future are summarised below.

- Evidence on adoption was limited—there have been relatively few ex-post impact assessments or adoption studies on African projects.
  - More ex-post impact assessments would help ACIAR to understand the impacts of its projects in Africa and provide a guide for future investments.
- Projects tended to have greater success in having outputs adopted by final users where:
  - final users were engaged in the research

  or
  - there was a clear dissemination strategy, including research into the most effective way of delivering outputs to final users.
- A number of projects are unlikely to have delivered any benefits to Africa in the near to medium term. Reasons for this include:
  - the project did not deliver any final outputs that could be adopted by final users
  - there was no clear dissemination strategy
  - there was insufficient consideration of socioeconomic factors in the development of solutions and disseminating them to final users.
- Some projects overestimated the capacity of the African partners—there were a number of instances where projects were compromised by a lack of capacity of African partners.

  - This suggests that Australian researchers should investigate the capacity of the African partners before research trials commence and maintain close contact with them during the course of the trials.

- Efforts to build capacity through ACIAR-funded research were mixed—most projects included some capacity-building elements, but there was little follow-up to test how effective this had been. It seems likely that African researchers enhanced existing skills through formal training activities and working with Australian researchers. However, efforts to build new skills were not always successful. The series of projects aimed at building modelling capacity in partner institutions appears to have had limited success.
  - High staff turnover rates were a common factor limiting the effectiveness of any capacity-building efforts.
  - ACIAR should be realistic about how much capacity can be built through short-term training and limited exposure to Australian scientists.
  - Highly specialised new skills should be developed through longer term training or extended periods working with Australian scientists.

1 Introduction

The Australian Centre for International Agricultural Research (ACIAR) funds research projects that reflect the priorities of Australia's aid program and national research strengths, together with the agricultural research and development (R&D) priorities of partner countries. Although Africa is one of five regions in which ACIAR projects operate, ACIAR's main focus in recent years has been the Asia–Pacific region.

The Australian International Food Security Centre (AIFSC) has recently been established within ACIAR. The AIFSC will assist developing countries maximise the benefits and opportunities of agricultural productivity to achieve food and nutritional security. While the AIFSC will have a broad international focus, particular emphasis will be given to Africa, whose countries have highest proportions of the world's poor. Africa is therefore becoming a more significant focus for ACIAR.

Learning from the past

Agricultural R&D involves an upfront investment anticipating a stream of future benefits. The challenge for ACIAR is to invest its scarce research funds in a way that maximises the benefits flowing to Australia and partner countries. Like any investment, agricultural R&D is risky, and future benefits from individual projects cannot be known in advance. Key risks relate to the level of adoption of research outputs.

One way to minimise risks and maximise returns from agricultural R&D is to learn from past investments. Reviewing past projects can help guide future investment decisions by highlighting the types of projects that deliver the best returns and identifying some of the barriers to success faced in different countries.

Despite its particular focus on the Asia–Pacific region, over the past 30 years ACIAR has funded more than 80 projects that have included African partners. Given the recent shift in focus towards Africa, it is timely to review the portfolio of projects ACIAR has funded in that region.

This report

This report reviews ACIAR's past projects in Africa, with a view to highlighting key lessons for the future. The review has been primarily undertaken as a desk study, focusing on the available project documents and based around the conceptual frameworks used in ACIAR impact assessments and adoption studies.

The report is structured as follows:

- Chapter 2 provides an overview of ACIAR research in Africa since 1983 and selects a subgroup of projects to review in detail.
- Chapters 3–10 provide a summary of selected projects aligned to relevant program areas.
- Chapter 11 highlights some key findings and some lessons for the future.

2 Overview of ACIAR's program in Africa

Since 1983 ACIAR has committed around $101.8 million[1] to projects and grants in various countries across the African continent, including Algeria, Botswana, Cameroon, Ethiopia, Kenya, Malawi, Mauritius, Morocco, Mozambique, Rwanda, South Africa, Tanzania, Tunisia, Uganda and Zimbabwe.

ACIAR funding to Africa has varied over time (Figure 1), reflecting changing priorities. In the 1980s and 1990s, ACIAR allocated around $27 million to projects in Africa. However, in the 2000s, ACIAR funding to Africa fell to around $12 million, as the centre's focus shifted to the Asia–Pacific region. Since 2010, ACIAR has already committed more than $36 million to projects in Africa, although a single project has accounted for around $20 million of this total.

Countries within the Southern African Development Community (SADC) and the eastern region of Africa have been the main focus of ACIAR-funded research in Africa (Figure 2). Only 10% of ACIAR funding on African projects has not included a country from the SADC or eastern regions, with:

- 33% of ACIAR funding spent on projects targeting the SADC region exclusively
- 24% of ACIAR funding targeting the eastern region
- 32% funding projects working in both SADC and eastern regions.

There was very little project activity in central, western and northern Africa.

Until 2010, the Republic of South Africa (RSA) was the primary focus of ACIAR's small bilateral investment program. ACIAR's program is aimed at delivering benefits to emerging African farmers and filling 'gaps' in the existing South African expertise (ACIAR 2006).

Since 1983, a large proportion of ACIAR funding for Africa has come from the soil management and crop nutrition, livestock production systems and forestry program areas (Figure 3). ACIAR has also undertaken a large number of relatively small projects in animal health, specifically relating to animal nutrition, and ticks and tick-borne diseases. More recently, ACIAR funding in Africa has focused on the cropping systems and economics program area, to research sustainable intensification of maize–legume cropping systems for food security in eastern and southern Africa (the SIMLESA program).

The program areas that received most funding were soil management and crop nutrition (26%), cropping systems and economics (25%), livestock production systems (16%) and forestry (14%) (Table 1).

The majority of funding to the cropping systems and economics program area is dominated by one project that has so far received $20.4 million. This is a large amount of funding dedicated to a single project, substantially higher than the average per-project funding of $1.0 million.

The distribution of projects by the amount of ACIAR funding is shown in Figure 4. The number of projects is distributed relatively evenly across the five funding categories. However, 85% of the total funding for African projects has been allocated to larger projects attracting more than $1 million in ACIAR funding.

[1] Unless otherwise indicated, all monetary values in this report are in 2012 Australian dollars. Project budget data are based on ACIAR financial limitation figures as at 30 May 2012.

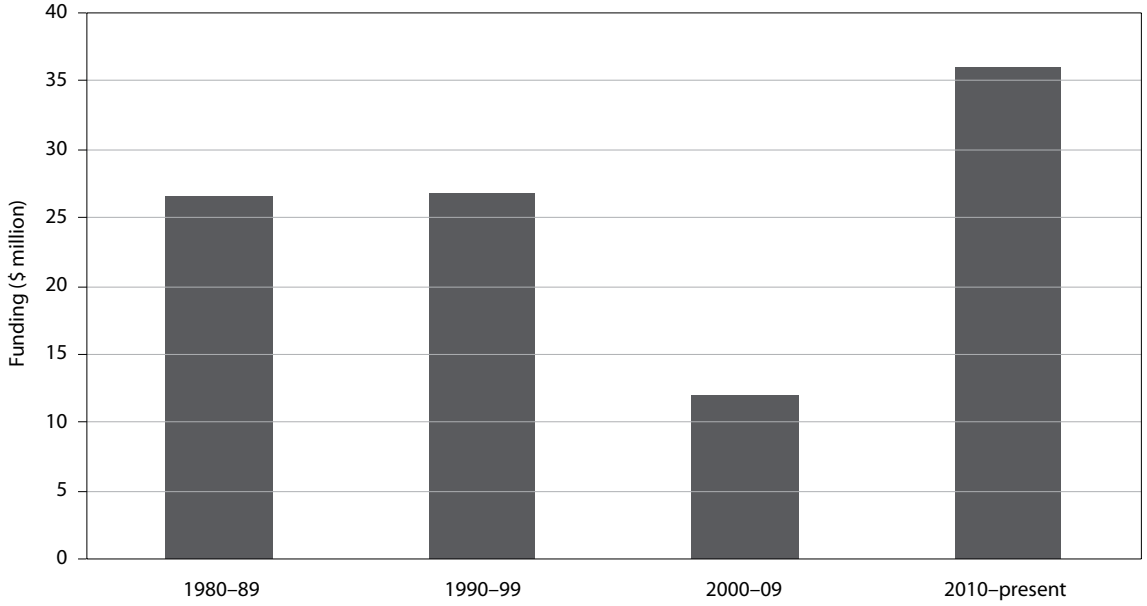

Figure 1. Australian Centre for International Agricultural Research (ACIAR) funds committed to projects in Africa (2012 Australian dollars). Source: Centre for International Economics, based on ACIAR data.

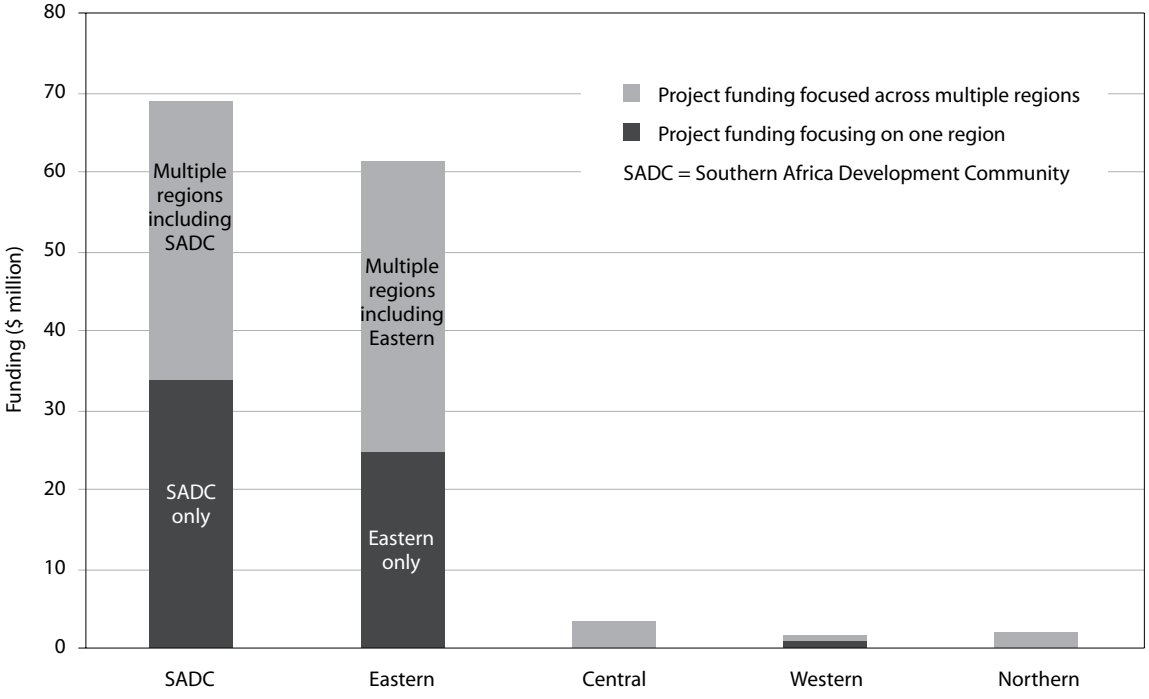

Figure 2. Australian Centre for International Agricultural Research (ACIAR) funding (2012 Australian dollars) to projects in Africa, by region. Source: Centre for International Economics based on ACIAR data. Note that there is double-counting in this figure because it was not possible to attribute funding to individual regions where project funding was spent across multiple regions.

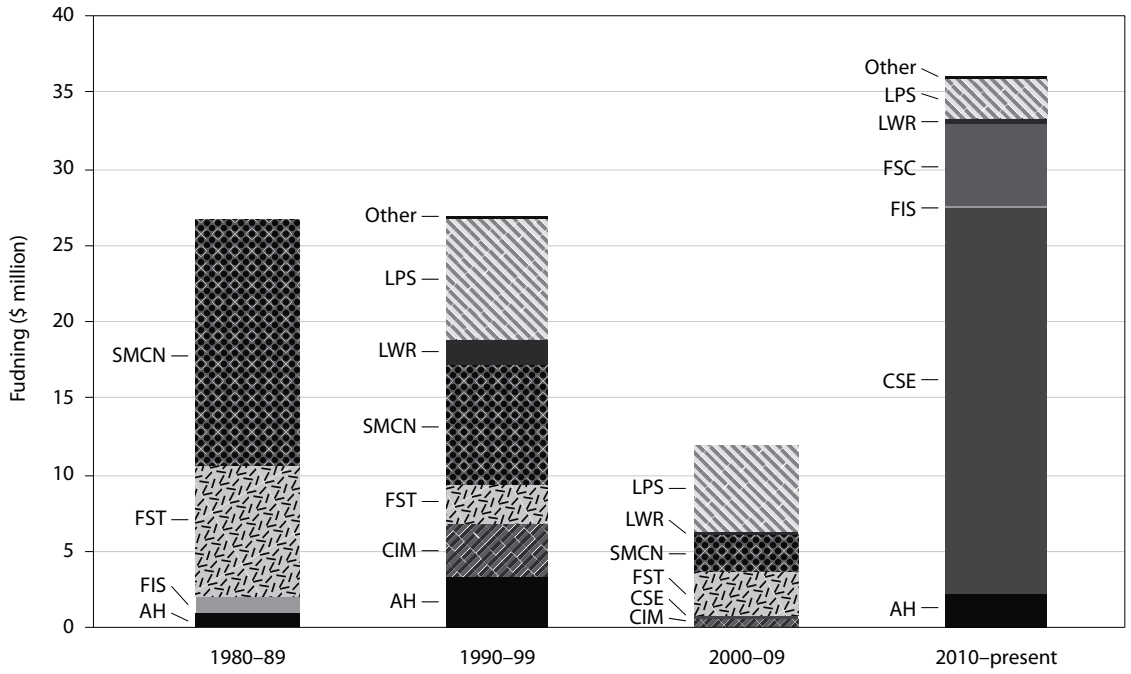

Figure 3. Distribution over time (based on program starting year) of Australian Centre for International Agricultural Research (ACIAR) funding (2012 Australian dollars) to projects in Africa, by program. Source: Centre for International Economics, based on ACIAR data. AH = Animal Health; AS = Animal Sciences; CIM = Crop Improvement and Management; CSE = Cropping Systems and Economics; FIS = Fisheries; FSC = Food Security Centre; FST = Forestry; LWR = Land and Water Resources; SMCN = Soil Management and Crop Nutrition; LPS = Livestock Production Systems; Other includes HORT = Horticulture and IAP = Impact Assessment Program.

Sampling approach used in this report

The project summaries presented in the next chapter are based on targeted desktop reviews of the 44 projects selected using a sampling approach driven largely by information availability and size of project. From a full list of 85 projects that contained some reference to Africa, eliminated were:

- 12 projects that are yet to start
- 15 projects judged too small (expenditure less than $100,000 in nominal terms)
- 12 projects judged too small (expenditure between $100,000 and $200,000 in nominal terms) and not primarily focused on Africa
- 2 projects focused mainly on other regions.

This left a remaining sample of 44 projects, which have been divided into groups that broadly align with ACIAR program areas (Table 2). Project summaries are given in the appendix.

Based on the review of project documents, the following chapters summarise the outputs delivered by each of the above projects and review any evidence of adoption and the associated outcomes. The material available varies significantly across projects. We summarise the evidence of adoption along the following lines:

- Evidence of adoption by next users—this indicates there is evidence in the material reviewed that key project outputs have been adopted by next users, but not final users. This may indicate that adoption by final users is unlikely, or that there is insufficient evidence to make a reasonable assessment.
- Evidence of adoption by final users—this indicates there is evidence in the material reviewed that key project outputs have been adopted by final

Table 1. Australian Centre for International Agricultural Research (ACIAR) funding (2012 Australian dollars) to projects in Africa since 1983, by program

ACIAR Program	**Program code**[a]	**Total value** ($ million)	**Proportion of expenditure** (%)
Animal Health	AH, AS1	6.4	6.3
Crop Improvement and Management	CIM, CS1, CS2, CP	4.1	4.0
Cropping Systems and Economics	CSE	25.4	24.9
Fisheries	FIS	1.2	1.2
Forestry	FST	14.2	13.9
Food Security	FSC	5.4	5.3
Soil Management and Crop Nutrition	SMCN, EFS, LWR2	26.6	26.1
Land and Water Resources	LWR, LWR1	1.9	1.9
Livestock Production Systems	AS2, LPS,	16.3	16.0
Other	HORT, IAP	0.4	0.4
Total		**101.8**[b]	**100.0**

Source: Centre for International Economics, based on ACIAR data

[a] Program codes were allocated to programs on the basis of ACIAR website information. AH = Animal Health; AS = Animal Sciences; CIM = Crop Improvement and Management; CS = Crop Sciences; CSE = Cropping Systems and Economics; EFS = Economics and Farming Systems; FIS = Fisheries; FST = Forestry; FSC = Food Security Centre; LWR = Land and Water Resources; LPS = Livestock Production Systems; SMCN = Soil Management and Crop Nutrition; HORT = Horticulture; IAP = Impact Assessment Program.

[b] This was the true expenditure. The slight discrepancy with the column total is due to rounding of individual values.

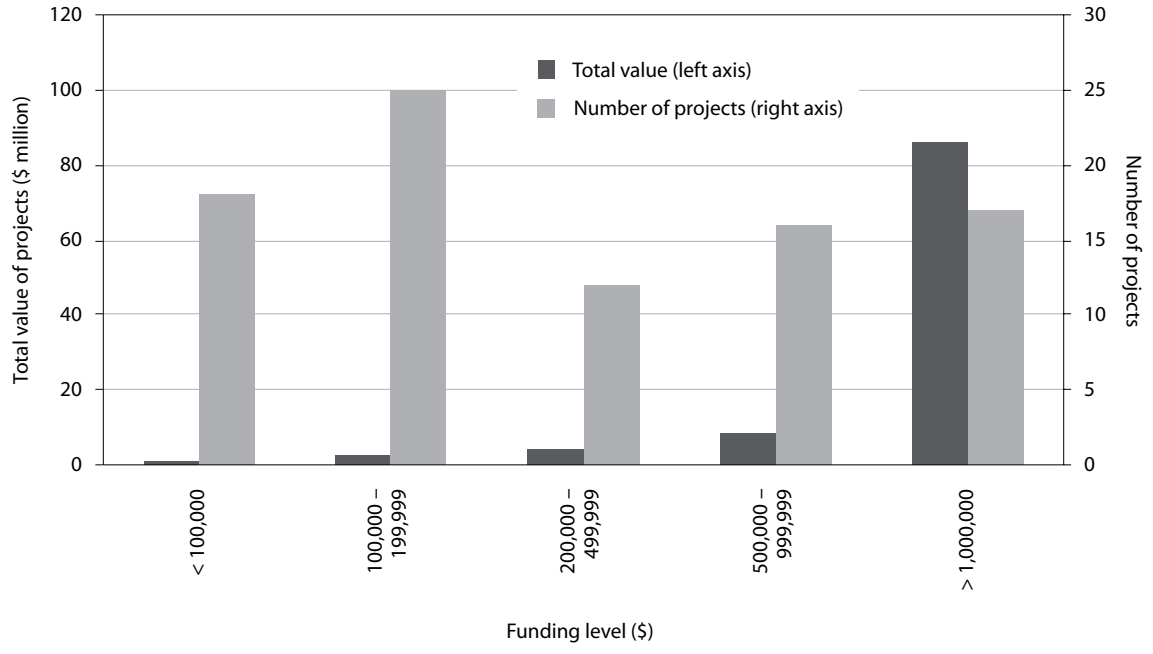

Figure 4. Distribution of Australian Centre for International Agricultural Research (ACIAR) projects in Africa, by level of funding (2012 Australian dollars). Source: Centre for International Economics, based on ACIAR data

Table 2. Groupings of Australian Centre for International Agricultural Research projects in Africa assessed in this report

Program area	Projects[a]
Animal Health	AS1/1983/003; AS2/1990/047; AS2/1991/018; AS2/1996/014; IAP/1996/181; AS2/1999/063; AS2/1996/090; AS2/1996/203; AS1/1995/040; AS1/1996/096; AS2/1993/724.
Animal Nutrition	AS1/1995/111; AS1/1998/010; AS2/1997/098
Forestry	FST/1983/020; FST/1983/031; FST/1988/008; FST/1988/009; FST/1983/057; FST/1991/026; FST/1996/124; FST/1996/206; FST/2003/002
Livestock Production Systems	LPS/1999/036; LPS/2002/081; LPS/2008/013
Sustainable Use of Natural Resources	LWR1/1994/046; FST/1995/107; LWR2/1996/163; LWRS/1996/215; LPS/2004/022; LWR/2011/015
Soil Management and Crop Nutrition	LWR2/1996/049; LWR2/1997/038; SMCN/1999/003; SMCN/1999/004; SMCN/2001/028; SMCN/2000/173; EFS/1983/026, LWR2/1987/035; AS2/1996/149
Cropping Systems and Economics	CSE/2009/024
Other	CS2/1990/007; CP/1994/126

Source: Centre for International Economics

[a] AS = Animal Sciences; IAP = Impact Assessment Program; FST = Forestry; LPS = Livestock Production Systems; LWR = Land and Water Resources; SMCN = Soil Management and Crop Nutrition; EFS = Economics and Farming Systems; CSE = Cropping Systems and Economics; CP = Crop Protection

users. These are the projects that are likely to have delivered benefits to African partner countries. Where the 'evidence' of adoption is an independent ex-ante assessment, this is noted.

- Adoption unlikely—this indicates that the evidence reviewed suggests that outputs will not be adopted. It is not possible to be definitive that there will be no adoption from project documents, because adoption may occur some time after the most recent assessment was completed (including in the future).
- Insufficient evidence on adoption—this indicates there is insufficient evidence in the documents reviewed to make an assessment on adoption.

3 Animal health

In total, ACIAR has allocated more than $6.87 million to animal health–related projects. The majority of funding in this area has gone to projects relating to ticks and tick-borne diseases. Of the reviewed projects, ACIAR has funded eight projects or grants on ticks and tick-borne diseases and four on other animal-health issues.

In general, there was good evidence of adoption of the outputs delivered by ACIAR-funded animal health projects by both next and final users (Table 3). More details on the projects follow.

Ticks and tick-borne diseases

Background

Ticks and tick-borne diseases have been a major theme of ACIAR's work in Africa. Research on ticks and tick-borne diseases has focused primarily on Kenya and Zimbabwe, although other countries such as Burundi, Tanzania, Zambia, South Africa and Malawi have also been involved in various projects.

ACIAR has funded five projects and provided five small grants in this research area, including:

- Ticks and tick borne diseases (AS1/1983/003)
- Genetic variation, resistance to acaricides and immunological cross-reactivity in ticks that infest cattle in Zimbabwe and Australia (AS2/1990/047)
- Improved methods for the diagnosis and control of bovine babesiosis and anaplasmosis in Zimbabwe and Australia (AS2/1991/018)
- Validation of the Australian model of the tick, *Rhipicephalus appendiculatus*, in Kenya and investigation of its use to facilitate collaboration with NARs (AS2/1996/014)
- Estimation of the cost of tick-borne disease to livestock in Africa, Asia and Australia (IAP/1996/181)
- Tick-borne diseases: Delivery of user-friendly and effective vaccine and diagnostics (AS2/1999/063)
- Bovine babesiosis and anaplasmosis: studies on field performance of live vaccines, diagnostic methods and host responses to infection (AS2/1996/090)
- Studies on genetic constraints to protective immunity in cattle (AS2/1996/203).

In addition to the eight projects selected above, there were two smaller projects funded within this cluster:

- Development of a computerised georeferenced decision support system for the control of tick-borne diseases in Zimbabwe (AS2/1993/714)
- Validation of diagnostic tests for bovine babesiosis and anaplasmosis and studies on strain variation in Babesia (AS2/1993/715).

These projects effectively finished work commenced in some of the other projects and therefore were not examined separately in detail.

The total funding for these 10 projects over the past 30 years was $6.87 million.

The initial tick-related project (AS1/1983/003) commenced in 1983 and finished in 1986. Due to budget cuts to ACIAR, this project was terminated before it could capture any practical benefits (Lubulwa and Hargreaves 1996). Research in this area became more prominent in the mid 1990s with two small grants, one (AS2/1993/714) to complete the computer modelling that commenced in the initial project

Table 3. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) animal health projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next user	Final user		
Ticks and tick-borne diseases					
AS1/1983/003	Ticks and tick-borne diseases		■		
AS2/1990/047	Genetic variation, resistance to acaricides and immunological cross-reactivity in ticks that infest cattle in Zimbabwe and Australia		■		
AS2/1991/018	Improved methods for the diagnosis and control of bovine babesiosis and anaplasmosis in Zimbabwe and Australia		■		
AS2/1996/014	Validation of the Australian model of the tick, *Rhipicephalus appendiculatus*, in Kenya and investigation of its use to facilitate collaboration with NARs	■			
IAP/1996/181	Estimation of the cost of tick-borne disease to livestock in Africa, Asia and Australia	■			
AS2/1999/063	Tick-borne diseases: Delivery of user-friendly and effective vaccine and diagnostics		■		
AS2/1996/090	Bovine babesiosis and anaplasmosis: studies on field performance of live vaccines, diagnostic methods and host responses to infection		■		
AS2/1996/203	Studies on genetic constraints to protective immunity in cattle				■
Newcastle disease					
AS1/1995/040	Production of a seed culture of heat resistant Newcastle disease virus suitable for producing in developing countries		■		
AS1/1996/096	Investigations into the control of Newcastle disease in village chickens in Mozambique		■		
Other					
AS2/1993/724	Development of phenotypic markers for resistance to gastrointestinal nematodes in African small ruminants				■

Source: Centre for International Economics, based on documents provided by ACIAR

(AS2/1993/714), the other (AS2/1993/715) to produce a user-friendly version of the computer model. A number of other projects and grants also commenced between 1993 and 1997. The most recent tick-related project was completed in 2004.

ACIAR commissioned the CSIRO Division of Animal Health to undertake the initial tick study (AS1/1983/003). The commissioned organisations for the other tick-related projects were the Queensland Department of Primary Industries or the International Livestock Research Institute.

ACIAR-funded tick research focused on a range of issues relating to diagnosing the major tick-borne diseases and various management strategies, including chemical control and vaccines.

Outputs

While the information available for the desk study varied across projects, the evidence is that the various tick-related studies delivered a range of outputs.

ACIAR-funded research increased the scientific knowledge on ticks and tick-borne diseases, including:

- on the ecology of the main tick species in eastern and southern Africa (AS1/1983/003)
- an improved understanding of immunogenetic influences on the outcome of vaccination in cattle vaccinated with live babesia strain (AS2/1996/203).[2]

The level of understanding of the extent to which tick-borne diseases affect agricultural production was also improved, including that on the effects of the main tick species on milk production (AS1/1983/003). The research also found that in African countries such as Zimbabwe, Kenya and South Africa, the costs of ticks and tick-borne diseases are relatively high, with producers employing high frequency (and relatively costly) control methods (IAP/1996/181).

ACIAR-funded research also improved understanding on the effectiveness of existing management strategies (AS1/1983/003). This included recognition of the relative resistance of different breeds of cattle to a specific tick disease (AS1/1983/003). Results from another ACIAR-funded project suggest that there is still potential for the use of acaricides to control ticks in Zimbabwe (AS2/1990/047). A further critical conclusion from this study is that antigens that have been shown to protect cattle against tick infestation are conserved across several genera of ticks causing economic losses in Australia and Africa. Researchers therefore concluded that a generic tick vaccine targeted to conserve gut antigens, effective against several genera, may be feasible (AS2/1990/047).

ACIAR projects also developed new scientific techniques for diagnostic and other testing, including:

- an assay kit for identifying resistant genes (Lubulwa and Hargreaves 1996)—the aim was to reduce the length of time required to assess whether there is pesticide resistance in a tick population from 6 weeks to within 24 hours (AS2/1990/047)
- new or improved diagnostic tests (AS2/1996/090)
- ELISA tests for detecting antibodies to *Babesia bovis* and *B. bigemina* and *Anaplasma* (AS2/1996/203)
- an assay enabling researchers to differentiate between the Australian vaccine strain and African field isolates of *B. bigemia* (AS2/1996/203)
- techniques for differentiating species and strains of *Anaplasma* (AS2/1996/203)
- more-effective diagnostic tests for *Babesia bigemina* (AS2/1996/203)[3]
- DNA-based methods for typing tick species and strains (AS1/1990/047).

Other new knowledge and scientific techniques developed through ACIAR-funded research relate to cryopreservation of vaccines. In particular, glycerol and dimethyl sulfoxide (DMSO) were identified as the best cryoprotectants for vaccines (AS2/1999/063). Furthermore:

- ACIAR-funded research developed a simple and effective technique, using a flow cytometer, to count living and dead parasites to assess the viability of vaccine following cryopreservation and thawing (AS2/1999/063).
- a model system using mice and *Babesia microti* to evaluate various combinations of cryoprotectants

[2] Project AS2/1996/203, 100-word summary; available at <http://aciar.gov.au/project/AS2/1996/203>

[3] Ibid.

and vaccine diluents, to surmount the difficulty and expense involved in conducting trials with cattle was also developed (AS2/1999/063).

In addition, ACIAR-funded projects enhanced the capacity of partner organisations to deal with tick problems in various ways. One way the capacity of partner organisations was enhanced was by developing various computer-based models to guide decision-making. These included:

- a computer modelling tool that enables each country (and possibly each farmer) to choose the optimal tick control strategy (AS1/1983/003 and subsequent extensions)
- a tool for estimating the economic costs of tick-borne diseases in various countries and regions—the TICKCOST spreadsheet model—was developed (IAP/1996/181).

ACIAR-funded projects also built the capacity of the Kenya Agricultural Research Institute to manage and control ticks, by adapting the Australian computer model to the major African tick vector species (*Rhipicephalus appendiculatus*) (AS2/1996/014).[4]

An important capacity-related output from these projects was building the capability of Zimbabwe's Central Veterinary Laboratory to develop sustainable, effective methods for quality assurance, delivery and field monitoring of the vaccines (AS2/1996/090).

Through development of a computerised database, ACIAR-funded research increased the capacity of African partners to undertake further research (AS1/1983/003). The project also built the capacity of African scientists in experimental design and analysis techniques (AS1/1983/003). Training courses on the use of computer models were conducted for six African countries (AS2/1996/014).[5]

Furthermore, the projects delivered improved tick management strategies, particularly through the development of vaccines.

- The impact assessment by Lubulwa and Hargreaves (1996) indicated that ACIAR-funded research delivered the prime objective of developing and testing, in the laboratory and field, new vaccines of high quality against *Babesia bigemina* and *Anaplasma marginale* in Zimbabwe and for their production and quality control (AS2/1991/018).
- ACIAR-funded research also developed 'Dawn', a strain of *A. marginale* to meet the need for more-effective live vaccine against anaplasmosis (AS2/1999/063). Two separate cattle trials in Zimbabwe showed that the Dawn strain produced reduced clinical symptoms on vaccination and was at least as protective as *A. centrale* against challenge by local field isolates (AS2/1999/063).

ACIAR-funded research also demonstrated that the simultaneous use of three key vaccines (Bolvac (against *Theileria*), Babesia and Anaplasma) is safe and effective (AS2/1999/063). No severe clinical reactions to the live vaccines were observed, and vaccinated cattle were protected against all three diseases in field challenges.

In addition, the research identified a delivery method appropriate for African conditions. This included identifying, through surveys in Queensland and Zimbabwe, the preferred packaging, shelf life and methods of distribution of frozen vaccines (AS2/1999/063).

Adoption

The next users of most of the outputs developed under the ACIAR-funded research are the partner agencies in Africa. Various project documents suggest that these organisations adopted the outputs delivered by the research. Importantly, the Central Veterinary Laboratory in Zimbabwe used the capacity developed through ACIAR-funded projects to produce vaccines.

There is also evidence of some of the diagnostic tests developed through ACIAR projects being used in partner countries.

The final users are commercial farmers in tick-susceptible areas. The impact assessment by Lubulwa and Hargreaves (1996) of three tick-related projects (AS2/1983/003, AS2/1990/047 and AS2/1991/018) estimated there would be significant levels of adoption. However, this was effectively an ex-ante assessment for AS2/1990/047 and AS2/1991/018, as all adoption was estimated to occur in the future. For AS2/1983/003, the adoption profile suggested that there had already been some uptake, but most of the benefits would accrue in the future.

4 Project AS2/1996/014, 100-word summary; available at <http://aciar.gov.au/project/AS2/1996/014>

5 Ibid.

There were no obvious barriers to adoption identified in the project documents.

Outcomes and impacts

The impact assessment undertaken by Lubulwa and Hargreaves (1996) found that project AS1/1983/003 generated some significant outcomes.

The ACIAR-funded research led to an important policy change in Zimbabwe. New Animal Health Cleansing Regulations were introduced in 1993. These regulations require dipping in only those cases where cattle are tick-infested. Cattle owners were previously required to dip every week, irrespective of tick challenges (Lubulwa and Hargreaves 1996).

The impact assessment found that, reflecting the policy change, project AS2/1983/003 led to a change in tick control strategies. There was a shift in the dipping practices from the intensive weekly dipping to less frequent, but strategic dipping. The net benefits of this change in tick control strategy were estimated to be around $1.8 million over a period of 30 years at a discount rate of 8%. The internal rate of return for the projects was estimated at 26% (Lubulwa and Hargreaves 1996). However, it is not clear whether adoption was maintained throughout the political unrest during the early 2000s.

The impact assessment by Lubulwa and Hargreaves (1996) also indicated that:

- the genetic assay kit developed through ACIAR-funded research (AS2/1990/047) would contribute to reducing the spread of tick strains resistant to acaricides.
  - The net benefits were estimated at around $11.21 million (in 1990 Australian dollars) at a discount rate of 8% over 30 years. The internal rate of return was estimated at 33%.
- the availability of new vaccines of high quality against *B. bigemina* and *A. marginale* in Zimbabwe, and of new tools (molecular markers) that allow Australian scientists to distinguish between strains (within species) of *Babesia*, and new diagnostic tests for epidemiological studies in Australia and for screening of export animals in accordance with requirements of Australia's trading, would deliver benefits in both Zimbabwe and Australia (AS2/1991/018).
  - Benefits were estimated to be $23.78 million to Zimbabwe and $11.47 million to Australia. The total net benefit, after deduction of research costs of $1.5 million, was estimated at $33.75 million in 1990 dollars, using a discount rate of 8%. The internal rate of return was estimated at 40%.

It is not clear whether the level of adoption assumed by Lubulwa and Hargreaves (1996) was ultimately realised, particularly given the political unrest in Zimbabwe during in the first years of the century.

There do not appear to have been any follow-up studies (adoption studies or impact assessments) on any of the remaining projects or grants. Nevertheless, various ACIAR documents point to a range of other outcomes arising from the adoption of outputs delivered by these projects.

Computer models developed through ACIAR-funded research were used to identify risks from the spread of ticks and tick-borne diseases, and for designing and communicating policy options to policymakers, extension officers and farmers in Kenya (AS2/1996/014).[6] It is not clear whether this has led to any changes in policy or on-farm practices.

There is evidence that some of the diagnostic tests developed are being used.

- Project documents indicated that enzyme-linked immunosorbent assay (ELISA) tests were in routine use for epidemiological studies to identify the need for vaccination and inform producers in Australia and Zimbabwe. The tests were also available to institutions in Kenya, Tanzania and Mozambique.
- The assay developed during the project was being used in Zimbabwe to investigate and confirm reported cases of vaccine failure or severe vaccine reactions.
- An ELISA test to detect the presence of *A. centrale* has been used successfully to confirm vaccination in vaccine breakdown investigations in Australia. It has also been incorporated as a critical component of the import-testing protocol for live Australian

[6] ACIAR project AS2/1996/014, 100-word summary; available at <http://aciar.gov.au/project/AS2/1996/014>

cattle destined for Mexico and is currently being evaluated for use in Israel.[7]

Project documents reported that the *Babesia* and *Anaplasma* vaccines developed through ACIAR-funded research (AS2/1999/063) were in use concurrently with the *Theileria* vaccines in regional offices around Zimbabwe. Reports from field veterinarians at the end-of-project meeting in Harare were all positive, and trials to test inclusion of heartwater vaccine are planned for the near future.

In Zimbabwe, the Dawn strain of *A. marginale* will be used as an alternative vaccine to *A. centrale*, and trials to develop and evaluate a vaccine based on a local *A. marginale* strain are planned.[8]

The ACIAR-developed TICKCOST model (project IAP/1996/181) has been used by International Livestock Research Institute (ILRI) scientists writing research proposals for new research in tick-borne diseases in Asia and Africa. However, it is not clear whether this has changed any resource allocation decisions.

Newcastle disease

Background

In the mid 1990s, ACIAR funded two projects relating to Newcastle disease in chickens in Mozambique. These projects were an extension of small-scale trials funded by ACIAR in Tanzania, Vietnam and Zambia.

Since 1984, ACIAR has been supporting the development of a vaccine for Newcastle disease. Projects involving Africa were:

- Production of a seed culture of heat resistant Newcastle disease virus suitable for producing in developing countries (AS1/1995/040)
- Investigations into the control of Newcastle disease in village chickens in Mozambique (AS1/1996/096).

The total funding for these two projects was $1.89 million.

Outputs

The projects delivered an I-2 vaccine against Newcastle disease. The ACIAR-funded research also established that, in the field, eye-drop administration of the vaccine gave the best results, yielded the greatest increase in flock size and was the preferred approach of farmers.

Through training, the project also built the capacity of Mozambique researchers in vaccine production and quality control.

Adoption

The next user of the outputs of the Newcastle disease projects was the partner organisation in Mozambique, the National Veterinary Research Institute (INIVE). In 1999–2000, INIVE produced 2 million doses of the I-2 vaccine.

The final users were smallholder farmers with chickens. Adoption by these final users was supported by a distribution system for the vaccine, trained vaccinators and an effective extension package developed as part of the project. The project led to a three-year Australian Agency for International Development (AusAID)-funded Southern African Newcastle Disease Control project that commenced in 2002.

Outcomes and impacts

The Newcastle disease projects resulted in effective vaccination of chickens in village flocks. Project documents report that this has greatly increased the numbers of chickens in these flocks.

Other projects

The sole remaining animal health-related project reviewed was a restricted grant for 'Development of phenotypic markers for resistance to gastrointestinal nematodes in African small ruminants' (AS2/1993/724).

This project suffered a setback following the outbreak of disease and the subsequent loss of lambs. Nevertheless, progress was made towards developing immunological assays and procedures. The project also enhanced the capacity of an African researcher by funding a visit to Australia to broaden their skills base.

7 ACIAR project AS2/1996/090, 600-word summary; available at <http://www.aciar.gov.au/project/AS2/1996/090>

8 ACIAR project AS2/1999/063, 2004 final report; available from ACIAR on request

4 Animal nutrition

Background

In the 1990s, ACIAR provided a number of grants to ILRI for research on ruminant nutrition. The focus of these grants was on improving feed for ruminants to support efficient animal production and promote animal health. Projects supported by these grants included:

- Isolation and characterisation of micro-organisms from non-domesticated browsing ruminants in Africa capable of improving the utilisation of tannin containing shrub legumes (AS1/1995/111)
- Managing the rumen ecosystem to improve utilisation of thornless acacias (AS1/1998/010)
- Development and use of molecular genetic markers for enhancing the feeding value of cereal crop residues for ruminants (AS2/1997/098).

These were all multilateral grants applying to a number of African countries, as well as countries in other regions. The total funding for the three projects was $1.67 million.

The evidence on adoption is summarised in Table 4. The research was generally considered to be of use to the research community, but unlikely to lead directly to adoption by farmers.

Outputs

Research funded by these grants contributed to the stock of knowledge on various issues relating to ruminant nutrition.

- Research findings from project AS1/1995/111 suggested that free-ranging, indigenous domestic ruminants may have developed rumen microbial populations capable of tolerating or degrading tannin-containing feeds. The research also found that *Acacia angustissima* may contain not only tannin but also other poisonous compounds inhibiting the growth of most rumen micro-organisms.[9]
- Although the research funded by ACIAR in project AS1/1998/010 failed to identify the toxins and toxin-degrading bacteria in thornless acacias, there was significant scientific knowledge developed through the project, as evidenced by the significant number of scientific papers generated by it. The final report identifies progress in scientific knowledge in the following areas:
  - the phytochemistry of *A. angustissima*
  - understanding of the importance of interactions among antinutritional factors in forages
  - knowledge of the metabolism of non-protein amino acids
  - the effect of microbial inoculation and polyethylene glycol in alleviation of tannin toxicity in ruminants
  - the taxonomy of *A. angustissima*
  - the toxicology of the amino acids ADAB and DABA in rats, sheep, chickens and rabbits
  - mechanisms of tannin tolerance in *Streptococcus bovis* and *S. gallolyticus*

[9] ACIAR project AS1/1995/111, 100-word summary; available at <http://aciar.gov.au/project/AS1/1995/111>

Table 4. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) animal nutrition projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next users	Final users		
AS1/1995/111	Isolation and characterisation of micro-organisms from non-domesticated browsing ruminants in Africa capable of improving the utilisation of tannin containing shrub legumes				
AS1/1998/010	Managing the rumen ecosystem to improve utilisation of thornless acacias				
AS2/1997/098	Development and use of molecular genetic markers for enhancing the feeding value of cereal crop residues for ruminants				

Source: Centre for International Economics, based on documents provided by ACIAR

  - identification of low-molecular-weight flavanol glycosides as potential toxins.[10]
- Research also developed a number of new scientific methods relevant to rumen ecological research, including the following:
  - molecular ecology tools for determining the populations of bacteria responsible for degrading toxins is well advanced and a collection of micro-organisms has been made from enrichments on *A. angustissima*
  - analytical procedures for identifying toxins.[11]
- ACIAR-funded research on rumen nutrition also demonstrated that there are links between molecular markers and digestibility traits in barley, pearl millet and perennial ryegrass.[12] For *Brachiara* grasses, variability in digestibility within the mapped population has been demonstrated and linkages between this and molecular markers can be expected once mapping of the population is completed.[13]

Through training of researchers, the ACIAR grants contributed to building the capacity of ILRI to undertake rumen ecology research. However, in some cases progress was hampered by changes to project staff.[14]

Adoption

The next users of the outputs delivered by ACIAR-funded research in the area of nutrition for ruminants are the members of the research community. Subsequent research may lead to practical solutions to some of the problems associated with ruminant nutrition.

Various documents referred to subsequent research being undertaken to build on the findings of the ACIAR-funded research. One report proposed additional research to be undertaken at various International Agricultural Research Centres (IARCs), including ILRI, the International Crops Research Institute for the Semi-arid Tropics, the International Centre for Agricultural Research in the Dry Areas and the International Center for Tropical Agriculture

10 ACIAR project AS1/1998/010, final report (page 20); available from ACIAR on request

11 Ibid.

12 ACIAR project AS2/1997/098, final report; available from ACIAR on request

13 ACIAR project AS2/1997/098, termination report, 'Development and use of molecular genetic markets for enhancing the feeding value of cereal crop residues and pastures for ruminants'; available from ACIAR on request

14 Copland J. 2005. Evaluation of final project report by ACIAR research program manager: AS1/1998/010; available from ACIAR on request

and, in Australia, at the Cooperative Research Centre for Molecular Plant Breeding. However, it is not clear from project documents whether this research was undertaken, or if this subsequently led to benefits for the final users, the farmers.

Outcomes

There was no evidence in project documents of any tangible outcomes arising from the ACIAR-funded research.

The documentation for one of the grants (AS1/1995/111) was limited. ACIAR noted that the review report was meagre in content and that this was due to the lack of information provided by ILRI. The reviewers indicated that the ILRI activities, as reported, did not fully comply with the objectives of the project. The project was terminated, but the termination report was not to a standard expected of an international centre.

Project documents indicated that new information about thornless acacia generated through the project had not yet furthered its adoption as a fodder species (AS1/1998/010).[15] The evaluation of the final report by the ACIAR research program manager noted that the outputs of the project were of value in the research arena, but had not resulted in any practical outcomes. It was also considered unlikely that there would be any direct impact on rural communities in the subsequent 5 years.[16]

While the capacity of ILRI to conduct this type of research was built, due to the reorganisation of the institute and the termination of all but one ILRI staff member involved in the project, ACIAR considered it unlikely that this capacity would be used. ILRI overstated its priority for working in the field of rumen ecosystems to several partners in the project, to whom closure of the relevant ILRI program came as a shock. The review noted it would be prudent to establish the forward research program for a CGIAR centre before committing any future funding.[17]

Based on the foundation marker populations generated in one of the ACIAR projects (AS2/1997/098) it will be possible to confirm the current analyses and extend them to locate further genetic (molecular and perhaps morphological) markers associated with digestibility traits.[18] However, it is not clear from project documentation whether any subsequent work on this topic led to on-farm changes.

15 ACIAR project AS1/1998/010, 600-word summary; available at <http://www.aciar.gov.au/project/AS1/1998/010>

16 Copland J. 2005. Evaluation of final project report by ACIAR research program manager: AS1/1998/010; available from ACIAR on request

17 Ibid.

18 ACIAR project AS2/1997/098, termination report, 'Development and use of molecular genetic markets for enhancing the feeding value of cereal crop residues and pastures for ruminants'; available from ACIAR on request

5 Forestry

Nine forestry project were reviewed, in two categories:

- five projects addressing shortage of hardwoods for fuelwood and agroforestry
- four projects relating to reforestation and agroforestry.

In general, there was insufficient evidence of adoption across most of the ACIAR-funded forestry projects reviewed (Table 5). Where there was evidence, it indicated that adoption was limited to next users.

Hardwoods for fuelwood and agroforestry

Background

The broad aim of these projects was to explore and use the potential of lesser-known Australian trees and shrubs for forestry and agroforestry in developing countries. The five projects reviewed are:

- Australian hardwoods for fuelwood and agroforestry (FST/1983/020)
- Australian hardwoods for fuelwood and agroforestry (FST/1983/031)
- Australian hardwoods for fuelwood and agroforestry (FST/1988/008)
- Australian hardwoods for fuelwood and agroforestry (FST/1988/009)
- Casuarina for fuelwood and nitrogen fixation (FST/1983/057)

The first four projects form two phases of a broader program. Projects FST/1983/020 and FST/1983/031 were competed as Phase I, and FST/1988/008 and FST/1988/009 as Phase II of the program. The total funding for the five projects was $8.67 million.

Outputs

Outputs from Phase I (FST/1983/020 and FST/1983/031) include increased scientific knowledge on the suitability of nitrogen-fixing exotics for afforestation of communal lands. Attributes assessed to determine suitability included nitrogen fixation, production of fuelwood and rough poles, and adaptability to infertile soils and dry sites. The key finding was that these nitrogen-fixing exotics generally have faster growth relative to indigenous species and have potential for afforestation in communal lands (Lubulwa et al. 1995).

Scientific knowledge gained through Phase II projects (FST/1988/008 and FST/1988/009) included identifying promising *Acacia*, *Eucalyptus*, *Casuarina* and *Grevillea* species for afforestation in Africa. A key finding was the identification, in Zimbabwe and Kenya, of species with the greatest potential to increase the supply of wood for construction (Lubulwa et al. 1995).

Project FST/1983/057 assessed the suitability of strains of *Frankia* fungus for nitrogen fixation in various species of *Casuarina*. Outputs from the project included increased scientific knowledge on, and techniques for, use of the *Frankia–Casuarina* symbiosis in Australia and other countries. Key findings included development of techniques to isolate *Frankia* strains from nodules, the importance of adequate levels of phosphorus for *Frankia* to function effectively and understanding that measurements of isolate activity must be reproducible.

Another major output across the five projects in this cluster was development of climatic interpolation surfaces for the whole of Africa, using data from over 1,000 meteorological stations (Lubulwa et al. 1995).

Capacity built amongst forestry staff included increased awareness about social forestry and its special needs, and its importance to rural livelihoods.

Table 5. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) forestry projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next users	Final users		
Hardwoods for fuelwood and agroforestry					
FST/1983/020	Australian hardwoods for fuelwood and agroforestry				
FST/1983/031	Australian hardwoods for fuelwood and agroforestry				
FST/1988/008	Australian hardwoods for fuelwood and agroforestry				
FST/1988/009	Australian hardwoods for fuelwood and agroforestry				
FST/1983/057	Casuarina for fuelwood and nitrogen fixation				
Reforestation and agroforestry					
FST/1991/026	Improvement in tree establishment for tropical dryland conditions in east Africa				
FST/1996/124	High performance eucalypts and interspecific hybrids for marginal lands in south and eastern South Africa and south-eastern Australia				
FST/1996/206	Assessment of eucalyptus rust as a pathogen of *Eucalyptus* species and other Myrtaceae, and development of sensitive methods for its detection in germplasm				
FST/2003/002	Development and evaluation of sterile triploids and polyploidy breeding methodologies for commercial species of acacia in Vietnam, South Africa and Australia				

Source: Centre for International Economics, based on documents provided by ACIAR

The review report for FST/1983/057 noted that the project did not achieve the information necessary to successfully use the symbiosis developed. Furthermore, the success of the project was limited because of a lack of expertise in collaborating institutions in Zimbabwe. Local scientists did not have a microbiological background and field trials were poorly designed and executed, partly because of a lack of expertise but also because of economic constraints on fertiliser use in Zimbabwe during the project. Another factor was insufficient visits by Australian scientists to supervise at critical stages of experimentation.[19]

Adoption

Next users of the research outputs are the organisations involved in distributing germplasm to smallholders. They could include plant nurseries or extension service providers. However, at the time of writing

[19] ACIAR project FST/1983/057, review report; available from ACIAR on request

the economic evaluation report, a Zimbabwe Forest Commission extension officer indicated that there was limited availability of the lesser-known Australian tree species in nurseries that supply planting materials to smallholders.[20] Adoption by these next users was therefore low.

It was expected that lesser-known Australian species would be used in rural afforestation, most likely for establishment of woodlots by individuals. Adoption by these final users was low due to restricted availability of these species in nurseries.

Despite the lack of evidence on adoption in project documents, the economic evaluation report assessed that research outputs would ultimately be adopted.[21] The report noted the research has the potential to benefit 60% of households in the subsistence sector.

There was little information on adoption for project FST/1983/057. However, adoption seems unlikely because the project did not meet all its data-collecting goals.

Outcomes

If the research outputs were adopted, these projects would provide essential tree products such as fuelwood to people living on subsistence farms. This would reduce the pressure on indigenous forest on communal lands, and contribute to the rehabilitation of degraded land.[22] The economic evaluation report estimated the net present value of this research would be around $27.3 million.[23] Of this, $4.7 million and $5.5 million would be distributed to Kenya and Zimbabwe, respectively. However, it is not clear if these benefits were ultimately realised.

The economic evaluation report also noted that attributing adoption of research findings to the ACIAR projects was difficult because other forestry projects were being funded by other organisations in collaborating countries at the same time (Lubulwa et al. 1995).

20 ACIAR project FST/1983/057, review report; available from ACIAR on request

21 Ibid.

22 ACIAR project FST/1983/057, review report; available from ACIAR on request

23 Estimated in 1995 over a 30-year time horizon

Reforestation and agroforestry

Projects in this category were:

- Improvement in tree establishment for tropical dryland conditions in east Africa (FST/1991/026)
- High performance eucalypts and interspecific hybrids for marginal lands in south and eastern South Africa and south-eastern Australia (FST/1996/124)
- Assessment of eucalyptus rust as a pathogen of *Eucalyptus* species and other Myrtaceae, and development of sensitive methods for its detection in germplasm (FST/1996/206)
- Development and evaluation of sterile triploids and polyploidy breeding methodologies for commercial species of acacia in Vietnam, South Africa and Australia (FST/2003/002).

Background

The broad aim of the four projects in this cluster was to improve and increase reforestation and agroforestry by developing suitable commercial species, improve the efficiency and effectiveness of tree establishment, and reduce the threat of disease. Improved reforestation and agroforestry can improve rural livelihoods and environmental conditions.

These projects were completed between 1993 and 2009, with total funding of $4.51 million.

Outputs

These projects increased scientific knowledge of the reproductive biology of a number of eucalypt species of current or potential commercial importance for South Africa (FST/1996/124) and developed breeding programs to manipulate ploidy (chromosome number) to improve effectiveness (FST/2003/002). The projects also developed improved nursery techniques for seedling development (FST/1991/026) and increased scientific knowledge on the *Puccinia psidii* pathogen and its threat to eucalypt and melaleuca plantations and species (FST/1996/206).

Technical outputs produced by project FST/1996/124 included software for genetic analysis of hybrid

populations. FST/1996/124 developed three prototypes of low-technology portable propagation systems suitable for use by community-based or small-scale enterprises. Key outputs were identification of suitable eucalypt hybrids for marginal lands and increased scientific knowledge about reproductive biology (ACIAR 2006).

Technical outputs from FST/2003/002 included less time-consuming tools for determining ploidy, by successful employment of near infra-red spectrometry (ACIAR 2007).

Capacity outputs at individual and organisational level were also achieved through projects FST/2003/002 and FST/1996/124. For example, project FST/2003/002 developed organisational capacity at the Forest Science Institute of Vietnam and the Council for Scientific and Industrial Research in the Republic of South Africa to continue polyploidy breeding and associated technologies without direct support from Australian scientists. Project FST/1996/124 built capacity through experience in using software developed as part of the project.

Policy outputs were produced in FST/1996/206 in terms of a draft national diagnostic standard for *P. psidii* and diagnostic DNA sequences.

Key limitations to completing projects and delivering outputs were highlighted in the review of the review report for FST/1991/026.[24] These included an ambitious project scope that could not be completed in full, project delays, poor nursery and experimental procedures in Zimbabwe and Kenya, poor communication and a high turnover of project staff.

Adoption

The use by CSIRO of the diagnostic DNA sequences to test, for the Australian Quarantine and Inspection Service, a consignment of wood from Brazil for the presence of the *P. psidii* pathogen, was evidence of adoption of policy outputs from FST/1996/206.

Agencies and organisations involved in breeding eucalypts in South Africa and Australia have adopted genetic knowledge outputs from FST/1996/124. In particular, CSIRO and associated companies involved in tree improvement have adopted the genetic knowledge from the project in design and implementation of breeding strategies (Kanowski and Verryn 2011). It is expected that the advanced breeds generated will be adopted by smallholders, but adoption by the final users had not yet occurred and was not expected for at least the 5 years after the end of the project.

Adoption of key outputs from FST/1996/124 had not occurred at the time of writing the adoption study because of inherent time lags involved in biological testing and breeding experiments. Adoption was expected to progress to the final user stage over the subsequent 5 years. There is no information available on whether adoption did occur.

Project FST/1991/026 and FST/2003/002 documents did not provide details on adoption by next and final users.

Outcomes

The adoption of diagnostic DNA sequences from FST/1996/206 could lead to economic and environmental benefits by preventing incursion of *P. psidii* into Australia and other countries where Myrtaceae are present. The degree of impact in Africa will depend on the importance of Myrtaceae species as plantation crops.

According to the material reviewed, FST/1996/124 was yet to deliver any outcomes for South African smallholders because of time lags in pathways from project activities. It is not known whether outcomes have been achieved since.

Outcomes for FST/1991/026 and FST/2003/002 were not documented in the material reviewed.

Due to the limitations outlined above, project FST/1991/026 was not considered to have delivered a good return on investment.[24]

[24] ACIAR project FST/1991/026, review of review report; available from ACIAR on request

6 Livestock production systems

Background

A cluster of projects in the livestock production systems program area was completed over the period 1999–2008. These projects aimed to improve emerging crop and livestock farmers' access to markets for their products and to help them commercialise their farming operations. Focusing on South Africa, these projects emphasised income-generation in crop and livestock systems for emerging farmers. The aim was to assist farmers to develop as entrepreneurs who could capture the benefits of improved technology and then provide leadership to other groups (ACIAR 2010).

This research focused on enhancing the supply chain for emerging crop and livestock famers. Research in this area targeted increasing productivity of crop and cattle production and developing and improving access to rural and urban commercial markets.

The projects assessed were:

- Developing profitable beef business systems for previously disadvantaged farmers in South Africa (LPS/1999/036)
- Development of emerging farmer crop–livestock systems in northern RSA (LPS/2002/081)
- Can we segment the South African market for beef palatability? (LPS/2008/013).

Total funding for the three completed projects was $3.17 million. For all three projects, there was good evidence of adoption by final users (Table 6).

Outputs

A key output from research focusing on improving productivity at the farm level (LPS/2002/081) was a prototype Limpopo Emerging Farmer Model (LEFarM) calibrated with data sourced from local agribusiness enterprises. The model can inform farmers' decisions about inputs and the mix of activities needed to maximise profit from commercial markets.

Research to develop and improve farmers' access to commercial markets found that cattle reared by resource-poor farmers can meet specifications of commercial beef markets (LPS/1999/036) (ACIAR 2003). This result may underpin a future supply chain study to develop a niche market for indigenous cattle. This project also increased capacity amongst final users, with a large and growing number of motivated and trained farmers able to improve beef businesses and take control of negotiations to market their cattle (ACIAR 2007).

The projects focused on engagement with local extension officers and emerging and communal farmers, thus building capacity of the projects' farmers, extension officers, technical staff, scientists and managers.

Adoption

The knowledge and skills developed through the ACIAR-funded projects have been used by both next and final users to improve the commercial focus of smallholder farmers.

Table 6. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) livestock production systems projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next users	Final users		
LPS/1999/036	Developing profitable beef business systems for previously disadvantaged farmers in South Africa				
LPS/2002/081	Development of emerging farmer crop–livestock systems in northern RSA				
LPS/2008/013	Can we segment the South African market for beef palatability?				

Source: Centre for International Economics, based on documents provided by ACIAR

The next users of the outputs delivered by ACIAR-funded research include local extension staff, as well as organisations such as the National African Farmers Union and the South African Feedlot Association. There was evidence of these organisations using, in various ways, the information developed through the projects.

The final users are smallholder farmers. There was evidence that most farmers who participated in the project were using the skills and knowledge they built through the project to improve their commercial focus. A key factor supporting high levels of adoption was early engagement with, and building capacity of, local extension staff and farmers, and a focus on practical, low-risk and simple techniques such as row planting, weed and pest control, with application of fertilisers in small doses.

As a part of the 'participatory approach' farmers conducted the experiments themselves and witnessed firsthand the results. This approach of engagement with the final users aided adoption and, in many cases, adoption extended beyond the initial study areas because the farmers had confidence to deliver the key messages and success stories to neighbours and the local community. In project LPS/1999/036, for instance, adoption expanded to five new South African provinces at the end of the project. A key result was that other farmers saw the benefits attained by those involved in the project and were keen to join the project teams (ACIAR 2006). Part of the success of this project was due to a focus on both genetic and social science components.

Key components were:

- in LPS/1999/036, a continuous-improvement process was used for decision-making at almost every level of the cattle industry managed by emerging farmers
- beef profit partnerships which, by the end of the project, had expanded to five new South African provinces as well as the initial Limpopo and North West provinces.

Constraints consequent on land-distribution policies were a significant limitation to adoption. Many crop farmers involved in the projects could not move into commercial production because the scale of their operations (less than 1 hectare) was too small for profitable commercial production. The current Land Redistribution for Agricultural Development scheme prohibited landholders from increasing their landholdings, and the consequent lack of certainty diminished the ability of farmers to borrow or invest in development of infrastructure.

Outcomes and impacts

The ACIAR projects have led to a range of outcomes. The National African Farmers Union has used the outputs delivered by LPS/1999/036 to develop a proposal to establish a new feedlot system based on cattle reared by resource-poor farmers. Members of the

South African Feedlot Association have also established buyers in the region to access this previously untapped supply of cattle, creating a valuable income source for poor farmers (LPS/1999/036) (ACIAR 2003).

A new initiative has also commenced to foster beef market chains through the development of branded beef products based on indigenous cattle (LPS/2008/013) (ACIAR 2009b).

Two communities of emerging farmers are using legume crop–livestock technologies to improve the sustainability of farming practices and farm-level productivity (LPS/2002/081). This has demonstrated that it is possible to transform low-productivity maize-based farming systems into more profitable enterprises by incorporating grain-legume cash crops into maize rotations (ACIAR 2009a).

Crop-only farmers have also increased productivity by using high-quality seed of adapted cultivars and applying relatively simple techniques of row planting, weed and pest control, with application of fertiliser in small doses.

Farmers who adopted outputs from LPS/2002/081 are now packaging, storing and selling high-value legume products (ACIAR 2009a).

These changes in farming practices and improved supply chains have increased the productivity of emerging farmers and, in some cases, have raised the prices they receive for their goods as a consequence of their improved knowledge of marketing their stock and of the feedlot buyers being aware of the quality of the meat they produce (LPS/1999/036) (ACIAR 2007). This has contributed to higher incomes, stronger financial positions and improved welfare.

Knowledge gained from the above projects has also contributed to the following two projects:

- Expanding and diversifying markets and value chains for small-scale and emerging beef cattle farmers in South Africa (LPS/2005/128) (currently at the proposal stage)
- Enhancing the competitiveness of beef cattle smallholders in Botswana (LPS/2010/010).

7 Sustainable use of natural resources

Background

The broad aim of these projects was to research sustainable use of natural resources, particularly with regard to croplands and communal grazing lands (ACIAR 2010). The projects focused on efficient farm management in terms of water use, agroforestry and production of crops and pastures. Projects reviewed in this cluster were:

- Measurement and prediction of agrochemical movement in tropical sugar production (LWR1/1994/046)
- Competitive interaction of trees and crops for water by agroforestry systems (FST/1995/107)
- Enhanced resource-use planning for tropical woodland agroecosystems (LWR2/1996/163)
- Capturing the benefits of seasonal climate forecasts in agricultural management (LWR2/1996/215)
- Pasture development for community livestock production in the Eastern Cape province of South Africa (LPS/2004/022)
- Potential incentives for sustainable farming for food and water security, and poverty reduction in southern Africa (LWR/2011/015).

Total ACIAR funding for these projects since 1994 is $5.52 million.

In general there was insufficient evidence to confirm adoption across the six projects reviewed (Table 7).

Outputs

The majority of outputs from this cluster of projects relate to increased scientific knowledge and/or development of new scientific methods. For instance, FST/1995/107 increased the scientific knowledge about the redistribution of water from the surface to deeper soil horizons and root systems, and the effects on root growth and the water status in tree–crop interactions. New scientific methods using the heat-pulse method were also developed, as well as a sap-flow model suitable for use on woody roots.[25]

Projects incorporating systems-modelling increased scientific knowledge about management strategies to minimise the movement of pesticides and nutrients, and about the use of climate forecasts for agricultural management. The key finding from LWR1/1994/046 was that adopting strategies to minimise sediment losses and giving greater attention to the timing of fertiliser and pesticide application can efficiently and effectively manage off-site losses.

LWR1/1994/046 also found that current practices in the sugar industry in Mauritius are not causing unacceptable levels of pollution. This improved scientific understanding leaves the sugar industry in a strong position to immediately cope with any issues that might arise in the future.

Outputs from LWR2/1996/215 included increased scientific knowledge about climate and seasonal forecasts, a database of Zimbabwe climate information, an improved seasonal climate forecast scheme, and successful validation of the GRASP pasture simulation

[25] ACIAR project FST/1995/107, final report; available from ACIAR on request

Table 7. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) sustainable use of natural resources projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next users	Final users		
LWR1/1994/046	Measurement and prediction of agrochemical movement in tropical sugar production		Project findings confirmed practices already in use by final users		
FST/1995/107	Competitive interaction of trees and crops for water by agroforestry systems				
LWR2/1996/163	Enhanced resource-use planning for tropical woodland agroecosystems				
LWR2/1996/215	Capturing the benefits of seasonal climate forecasts in agricultural management			Adoption not possible for grazing systems because of lead times required	Adoption possible by cropping systems but no evidence
LPS/2004/022	Pasture development for community livestock production in the Eastern Cape Province of South Africa				Project to finish in 2013
LWR/2011/015	Potential incentives for sustainable farming for food and water security, and poverty reduction in southern Africa				

Source: Centre for International Economics, based on documents provided by ACIAR

model in Zimbabwe. Two key findings from this project were that daily forecasts could help summer planting decisions in Zimbabwe, while seasonal forecasts could help communal farmers manage drought.

Project LPS/2004/022 identified species of annual and perennial legumes that have the potential to increase forage quality and thus animal production on arable lands in the Eastern Cape. A growing awareness of the contribution that legume-based pastures can make to improve livestock production, combat soil erosion and improve soil quality has led to the establishment of a number of additional trial sites and collaborations.

The capacity of individuals and organisations was built in projects FST/1995/107 and LWR1/1994/046. For example, FST/1995/107 increased the capacity of a Kenyan scientist and partner institutions in the use of Australian crop and catchment models adapted to Kenyan conditions.[26]

Outputs from LWR2/1996/163 were policy knowledge and decision-support tools, including performance indicators and guidelines for agency implementation of participatory land-use planning in Zimbabwe. A key output was better understanding of the processes and inputs required to evolve the land-planning systems in communal lands to a more equitable and participatory system.

[26] ACIAR project FST/1995/107, final report; available from ACIAR on request

It was not clear from the project documents what were the outputs from LWR/2011/015.

Overall, projects in this cluster led to the development of new maize and legume varieties that perform better under the types of stresses faced by smallholder farmers in Africa. They also identified research methods that are successful in adapting conservation agricultural technologies to smallholder systems.[27]

Key limitations noted for projects in this cluster included: a lack of capacity and appropriate skill sets in partnering institutions undertaking the project; the political climate in Zimbabwe with reference to land planning; continual turnover of personnel (LWR2/1996/163); and a lack of synthesis and consolidation across subprojects (LWR2/1996/215).

The final report for LWR2/1996/163 discussed key lessons learned during the project. They are relevant to many other ACIAR projects. The main lessons to assist the planning process and increase adoption included engaging the community in project planning and content (modelling and science) to build trust. Additional lessons included requirements for an explicit coordinator role, better communication, and clearly defined roles and mechanisms for increasing ownership at the community level.

Adoption

Most participants in the sugar industry in Mauritius were already following the management practices recommended by project LWR1/1994/046. Consequently, no adoption was required.[28]

Adoption of outputs from LWR2/1996/215 is limited to cropping systems and not available for grazing systems because of the lead times required. Crop management needs shorter lead times, is more flexible, impacts occur in a shorter timeframe and benefits are easier to quantify. It is not clear if on-farm changes have occurred since the project.

Unanticipated adoption occurred from outputs from LPS/2004/022, with interest shown in the use of annual legumes in the maize cropping programs (ACIAR 2009a). Further adoption has not been documented because the project does not finish until 2013.

Two of these projects (LWR1/1994/046 and LWR2/1996/215) included extension activities such as workshops and information dissemination. However, it was not clear if adoption resulted from these extension activities.

There was no discussion of adoption in project documents for LWR2/1996/163.

Adoption of outputs from LWR2/1996/215 was restricted by a lack of resources in Zimbabwe. A book titled 'Will it rain?', containing the results of the project's work in Indonesia was published, but a lack of resources prevented a similar book being published for Zimbabwe.[29]

Outcomes

Outcomes were discussed for only LWR1/1994/046. They included potential benefits to the sugar and tourism industries from changing community perceptions about pollution.

Project documents for projects LWR2/1996/163, LWR2/1996/215, FST/1995/107 and LWR/2011/015 did not include discussion of outcomes. LPS/2004/022 is expected to finish in 2013.

27 SIMLESA—Sustainable intensification of maize-legume cropping systems for food security in eastern and southern Africa—information leaflet 'SIMLESA FS Final_150312.pdf', available from ACIAR on request

28 ACIAR project LWR1/1994/046 adoption study; available from ACIAR on request

29 ACIAR project LWR2/1996/215 review report; available from ACIAR on request

8 Soil management and crop nutrition

ACIAR has funded a range of research projects broadly focused on soil management in cropping and mixed-farming systems. This has included six grants to IARCs, such as the International Maize and Wheat Improvement Center (CIMMYT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Center for Tropical Agriculture (CIAT) to improve farm system modelling capacity. A further three projects involved other aspects of soil management.

Total funding for these projects over the past 30 years was $24.8 million. The evidence on adoption of the outputs generated by these projects is mixed (Table 8)

Farm system modelling projects

Grants aimed at developing system modelling capacity within the IARCs and national agricultural research and extension systems (NARES) included:

- System modelling at ICRISAT: Increasing the effectiveness of research on agricultural resource management in the semi-arid tropics by combining cropping systems simulation with farming systems research (LWR2/1996/049; also known as CARMASAT—collaboration on agricultural resource modelling and applications in the semi-arid tropics)
- Risk management in southern African maize systems (Risk management project, Part 1, LWR2/1997/038)
- Integrated nutrient management in tropical cropping systems: Improved capabilities in modelling and recommendations (SMCN/1999/003)
- Improving phosphorus availability in cropping systems in Sub-Saharan Africa (SMCN/1999/004)
- Development and scaling out of targeted recommendations for smallholder maize systems in Southern Africa through integrating farmer participatory research and simulation modelling (Risk management project Part 2, SMCN/2001/028)
- Improved fertiliser recommendations and policy for dry regions of southern Africa (SMCN/2000/173).

Two of these grants (LWR2/1997/038 and SMCN/2001/028) were funded by AusAID, but managed by ACIAR. Total ACIAR (and AusAID) funding for these projects was around $7 million.

Outputs

A key objective of a number of the soil management grants was to build the capacity of various IARCs and NARES in farm system modelling. Simulations from these models can be used to guide agricultural policy and the research agenda and advise farmers on soil management strategies. Various grants sought to build capacity within IARCs and NARES by:

- providing a modelling tool suitable for use in various parts of Africa and other regions within the semi-arid tropics climatic zone (LWR2/1996/049), including Malawi and Zimbabwe (LWR2/1997/038 and SMCN/2001/028) and South Africa (SMCN/2000/173)

Table 8. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) soil management and crop nutrition projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		Next users	Final users		
Farm system modelling					
LWR2/1996/049	System modelling at ICRISAT: Increasing the effectiveness of research on agricultural resource management in the semi-arid tropics by combining cropping systems simulation with farming systems research		Adoption by aid agencies but not farmers		
LWR2/1997/038	Risk management in southern African maize systems				
SMCN/1999/003	Integrated nutrient management in tropical cropping systems: Improved capabilities in modelling and recommendations				
SMCN/1999/004	Improving phosphorus availability in cropping systems in Sub-Saharan Africa				
SMCN/2001/028	Development and scaling out of targeted recommendations for smallholder maize systems in Southern Africa through integrating former participatory research and simulation modelling				
SMCN/2000/173	Improved fertiliser recommendation and policy for dry regions of southern Africa				
Other					
EFS/1983/026	Improvement in dryland crop and forage production in the semi-arid tropics				
LWR2/1987/035	Improvement in dryland crop and forage production in the semi-arid tropics				
AS2/1996/149	Tropical forage and ley–legume technology for sustainable grazing and cropping systems in Southern Africa				

Source: Centre for International Economics, based on documents provided by ACIAR

- building the capacity of researchers in IARCs and NARES to use the model.

ACIAR projects provided a modelling tool by adapting the Agricultural Production Simulator (APSIM) model developed in Australia. Various enhancements to APSIM were funded under ACIAR projects, including modules for pearl millet and pigeon pea (LWR2/1996/049)[30], a module to describe the dynamics of phosphorus in soil and responses to fertiliser and organic inputs of phosphorus (LWR2/1996/049 and SMCN/1999/003), and a module for simulating manure decomposition and nutrient release (LWR2/1996/049).[31]

Some project reviewers noted that as a result of these enhancements, APSIM now adequately simulates most on-farm yields (SMCN/1999/003 and SMCN/2001/028).[32] However, various review reports note problems in obtaining the data required to parameterise and validate APSIM. The reviewers of SMCN/1999/003 noted that datasets required for modelling had not been gathered for the purpose of validating APSIM and work was constrained because they were incomplete (SMCN/1999/003).[33] Another review team noted there was an absence of the expected historical database of fertiliser trials (SMCN/2000/173)[34], while on-farm trials did not produce the necessary data for parameterisation and validation of APSIM. Model applications therefore depended upon parameterisation using data from elsewhere and a belief that extensive validation elsewhere in Africa was sufficient to give confidence in the model (SMCN/2000/173).[35]

Efforts to establish the credibility of APSIM to predict crop response to fertiliser inputs in Limpopo province were eventually pursued in the extension phase (SMCN/2000/173).[36] This work was undertaken in collaboration with the South African Agricultural Research Council's Grain Crops Institute and Institute for Soil, Climate and Water. The results from trials were incorporated into the model and assessed. However, APSIM greatly over-predicted the observed biomass and grain yield at Leeuwkraal, while simulating a long delay in crop growth at Bellingsgate with almost no grain yield (SMCN/2000/173).[37] The model also failed to simulate any differential response to nitrogen treatments. This may have been due to poor growing conditions during the field trials.

The model was therefore reconfigured and it was found that the observed nitrogen response displays a tendency to plateau at an application rate of about 20 kg/ha. This was considered encouraging, given that a large part of the argument that underpins the advocacy of small doses of nitrogen in drier regions is based on model analysis.

However, the desired local field data on maize response to small applications of nitrogen fertiliser to adequately test APSIM were not obtained.

This raises some uncertainty over the accuracy of APSIM simulations and therefore the validity of conclusions drawn from them. Project reviewers stressed the importance of having full confidence in the performance of APSIM before exposing farmers to some of the simulation results, to ensure credibility (LWR2/1997/038).[38]

Efforts to establish modelling capabilities within IARCs and NARES through the training of researchers appear to have had limited success. One review report noted that many of the national partners are able to set up scenarios, run APSIM and interpret the results. But understanding does not generally extend to model design and troubleshooting and more needs to be done to institutionalise modelling expertise (SMCN/1999/003). The reviewers described the training as being more model familiarisation than model training (SMCN/1999/003).[39]

Other review reports noted that the capability of ICRISAT has not been raised to the extent that it will

30 ACIAR project LWR2/1996/049, final report; available from ACIAR on request

31 Ibid.

32 ACIAR projects SMCN/1999/003 and SMCN/2001/028, review report; available from ACIAR on request

33 ACIAR project SMCN/1999/003, review report; available from ACIAR on request

34 ACIAR project SMCN/2000/173, review report; available from ACIAR on request

35 Ibid.

36 Ibid.

37 Ibid.

38 ACIAR project LWR2/1997/038, review report; available from ACIAR on request

39 ACIAR project SMCN/1999/003, review report; available from ACIAR on request

be able to support other partners (LWR2/1996/049).[40] The adoption study identified 24 research/extension staff associated with the project who had been trained in APSIM and were now competent in its use. However, only nine of these researchers saw APSIM as a key component of their current activities (LWR2/1996/049) (Carberry 2005). Another review report noted that a series of training courses for NARS scientists has had limited impact on the capacity of trainees (LWR2/1997/038).[41]

On the positive side, ACIAR-funded research improved scientific knowledge in various areas, including: understanding of the biophysical processes that underpin the maize system productivity in drought-prone areas of southern Africa (SMCN/2001/028); and forage legume adaptation and productivity, soil nitrogen and soil organic matter dynamics and the impact of forage or dual-purpose legumes on cereal and animal production (AS2/1996/149).

Other research improved scientific understanding of the performance of different lines of soybean and cowpea in different soils and the response to phosphorus (P) fertiliser application (SMCN/1999/004).[42] This included the identification of a P-efficient group (performs better in unfertilised soil) and P-responsive group (performs better when P applied), although there were inconsistencies between trials.[43] The project team also studied mechanisms of P efficiency, to identify features that could make screening for P efficiency quicker and more certain, although no clear understanding emerged of what makes one cultivar more P-efficient than another. The project team therefore concluded that direct selection for grain yield at well-characterised sites with low P would be a reasonable approach for developing adapted P-efficient and responsive cultivars. This conclusion was supported by the project review.[44]

The project provided basic information for quantifying the risks, by calculating nutrient budgets, for cropping systems and the carbon cycle contribution to the acidity budget, based around the yields obtained and the extent of removal and recycling of organic material. Soil acidification was identified as a serious threat to the sustainability of legume-based cropping in Sub-Saharan Africa.[45]

Another key output of this cluster of projects was the development of better soil and crop management strategies for smallholder farmers, taking account of the risks associated with various strategies. Strategies included improved use of fertiliser, such as low-dose applications, legumes and animal manures as alternative sources of nitrogen, grain legumes as alternative sources of food and use of drought-tolerant maize varieties (LWR2/1997/038, SMCN/2001/028 and SMCN/2000/173). Many of these strategies were developed and assessed using APSIM.

ACIAR-funded projects also enhanced the capacity of IARCs and NARES to undertake research on soil management and crop nutrition through training African partners, and by developing a database management system to record, store and retrieve climatic data and to perform certain routine computations of relevance to agricultural system modelling (LWR2/1996/049).

A final important output developed through this cluster of projects was methods to integrate research, farmer participation and simulation modelling, as well as means to scale out these practices to larger areas (SMCN/2001/028).

Adoption

The next users of the farm system models are researchers within IARCs and NARS. APSIM was used within the projects to evaluate various soil management strategies and identify those that provide the best pay-off to farmers. This included low-dose fertiliser strategies, which were accepted by senior staff from input suppliers and the Limpopo province Department of Agriculture, despite a lack of sound scientific evidence of their efficacy (SMCN/2000/173).[46]

40 ACIAR project LWR2/1996/049, final report; available from ACIAR on request

41 ACIAR project LWR2/1997/038, review report; available from ACIAR on request

42 ACIAR project SMCN/1999/004, review report; available from ACIAR on request

43 ACIAR project SMCN/1999/004, 600-word summary; available at <http://aciar.gov.au/project/SMCN/1999/004>

44 Ibid.

45 Ibid.

46 ACIAR project SMCN/2000/173, review report; available from ACIAR on request

However, there is little evidence of continuing use of APSIM after the projects had been completed. Given the limited success in building the expertise of researchers within IARCs and NARES, it seems unlikely that use is widespread. The only adoption study completed for these projects found that only nine researchers from around 140 trainees were regularly using APSIM as part of their work. This represents an adoption rate of around 6% (LWR2/1996/049) (Carberry 2005). Nevertheless, the modelling capacity built within ICRISAT–Zimbabwe appears to have been used to guide the research agenda. It was estimated that the use of simulation in a farming systems research context occurred in approximately 80% of activities.[47] This is in contrast to the experience in ICRISAT–India. There was also little evidence of active adoption of simulation analyses stemming from the CARMASAT project within the NARES in India, Zimbabwe or Kenya.

One review report identified five sets of potential end-users of model outputs:[48]

- farmers
- policymakers
- advisory services
- the private sector
- the research community.

However, in a number of modelling-related projects, little was done to use the modelling research for practical purposes.

Reviewers of one project considered the objective of applying APSIM in evaluating farmers' management options a failure[49] and no impacts were observed in terms of sustainable development of agriculture[50]. Another noted that the practical application of the models has not yet been demonstrated to farmers and other potential users.[51]

A number of review reports also noted the need for greater effort dedicated to using the tools developed in practical situations. For example, reviewers of SMCN/1999/003 recommended that it be an urgent priority to engage more farmers, extension services and policymakers in understanding the usefulness of the tool. Without this step, the reviewers argued, it would be difficult to get APSIM in Africa out of the research domain, with its utility for aiding nutrient management issues unexplored and unexploited.[52] Similarly, another review report[53] noted that the project must find dissemination channels for some of its methodology. Moreover, there is a need to assess potential dissemination channels for technologies generated by the project. Attention needs to be paid to issues of sustainability of these channels, taking into account that it may be risky to rely entirely on government-supported channels in the face of dwindling resources in the public sector.

Nevertheless, there is some evidence of adoption in project documents. Fertiliser recommendations developed through ACIAR-funded research in project SMCN/2000/173 appear to have been adopted by some smallholders. A key pathway to adoption was the involvement of a private-sector input supplier. Based on recommendations developed through the project, a fertiliser supplier provided 10, 20 and 50 kg packs of starter and top-dressing fertiliser for distribution to community-based depots. Through the direct involvement of the fertiliser company in the supply of small packs, the cost premium per unit of nitrogen was reduced from over 100% to around 10%, compared with larger packs.

Fertiliser sales increased from around 17 tonnes/year to 96 and 140 tonnes/year in 2005–06 and 2006–07, respectively, to an estimated 2,800 farmers. A further 1,440 farmers have been exposed to low-dose strategies and improved agronomy.

The only other model-based project that appeared to include a strategy for disseminating model outputs to farmers was SMCN/2001/028. Pathways to adoption included a series of extension bulletins that quantify the risk associated with the use of existing technologies

47 Ibid.

48 ACIAR project SMCN/1999/003, review report; available from ACIAR on request

49 ACIAR project LWR2/1996/049, review report (p. 10); available from ACIAR on request

50 Ibid., p. 14

51 ACIAR project SMCN/1999/003, review report; available from ACIAR on request

52 Ibid., p. 5

53 ACIAR project LWR2/1997/038, review report (p. 16); available from ACIAR on request

under different farmer conditions, including those of land type and management (SMCN/2001/028).[54] There were also nine farmer stakeholder workshops held in Malawi and Zimbabwe, as well as various field days, study tours and field visits.

The project target area in Malawi was Chisepo. Over 40% of farmers in the target area adopted some of the recommended strategies. In the areas surrounding Chisepo, diffusion has largely been through farmer-to-farmer interchange. Adoption rates in the surrounding areas were lower, with around 20% of a random sample of farmers having adopted one of the strategies recommended by the project team. The lower adoption rate was thought to reflect the lower support and information given to these farmers. Nevertheless, the spread of project recommendations through farmer-to-farmer interchange is encouraging.

Farmers from Ekwendeni in northern Malawi also visited project farmers with the support of a local non-government organisation (NGO) and they experimented with legume crops using several of the project methodologies.[55] Over 90% of these farmers now use strategies recommended by the project.

Adoption of the technologies in Zimuto in Zimbabwe was considerably lower. About 25% of the population in the target areas was aware of the strategies recommended by the project but only around 9% has tried them. Nevertheless, project farmers reported that other farmers from outside the area had asked them for seed.

Several partners in Malawi continue to use some of the project methodologies, but scaling up of these has been limited in Zimbabwe. The 'mother–baby' trial and farmer experiment approach has been the most popular methodology, with less interest in whole-farm resource allocation maps.

According to the final report on project SMCN/2001/028, there are many possible reasons for the large differences in awareness, experimentation and adoption of the project recommendations between the Malawi and Zimbabwe focus areas. The project team was unable to define which are the most important reasons, although they suggested the following:[56]

- The technologies are more effective in Malawi because rainfall and inherent soil fertility are much higher in the areas targeted there than they are in the focus areas in Zimbabwe.
- The level of interest in the work varied between extension communities. There was considerable interest from, and interaction with, a series of NGOs involved in agricultural technology dissemination in Malawi. By contrast, in Zimbabwe, given the situation at the time, many of the NGOs traditionally involved in agricultural development were focusing more on food aid, and the engagement of partners interested in project technologies and methodologies was extremely sparse. Political and economic problems in Zimbabwe were raised as a risk in the project proposal.[57] Nonetheless, the project team felt that there are sound reasons for the second phase of this project to proceed.

Another final user of the model outputs was the aid community. A major aid-relief program conducted in Zimbabwe in 2003–04 and 2004–05 was coordinated by ICRISAT research leaders. APSIM simulations were influential in guiding the strategy used by the UK Department for International Development (DFID) in providing aid packages to 160,000 farms (LWR2/1996/049) (Carberry 2005).

One approach to disseminating the modelling results was to develop decision-making tools for farmers. These included:

- resource allocation maps (RAMs)—although the project review (SMCN/2001/028) noted that RAMs appeared to be used more by project staff than farmers[58]
- decision trees and rules of thumb—the review noted that the draft guidelines required verification

54 ACIAR project SMCN/2001/028, final report; available from ACIAR on request

55 ACIAR project SMCN/2001/028, 600-word summary; available at <http://aciar.gov.au/project/SMCN/2001/028>

56 ACIAR project SMCN/2001/028, final report; available from ACIAR on request

57 ACIAR project SMCN/2001/028, project proposal (pp. 30–31); available from ACIAR on request

58 ACIAR project SMCN/2001/028, review report; available from ACIAR on request

in the field, although the project did not have the staff capacity to accomplish this.[59]

There is no evidence of model simulations being used for agricultural policy development. Indeed, this is specifically noted in the review report for one project.[60]

It appears likely that the ACIAR-funded research led, in some instances, to additional research.

Barriers to adoption

A key barrier to adoption in one project was the licensing arrangements for APSIM. IARCs and NARES required a licence for the use of APSIM. The Agricultural Production Systems Research Unit, the developers of APSIM, felt that licensing the system until it is commercialised is in its interests to maintain its reputation. However, ICRISAT did not accept this arrangement (LWR2/1996/048).[61] Nevertheless, in subsequent projects (SMCN/1999/003), APSIM was made available to users either free of charge, or at a modest cost.[62]

The adoption study for project LWR2/1996/049 (Carberry 2005) proposes a number of reasons for the lack of adoption of outputs relating to building the capacity of researchers:

- NARES researchers/extension staff do not have the underlying skills in computer literacy, mathematics and university-level modelling courses to adopt modelling
- learning to become proficient in modelling takes significant time—the few who do become proficient get poached to other jobs
- there is a perception among non-modellers that models have little value.

High rates of personnel turnover in IARCs and NARES was also noted in a number of review reports (e.g. SMCN/1999/003[63]).

There was also evidence of a lack of dissemination strategies for a number of projects. Review reports noted that no broadscale dissemination or communication activities were undertaken as part of the project to engage any final user groups (LWR2/1996/049).[64]

Outcomes

Due to a lack of adoption, the outcomes arising from ACIAR-funded research were limited. For example, the only adoption study for this cluster of projects noted that, based on evidence available up to early 2005, there is little documented practice change attributable to the CARMASAT project (LWR2/1996/049) and its related follow-on activities. Most final users (smallholder farmers, aid agencies and agribusiness companies) are continuing their practices without significant consequence from the input of systems simulation or participatory research intervention (LWR2/1996/049) (Carberry 2005).

Outcomes within IARCs and NARES as a result of the ACIAR-funded research included the promotion of low-dose fertiliser application by the Limpopo province Department of Agriculture (LPDA) and input suppliers. According to the review report for project SMCN/2000/173,[65] this is a change in paradigm and a crucial project impact.

The project has also led to a change in fertiliser use by farmers (SMCN/2000/173). The increased use of low-dosage fertiliser is expected to increase profits by around 400 rand per farmer, based on reasonable estimates per yield response (SMCN/2000/173).[66]

However, the review report notes that there is some uncertainty about the validity of the conclusion that small doses of nitrogen (N) increase yields, and even more uncertainty about conclusions at any individual site (SMCN/2000/173).[67] The results of on-farm trials were mixed. One trial demonstrated that small inputs of N can increase yield (by around 50%) with little increase in risk. However, these results were not replicated. The review report notes that the very high variability at field

59 Ibid.

60 ACIAR project SMCN/2000/173 (p. 5), review report; available from ACIAR on request

61 ACIAR project LWR2/1996/048, review report; available from ACIAR on request

62 ACIAR project SMCN/1999/003, review report; available from ACIAR on request

63 Ibid.

64 ACIAR project LWR2/1996/049, review report; available from ACIAR on request

65 ACIAR project SMCN/2000/173, review report; available from ACIAR on request

66 Ibid.

67 Ibid.

sites means there is uncertainty about the validity of any conclusion that small doses of N increase yields. The review report notes furthermore that there is even more uncertainty about conclusions at any individual site. So, farmers who were convinced by what they have seen may be misled by a chance result from a fortuitous location.[68]

Other changes in practice by farmers as a result of ACIAR-funded projects included farmers planting velvet bean, pigeon pea and erect cowpeas and, to a lesser extent, tephrosia, and two *Crotolaria* species in the Chisepo and surrounding areas of Malawi, and less so at Zimuto in Zimbabwe.

Another key outcome has been the aid strategy pursued by DFID during the crisis in Zimbabwe in 2003–04 and 2004–05. The food relief and aid strategies were coordinated by ICRISAT and were guided by APSIM simulations (LWR2/1996/049) (Carberry 2005).

In 2003–04, around 160,000 farms received aid packages based on maize seed and small doses of inorganic fertiliser, along with specific advice on application of the latter. ICRISAT coordinated monitoring of 1,200 of these farms, where 1-acre plots were split into control and applied seed and fertiliser areas. Data collection and analysis were successful in over 800 farms. Average yield gains were measured at 30–50% relative to traditional farmer practice and almost every recipient achieved significant gains. This effort was to be repeated in 2004–05 with 30,000 households in Zimbabwe, but was hampered by lack of access to fertiliser.[69]

Other soil management projects

ACIAR has also funded three other projects with soil management components:

- Improvement of dryland crop and forage production in the semi-arid tropics (EFS/1983/026 and LWR2/1987/035)
- Tropical forage and ley–legume technology for sustainable grazing and cropping systems in southern Africa (AS2/1996/149).

Total ACIAR funding for these projects was A$17.8 million.

Outputs

These ACIAR projects delivered some significant outputs, including new scientific knowledge, new technologies and enhanced capacity of African partners.

The projects delivered the greatest scientific knowledge in areas such as the efficiency of farmyard manure, forage legume adaptation and productivity, soil nitrogen and soil organic matter dynamics, the impact of forage or dual-purpose legumes on cereal and animal production, and planting density in improving maize yields. Specific insights with direct relevant to farm management practices included:

- modest application of phosphorus fertilisers on soils with low P fixation is viable and profitable
- use of the KCB maize cultivar, desired levels of nitrogen application and the plant population required for optimal crop protection
- N fertiliser or significant N input from legumes was needed to obtain grain yields above 1 tonne/hectare—some dual-purpose legumes have special attraction in these systems, providing human food as a vegetable or pulse crop and feed for the small number of animals present
- the decline in maize yield can be avoided by sowing legumes after maize establishment
- in Zimbabwe and south-eastern Queensland, velvet beans and lablab both provided considerable benefits to farmers via increases to subsequent maize yields, especially if the legumes were incorporated as a green manure
- removal of legumes for animal feed reduced the benefits to crops, but the legume hay then provided a viable substitute for the high-cost feed concentrates that are typically fed by dairy and beef-finishing farmers.

The projects also delivered a new version of the CERES–Maize crop model to predict maize yields and improved understanding of the sequence of adoption of innovative management practices and the priorities in allocation of household income.

68 Ibid.

69 Ibid.

The capacity of African researchers was also built through formal training in Australian universities and collaboration with Australian researchers in projects EFS/1983/026, LWR2/1987/035 and AS2/1996/149.

Adoption

Despite the significant achievements of these projects in terms of delivery of outputs, in the project material reviewed there was little evidence of adoption of better farming practices by farmers.

The external reviewers of LWR2/1987/035 noted that there remained a need for an enhanced extension effort to transfer the findings to the farmers and incorporate the results in improved farming systems.

The final report for AS2/1996/149 noted that while there was some adoption, widespread and persistent adoption of better farming practices was not expected. The farmers targeted were among the poorest in the region and unlikely to be able to invest in significant inputs into their cropping systems.[70]

Outcomes

There was no evidence of significant tangible outcomes in the material reviewed.

[70] ACIAR project AS2/1996/149, final report; available from ACIAR on request

9 Cropping systems and economics

Background

In 2010, a four-year program, 'Sustainable intensification of maize–legume cropping systems for food security in eastern and southern Africa (SIMLESA)' (ACIAR project CSE/2009/024), started in multiple countries across Africa, including Ethiopia, Kenya, Malawi, Mozambique, the Republic of South Africa, Tanzania and Uganda.

The aim of this program is to improve farm-level food security, incomes and productivity at household and regional levels, through the development of more-resilient, profitable and sustainable maize-based farming systems.[71] The program focuses on arid and semi-arid farming systems and places an emphasis on capacity building and training (ACIAR 2010).

The total funding for this program in real terms is $20.42 million, much greater than the average funding provided to individual projects.

Outputs

Intended outputs include improved knowledge and understanding of the socioeconomic and agroecological profile of maize–legume farming systems, resource use, maize and legume input and output markets and value chains—including chain constraints and opportunities, and costs and pricing patterns associated with the 10 farming systems studied.

From the additional knowledge about farming systems it is intended that effective adoption and impact pathways will be developed and that options for systems intensification and diversification that reduce risk will be identified.

Stress-tolerant maize varieties and higher yielding legume varieties will be made available to farmers in selected farming systems, and a regional nursery will be developed to further improve maize and legume varieties and hybrids.

Capacity outputs may include skills in simulation model utilisation and participatory evaluation, cropping systems management research, and the principles and practice of conservation agriculture. Capacity will also be built in terms of training new plant breeders and modellers. An example of the latter will be application of APSIM models to farming systems in relation to climate change, to inform decision-makers about adaptive strategies.

Adoption

No evidence of adoption has been documented because this project is currently under way, with an expected completion date of 2013.

71 SIMLESA—Sustainable intensification of maize-legume cropping systems for food security in eastern and southern Africa—information leaflet 'SIMLESA FS Final_150312.pdf'; available from ACIAR on request

Outcomes

The program is intended to have a local impact within the initial lifespan of the program itself (4 years) and is expected to have significant community impact within a 10-year time frame.[72]

The intended outcome is to sustainably increase the productivity of maize–legume systems in eastern and southern Africa with a target of increasing productivity by 30% and decreasing yield risk by 30% within 10 years in the target regions. [73] No evidence of outcomes from this program has been documented do date.

72 Ibid.

73 Ibid.

10 Other projects

Background

Two projects focused on human health—CS2/1990/007, 'Cassava cyanide: improved techniques for estimation and influence of environment on concentration', and an associated smaller project, CP/1994/126, 'Cassava safety: development and evaluation of simple tests of the cyanogenic potential of cassava flour and cassava tubers'.

The aim of these projects was to develop a simple semiquantitative screening method suitable for cassava flour and to measure the cyanide risk in bread made with cassava flour. A simple yet efficient screening technique for cyanide content of cassava can reduce the negative human health impacts from consumption of cassava.

While there was no evidence of adoption for the initial project CS2/1990/007 there was adoption by next users of outputs from project CP/1994/126 (Table 9).

Outputs

Key outputs in increased scientific knowledge included:

- progress in understanding the factors affecting cyanogenesis in cassava
- elucidation of a broad relationship between bitterness or sweetness and cyanide potential, but with potentially dangerous exceptions.

Among additional outputs were development of improved or new techniques including:

- a simple method for screening cassava genotypes for cyanide potential
- improved techniques for analysing cyanide and the major carotenoids in cassava
- identification of cassava cultivars that have low hydrogen cyanide potential (Lubulwa 1995)
- a general method for determination of total cyanide in all cyanogenic plants, and development of strategies to eliminate konzo disease.[74]

A key output was the contribution to the low-cyanide cassava germplasm bank of the International Institute of Tropical Agriculture in Nigeria.

Project CP/1994/126 delivered several kits to test different cassava materials and other plants. The kits have been used successfully to determine total cyanide in cassava roots, in cassava products such as flour, in leaves of various cyanide-containing plants, including sorghum, in bamboo shoots and in flax seed meal. An additional kit was also developed to measure thiocyanate in human urine.

Adoption

At the time of writing the economic evaluation, new cassava varieties had not been developed in project CS2/1990/007, but it was expected that low-cyanide cultivars would be introduced over the next 10–15 years. The economic evaluation stated that, if these new cultivars were not developed over the next 10–15 years, then the human health benefits from the project would

[74] ACIAR project CSE/1994/126, final report; available from ACIAR on request

Table 9. Evidence of adoption of outputs of reviewed Australian Centre for International Agricultural Research (ACIAR) 'other' projects in Africa

Code	Name	Evidence of adoption		Adoption unlikely	Insufficient evidence
		next users	final users		
CS2/1990/007	Cassava cyanide: improved techniques for estimation and influence of environment on concentration				
CP/1994/126	Cassava safety: development and evaluation of simple tests of the cyanogenic potential of cassava flour and cassava tubers				

Source: Centre for International Economics, based on documents provided by ACIAR

be zero and the internal rate of return of the project would be negative (Lubulwa 1995).

Project CP/1994/126 supplied free kits to more than 100 health workers and agriculturalists in developing countries and demand for the kits increased steadily over the life of the project to a level of about 100 kits per year.

Outcomes

The economic evaluation reported that there would be lasting economic impacts in Africa if the new varieties with very low levels of cyanogenic glucosides were introduced into areas affected by cassava toxicity (Lubulwa 1995).

However, it was not clear from project documents for either project (CS2/1990/007 and CP/1994/126) whether impacts and outcomes occurred.

11 Key findings

The success of ACIAR-funded R&D in Africa in delivering benefits to smallholders has been mixed. In this chapter we summarise some key findings from the desk review of ACIAR's projects in Africa.

Projects were generally successful in delivering outputs

ACIAR-funded projects were mostly successful in delivering outputs. The types of outputs delivered included:

- capacity—covering contributions to the stock of scientific knowledge, building the understanding and skills of IARCs and NARES and the individuals within them, as well as farmers (ACIAR 2012).
- technologies—covering:
  - models and frameworks to guide decision-making, including the agricultural production simulation model (APSIM), computer models to estimate patterns of tick-borne diseases and their costs, validation of the GRASP pasture model in Zimbabwe and an improved seasonal climate forecast scheme
  - new products and systems to improve production, including development of vaccines for tick-borne diseases and Newcastle disease, tick-resistance diagnostic testing, low-dose fertiliser systems, selection of Australian trees suitable for reforestation and agroforestry, low-input fertiliser strategies for crops, improved nursery and breeding techniques, new scientific methods using the heat-pulse method for measuring redistribution of water in root systems, and identification of annual and perennial legume species suitable for arable lands.
- Policy—there were instances of new policies being developed as a result of the ACIAR-funded research.

Capacity outputs

Most projects delivered intermediate outputs, by contributing to the stock of scientific knowledge on various challenges facing agriculture in Africa. However, there were a number of cases where research trials were inconclusive. While inconclusive trials are a normal part of scientific research, on some occasions in the projects considered here they were due to poor scientific practices. This was particularly the case where the trials were primarily undertaken by African partners. A key problem appeared to be overestimation of the capacity of African partners, including those in IARCs and NARES. This was noted in the review report for project FST/1983/057 as a key limitation, particularly because local scientists in the collaborating institution in Zimbabwe did not have the necessary experience in microbiology required for the project. This limitation may have been exacerbated by insufficient visits by Australian scientists to supervise at critical stages of experimentation, which raises a question about the effectiveness of the fly-in, fly-out model, particularly where the research focus is new ground.

There were also instances where political and environmental factors affected the outputs delivered. For example, one project (SMCN/2001/028) was constrained because of drought in Zimbabwe and floods in Malawi which forced NGOs to move their agenda into providing food aid and emergency supplies, rather than working on rural development programs.[75]

[75] ACIAR project SMCN/2001/028, review report (p. 27); available from ACIAR on request

Documents for most projects refer to ACIAR-funded projects enhancing the capacity of African partners, both at the organisational and individual level. This occurred through formal training, as well as through collaborative research with Australian partners.

In a number of cases, efforts to build institutional capacity within partner agencies appear to have been successful. One example is that of a number of ACIAR projects developing the capacity of the Central Veterinary Laboratory in Zimbabwe to make effective vaccines for tick-borne diseases.

In some instances, however, capacity-building efforts were less successful. In particular, efforts to build agricultural system modelling capacity within IARCs and NARES through a series of grants appear to have had limited success. The only adoption study on this cluster of projects noted that this may have been due to:

- lack of underlying skills
- the long time taken to learn new techniques
- high turnover of personnel.

System modelling is a highly specialised area of research. The lack of experience with it in Africa raises the question of whether ACIAR's general approach of flying-in researchers for short periods is conducive to building capacity in such a specialised area of research. One project realised that a focus on detailed science and modelling may not be the most fruitful approach, and instead focused on socioeconomic factors conducive to achieving better adoption and outcomes.

Technologies

ACIAR-funded research delivered a number of tools to guide decision-making. In particular, a number of ACIAR grants focused on adapting the APSIM model used in Australia to African conditions. Significant progress was made in this area. However, a number of project reviews raised some questions over the validity of the model simulations. Other tools delivered included computerised tick models and the TICKCOST spreadsheet model.

A limited number of projects developed final outputs in the form of new technologies that could be adopted by farmers. These included:

- vaccines for tick-borne diseases
- vaccines for Newcastle disease
- low-dose fertiliser schedules
- Australian species suitable for reforestation and agroforestry
- annual and perennial legume species suitable for arable lands
- software for genetic analysis of hybrid populations
- prototypes of low-technology portable propagation systems
- eucalypt hybrids for marginal lands
- conservation agriculture technologies
- farm risk-management strategies
- diagnostic DNA sequences.

Policy outputs

There were also a number of policy outputs, including a draft National Diagnostic Standard for the *P. psidii* pathogen and a new policy for tick management.

Adoption was mixed

The evidence reviewed suggests that adoption of the outputs delivered by ACIAR-funded research was mixed.

Since there were relatively few impact assessments or adoption studies, the information on adoption was limited in many cases. We encountered two impact assessments, covering eight projects in total. One covered three projects relating to ticks and tick-borne diseases (Lubulwa and Hargreaves 1996), while the other covered five projects relating to the shortage of fuelwood and wood for construction (Lubulwa et al. 1995). While both of these impact assessments found the ACIAR-funded research would deliver a solid return on investment, they were both effectively ex-ante assessments; nearly all adoption was expected to occur in the future. It is not clear whether the expected adoption rates were ultimately realised. The political tension in Zimbabwe—where most of the benefits to Africa were expected to accrue—during the first years of the century raises some doubt on this in the case of the tick-related projects.

Despite the lack of adoption studies and ex-ante impact assessments, there was nevertheless some evidence of adoption of outputs by next and final users. Projects that engaged final users in the research tended to report significant levels of adoption. Projects using this 'participatory approach' included the cluster of projects relating to livestock production systems (LPS/1999/036, LPS/2002/081 and LPS/2008/013) and maize farm-system modelling (SMCN/2001/028). There was also evidence of adoption spreading, through farmer-to-farmer contact, beyond those farmers who participated in the project.

Other projects that achieved significant levels of adoption also tended to have clear strategies for disseminating final outputs to final users, sometimes including research into ways to maximise uptake as part of the project. Examples include research into the best way to deliver the tick-borne disease vaccines (AS2/1999/063) and Newcastle disease vaccines (AS1/1995/040 and AS1/1996/096), and the packaging of fertiliser in small packets (SMCN/2000/173).

It should be noted that the low-dose fertiliser recommendations appear to have been adopted by both next users, such as government officials and suppliers, as well as farmers. This was despite a lack of sound scientific evidence to support the recommendation.[76] In general, this should be avoided. Recommendations emerging from ACIAR projects should be based on sound scientific evidence.

As there were few adoption studies and ex-ante impact assessments, in many cases it was not possible to make any assessment about adoption. However, in other cases, adoption by final users seemed unlikely, based on the evidence reviewed. This included projects that did not deliver any outputs that could be adopted by final users, and projects that did not appear to have any clear strategy to disseminate project outputs to final users. This observation particularly relates to earlier ACIAR projects.

Projects that did not seem to have a clear dissemination strategy included some of the computer-modelling projects (LWR2/1996/049, LWR2/1997/038, SMCN/1999/003, SMCN/1999/004) and some of the forestry projects (FST/1996/124, FST/1988/008, FST/1988/009, FST/1991/026 and FST/2003/002). These projects seemed to focus excessively on research and not enough on development.

A number of projects contributed to a broader international research effort on important issues. These projects often contributed to the stock of knowledge, but did not develop any final outputs that could be adopted by farmers or other final users. Where subsequent research builds on the findings of ACIAR-funded research to develop some final outputs that deliver benefits to farmers, some of these benefits could be attributed to ACIAR. However, there was insufficient information available to trace these benefits.

There have also been instances where policy and socioeconomic factors have constrained adoption. Limitations caused by the Land Redistribution for Agricultural Development scheme were mentioned for many projects in South Africa. It was noted the scheme creates barriers to landholders increasing land size, and reduces certainty for investments. In another project, economic constraints restricted the fertiliser available for the experiments, which limited the robustness of the results, while for other projects, adoption by farmers was considered unlikely because they were too poor to invest in the inputs required (AS2/1996/149). These experiences highlight the importance of full consideration of socioeconomic factors in both developing solutions and disseminating them to final users.

Summary of findings and lessons for the future

The key findings from this review of ACIAR-funded research in Africa and some lessons for the future are summarised below.

- Evidence on adoption was limited—there have been relatively few ex-post impact assessments or adoption studies on African projects.
  - More ex-post impact assessments would help ACIAR to understand the impacts of its projects in Africa and guide future investments.
- Projects tended to have greater success in having outputs adopted by final users where:
  - final users were engaged in the research

  and/or
  - there was a clear dissemination strategy, including research into the most effective way of delivering outputs to final users.

[76] ACIAR project SMCN/2000/173, review report; available from ACIAR on request

- A number of projects are unlikely to have delivered any benefits to Africa in the near to medium term. Reasons for this include:
  - failure to deliver any final outputs that could be adopted by final users
  - lack of a clear dissemination strategy
  - inadequate consideration of socioeconomic factors in developing solutions and disseminating them to farmers.
- Some projects overestimated the capacity of African partners—there were a number of instances where projects were compromised by a lack of capacity of African partners.
  - This suggests that Australian researchers should investigate the capacity of the African partners and fill any gaps before research trials commence, and maintain close contact during the course of research trials.
- Efforts to build capacity through ACIAR-funded research were mixed—most projects included some capacity-building elements, but there was little follow-up to test how effective this had been. It seems likely that African researchers enhanced existing skills through formal training activities and working with Australian researchers. However, efforts to build new skills were not always successful. The series of projects aimed at building modelling capacity in partner institutions appears to have had limited success.
  - High staff turnover rates were a common factor limiting the effectiveness of any capacity-building efforts.
  - ACIAR should be realistic about how much capacity can be built through short-term training and limited exposure to Australian scientists.
  - Highly specialised new skills should be developed through longer term training or extended periods working with Australian scientists.

Appendix
Project summaries

Animal health

Ecology and epidemiology of ticks and tick-borne diseases in Sub-Saharan Africa

- AS1/1983/003

Commissioned organisation

- CSIRO Division of Animal Health (Australia)

African and Australian collaborators

- Ministry of Agriculture and Livestock (Burundi), Kenya Agricultural Research Institute (Kenya), Banda Agricultural College of the University of Malawi (Malawi), Veterinary Research Laboratory (Zambia), Veterinary Research Laboratory (Zimbabwe), FAO DANIDA project, International Laboratory for Research on Animal Diseases (Kenya) and International Centre of Insect Physiology and Ecology (ICIPE)

Budget and timing

- $298,282
- July 1983 to June 1986

Outputs

- Increased scientific knowledge in the following areas:
  - ecology of the main tick species in eastern and southern Africa
  - the effectiveness of different management strategies
  - the effects of the main tick species on milk production
  - relative resistance to one tick disease of different breeds of cattle.
- Computer modelling tool that enabled each country (and possibly each farmer) to choose the optimal tick control strategy
- Enhanced capacity of African partners to undertake further research through:
  - development of a computerised database
  - training in experimental design and analysis techniques.

Adoption

- Impact assessment suggested adoption was likely, although it is unclear if this was sustained.

Outcomes

- Change in tick control strategies — shift in the dipping practices from the intensive weekly dipping practices to less frequent, but strategic dipping.
- Policy change — the Animal Health Cleansing Regulations in Zimbabwe were changed in 1993 so that dipping is required in only those cases where cattle are tick-infested. Previously, cattle owners were required to dip every week irrespective of tick challenges (Impact assessment, p.17).
- The impact assessment estimated that the project is likely to generate a NPV of around $1.8 million over

a period of 30 years at a discount rate of 8%. The internal rate of return is estimated at around 26% (Impact assessment, p.18).

Information availability

- Impact assessment
- Review

Source

- Centre for International Economics, based on documents provided by ACIAR

Genetic variation, resistance to acaricides and immunological cross-reactivity in ticks that infest cattle in Zimbabwe and Australia

- AS2/1990/047

Commissioned organisation

- University of Queensland

African and Australian collaborators

- Veterinary Research Laboratory (Zimbabwe)

Budget and timing

- $890,438
- July 1993 to June 1999

Outputs

- New scientific knowledge:
  - Antigens which have been shown to protect cattle against tick infestation are conserved across several genera of ticks which cause economic loss in Australia and Africa, suggesting that a generic tick vaccine targeted to conserved gut antigens, effective against several genera, may be feasible.
  - Preliminary results suggest that there is a mutation in the AC gene from resistant ticks that could be responsible for determining OP resistance.
  - Results suggest there is still potential for the use of acaricides in Zimbabwe.
- New scientific methods:
  - genetic assay kit for identifying resistant genes developed
  - DNA based methods for typing tick species and strains developed.

Adoption

- Impact assessment considered adoption likely.

Outcomes

- The genetic assay kit is considered likely to contribute to better management of the spread of tick strains resistant to acaricides.
- Net benefits were estimated at $11.21 million (in 1990 dollars) at a discount rate of 8% over 30 years (Impact assessment, p. 46). The internal rate of return was estimated at 33%.

Information availability

- Impact assessment
- Project proposal
- Project review
- Annual reports

Source

- Centre for International Economics, based on documents provided by ACIAR

Improved methods for the diagnosis and control of bovine babesiosis and anaplasmosis in Zimbabwe and Australia

- AS2/1991/018

Commissioned organisation

- Queensland Department of Primary Industries and Fisheries

African and Australian collaborators

- Veterinary Research Laboratory (Zimbabwe)

Budget and timing

- $735,149
- January 1993 to December 1996

Outputs

- Developed and tested, in the laboratory and field, new high-quality vaccines against *Babesia bigemina* and *Anaplasma marginale* in Zimbabwe and methods for their production and quality control.
- Built capacity of Zimbabwe's Veterinary Research Laboratory to produce frozen vaccines against tick-borne diseases, including quality control protocols.

- New diagnostic tools:
  - molecular markers that allow scientists to distinguish between strains (within species) of *Babesia*
  - new diagnostic tests for epidemiological studies in Australia and for screening of export animals in accordance with requirements of Australia's trading.

Adoption

- Impact assessment considered adoption likely.

Outcomes

- Use of vaccines and diagnostic tools.
- The impact assessment estimated that the project delivered a net benefit of $33.76 million (including benefits of $23.78 million to Zimbabwe and $11.47 million to Australia) in 1990 dollars, using a discount rate of 8%. The internal rate of return was estimated at 40%.

Information availability

- 600-word summary
- Impact assessment

Source

- Centre for International Economics, based on documents provided by ACIAR

Validation of the Australian model of the tick, *Rhipicephalus appendiculatus*, in Kenya and investigation of its use to facilitate collaboration with NARs

- AS2/1996/014

Commissioned organisation

- International Centre of Insect Physiology and Ecology (Kenya)

African and Australian collaborators

- Kenya Agricultural Research Institute, CRC for Tropical Pest Management (Australia)

Budget and timing

- $145,000
- January 1997 to June 1998

Outputs

- Enhanced the capacity of the Kenya Agricultural Research Institute to manage and control ticks through adapting the Australian computer model to the major African tick vector species (*Rhipicephalus appendiculatus*).
- Training courses for six African countries on the use of computer models.

Adoption

- There is evidence of adoption.

Outcomes

- Computer models were used to identify risks from the spread of ticks and tick-borne diseases, and for designing and communicating policy options to policymakers, extension officers and farmers.

Information availability

- 100-word summary

Source

- Centre for International Economics, based on documents provided by ACIAR

Estimation of the cost of tick-borne disease to livestock in Africa, Asia and Australia

- IAP/1996/181

Commissioned organisation

- International Livestock Research Institute (Kenya)

African and Australian collaborators

- Department of Veterinary Services (Zimbabwe)
- Queensland Department of Primary Industries (Australia)
- eSYS Development (Australia)

Budget and timing

- $138,900
- July 1997 to June 1999

Outputs

- Improved knowledge of the cost of tick-borne diseases in different regions.

- A tool for estimating the economic costs of tick-borne diseases in various countries and regions — the TICKCOST spreadsheet model — was developed.

Adoption

- The information has been used by ILRI scientists writing research proposals for new research in tick-borne diseases in Asia and Africa.

Outcomes

- Not clear whether this has changed any resource allocation decisions.

Information availability

- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Tick-borne diseases: delivery of user-friendly and effective vaccine and diagnostics

- AS2/1999/063

Commissioned organisation

- Queensland Department of Primary Industries and Fisheries

African and Australian collaborators

- Department of Veterinary Sciences, Central Veterinary Laboratory (Zimbabwe)

Budget and timing

- $670,129
- July 2001 to December 2004

Outputs

- Developed a 'Dawn' strain of *Anaplasma marginale* in Australia to meet the need for a more effective live vaccine against anaplasmosis.
  - Demonstrated that the simultaneous use of three key vaccines (Bolvac (against *Theileria*), *Babesia* and *Anaplasma*) is safe and effective.
- The preferred packaging, shelf life and methods of distribution of frozen vaccines were identified through surveys in Queensland and Zimbabwe.
- New cryopreservation techniques:
  - developed a simple and effective technique, using a flow cytometer to count living and dead parasites to assess the viability of vaccine parasites following cryopreservation and thawing
  - developed a model system using mice and *Babesia microti* to evaluate various combinations of cryoprotectants and vaccine diluents, to surmount the difficulty and expense involved in conducting trials with cattle.
- New knowledge relating to cryopreservation:
  - glycerol and DMSO (dimethyl sulphoxide) were found to be the best cryoprotectants
  - the research team demonstrated that the vaccine could be stored short-term at –70 degrees C (i.e. on dry ice) for a maximum of 6 months.
- Built (or sustained) the capacity of the Central Veterinary Laboratory in Zimbabwe to produce vaccines effective against *Theileria*, *Babesia* and *Anaplasma*.

Adoption

- There is evidence of adoption.

Outcomes

- The *Babesia* and *Anaplasma* vaccines are now in use concurrently with the *Theileria* vaccines in regional offices around Zimbabwe. Reports from field veterinarians at the end-of-project meeting in Harare were all positive, and trials to test inclusion of heartwater vaccine are planned for the near future.
- In Zimbabwe, the Dawn strain will be used as an alternative vaccine to *A. centrale*, and trials to develop and evaluate a vaccine based on a local *A. marginale* are planned.

Information availability

- Project document
- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Bovine babesiosis and anaplasmosis: studies on field performance of live vaccines, diagnostic methods and host responses to infection

- AS2/1996/090

Commissioned organisation

- Queensland Department of Primary Industries

African and Australian collaborators

- Department of Veterinary Services (Zimbabwe)
- Australian Volunteers International (Australia)
- Monash University (Australia)

Budget and timing

- $1,114,991
- January 1997 to December 2000

Outputs

- Built the capacity of Zimbabwe's Central Veterinary Laboratory (CVL) to develop sustainable, effective methods for quality assurance, delivery and field monitoring of the vaccines.
  - Full quality-assurance procedures and techniques for *Babesia* and *Anaplasma* vaccine production have been transferred and applied at CVL.
- Developed new diagnostic tests:
  - developed ELISA tests for detecting antibodies to *B. bovis* and *B. bigemina* and *Anaplasma*
  - an assay developed during the project extension enables researchers to differentiate between the Australian vaccine strain and African field isolates of *B. bigemia*
  - developed specific and sensitive techniques for differentiating species and strains of *Anaplasma*.

Adoption

- There is evidence of adoption.

Outcomes

- Capacity built through project is being used:
  - Capacity built through the project is being used in other tick-borne disease vaccine production.
  - ELISA tests are now in routine use for epidemiological studies to identify the need for vaccination and inform producers in Australia and Zimbabwe. The tests are also available for institutions in Kenya, Tanzania and Mozambique.
  - The assay developed during the project is being used in Zimbabwe to investigate and confirm reported cases of vaccine failure or severe vaccine reactions.
  - An ELISA test to detect the presence of *A. centrale* has been successfully used to confirm vaccination in vaccine breakdown investigations in Australia. It has also been incorporated as a critical component of the import testing protocol for live Australian cattle destined for Mexico and is currently being evaluated for use in Israel.

Information availability

- 600-word summary
- Project proposal

Source

- Centre for International Economics, based on documents provided by ACIAR

Studies on genetic constraints to protective immunity in cattle

- AS2/1996/203

Commissioned organisation

- International Livestock Research Institute (Kenya)

African and Australian collaborators

- Animal Disease Research Institute (Tanzania), Onderstepoort Veterinary Laboratory (South Africa), National Veterinary Research Centre (Kenya), Department of Veterinary Services (Zimbabwe), Queensland Department of Primary Industries

Budget and timing

- $104,505
- July 1997 to June 1999

Outputs

- Improved understanding of immunogenetic influences on the outcome of vaccination in cattle vaccinated with live babesia strain.
- New diagnostic capacity:
  - developed more-effective diagnostic tests for *Babesia bigemina*
  - capacity to differentiate *Anaplasma* species and strains through transfer of DNAbased protocols developed in Australia to ILRI for future applications in Africa

Adoption

- Insufficient evidence to make an assessment on adoption.

Outcomes

- No outcomes are reported in documents available.

Information availability

- 100-word summary
- Project proposal

Source

- Centre for International Economics, based on documents provided by ACIAR

Newcastle disease projects

Production of a seed culture of heat resistant Newcastle disease virus suitable for producing in developing countries

- AS1/1995/040

Investigations into the control of Newcastle disease in village chickens in Mozambique

- AS1/1996/096

Commissioned organisation

- University of Queensland, Department of Veterinary Pathology, Australia

African and Australian collaborators

- National Veterinary Research Institute, Vaccine Production Department, Mozambique

Budget and timing

- $166,867 (AS1/1995/040), then $1,069,237 (AS1/1996/096)
- July 1993 to December 1996 (AS1/1995/040) and July 1996 to December 2001 (AS1/1996/096)

Outputs

- Effective vaccine produced.
- Identified most effective way to administer vaccine in the field — eye-drop administration of the vaccine gave the best results, yielding the greatest increase in flock size and was the approach preferred by farmers.
- Built the capacity of Mozambique researchers in vaccine production and quality control through training researchers.

Adoption

- Evidence of adoption:
  - peak production of the vaccine of 2 million doses in 1999–2000
  - Tanzania is already producing I-2 vaccine and is undertaking field trials in the districts of the seven Veterinary Investigation Centres.

Outcomes

- Village chicken flocks being vaccinated for Newcastle disease.
- Effective vaccination resulted in greatly increased numbers of chickens in village flocks.

Information availability

- 100-word summary (AS1/1995/040)
- 600-word summary (AS1/1996/096)
- Final report (AS1/1996/096)

Source

- Centre for International Economics, based on documents provided by ACIAR

Development of phenotypic markers for resistance to gastrointestinal nematodes in African small ruminants

- AS2/1993/724

Commissioned organisation

- International Livestock Research Institute (KARI), Kenya

African and Australian collaborators

- Kenya Agricultural Research Institute, Kenya
- CSIRO Division of Animal Health, Australia

Budget and timing

- $114,974
- April 1993 to December 1995

Outputs

- Despite a setback with the outbreak of disease and subsequent loss of lambs, progress was made towards developing immunological assays and procedures.
- Capacity built—funding was provided for a KARI scientist to visit Australia to broaden her skills base.

Adoption

- Insufficient evidence on adoption

Outcomes

- No outcomes reported in documents available

Information availability

- 100-word summary

Source

- Centre for International Economics, based on documents provided by ACIAR

Animal nutrition

Isolation and characterisation of micro-organisms from non-domesticated browsing ruminants in Africa capable of improving the utilisation of tannin-containing shrub legumes

- AS1/1995/111

Commissioned organisation

- International Livestock Research Institute, DebreZeit Research Station, Ethiopia

African and Australian collaborators

- University of Adelaide, Australia
- CSIRO Tropical Agriculture, Australia

Budget and timing

- $138,360
- January 1996 to December 1997

Outputs

- New scientific knowledge:
  - results suggested that free-ranging indigenous domestic ruminants may have developed rumen microbial populations capable of tolerating or degrading tannin-containing feeds
  - *Acacia angustissima* may contain not only tannin but also other poisonous compounds inhibiting the growth of most rumen micro-organisms.

Adoption

- Insufficient evidence on adoption.

Outcomes

- No outcomes reported in project documents available. ACIAR review noted that reports provided insufficient information.

Information availability

- 100-word summary
- ACIAR review

Source

- Centre for International Economics, based on documents provided by ACIAR

Managing the rumen ecosystem to improve utilisation of thornless acacias

- (AS1/1998/010)

Commissioned organisation

- International Livestock Research Institute, Debre Zeit Research Station, Ethiopia

African and Australian collaborators

- University of Zimbabwe, Zimbabwe
- Animal Nutrition and Animal Products Institute, South Africa
- International Livestock Research Institute (ILRI), Kenya
- CSIRO Livestock Industries, Australia

Budget and timing

- $841,360
- January 1999 to June 2002

Outputs

- New scientific knowledge including:
  - phytochemistry of *Acacia angustissima*
  - understanding the importance of interactions among antinutritional factors in forages
  - knowledge of the metabolism of non-protein amino acids
  - the effect of microbial inoculation and PEG in alleviation of tannin toxicity in ruminants
  - taxonomy of *Acacia angustissima*
  - toxicology of ADAB and DABA in rats, sheep, chickens and rabbits
  - mechanisms of tannin tolerance in *Streptococcus bovis* and *S. gallolyticus*
  - identification of low molecular weight flavanol glycosides as potential toxins
  - development of molecular ecology tools for determining the populations of bacteria responsible for degrading toxins is also well advanced and a collection of micro-organisms has been made from enrichments on *A. angustissima*.
- Development of analytical procedures for identifying toxins.
- Built capacity of ILRI to undertake rumen ecology research.

Adoption

- Adoption considered unlikely.

Outcomes

- The evaluation of the final project report by the ACIAR project manager noted that the outputs of the project are of value to the research arena, but have not resulted in any practical outcomes.
- Impacts for rural communities were not expected in the 5 years following the end of the project.

Information availability

- 600-word summary
- Final report
- Evaluation of final report by research program manager

Source

- Centre for International Economics, based on documents provided by ACIAR

Development and use of molecular genetic markets for enhancing the feeding value of cereal crop residues for ruminants

- AS2/1997/098

Commissioned organisation

- International Livestock Research Institute, India

African and Australian collaborators

- Tunisian National Institute for Agricultural Research (INRAT), Tunisia
- International Livestock Research Institute, Kenya
- National Research Institute for Agriculture, Morocco
- Agriculture Victoria, Australia
- La Trobe University, Australia
- Cooperative Research Centre for Molecular Plant Breeding, Australia

Budget and timing

- $150,000
- July 1998 to June 2000

Outputs

- Increase in scientific knowledge:
  - The project demonstrated that for three of the commodities—barley, pearl millet and perennial ryegrass— there is a linkage between molecular markers and digestibility traits.
  - For *Brachiara* grasses, variability in digestibility within the mapping population was demonstrated.

Adoption

- Insufficient evidence on adoption

Outcomes

- No outcomes were documented.

Information availability

- 100-word summary
- Termination report

Source

- Centre for International Economics, based on documents provided by ACIAR

Forestry

Australian hardwoods for fuelwood and agroforestry

- Phase I — FST/1983/020 and FST/1983/031
- Phase II — FST/1988/008 and FST/1988/009

Commissioned organisation

- CSIRO Division of Forestry and Forest Products, Australia (FST/1988/008)
- Queensland Department of Forestry, Australia (FST/1988/009 and FST/1983/020)

African and Australian collaborators

- Zimbabwe Forestry Commission, Zimbabwe (FST/1988/008 and FST/1983/020)
- Kenya Forest Research Institute, Kenya (FST/1988/008 and FST/1983/020)

Budget and timing

- $394,000—27/12/1984 to 30/06/1988 (FST/1983/031)
- $976,500—01/01/85 to 30/04/89 (FST/1983/020)
- $1,292,450—01/07/88 to 31/12/91 (FST/1988/008)
- $424,555—01/07/88 to 30/06/92 (FST/1988/009)

Outputs

Outputs from Phase I — FST/1983/020 and FST/1983/031— include capacity building and increased scientific knowledge:

- on the suitability of nitrogen-fixing exotics for afforestation in communal lands
- about the growth rate of nitrogen-fixing exotics relative to indigenous species
- on the potential of nitrogen-fixing exotics for afforestation in communal lands.

Outputs from Phase II — FST/1988/008 and FST/1988/009 — include capacity building and increased scientific knowledge on:

- identifying promising acacia, eucalyptus, casuarina and grevillea species for afforestation in Africa
- key species with potential to increase the supply of wood for construction in both Zimbabwe and Kenya
- the lesser-known Australian tree and shrub species and on requirements for their domestication in harsher environments in Sub-Saharan Africa and South-East Asia.

Adoption

It is expected that lesser-known Australian species will be used in rural afforestation, most likely for establishment of woodlots by individuals.

Adoption was limited because of low availability of the lesser-known Australian tree species in nurseries that supply planting materials to smallholders.

Outcomes

The primary intended outcomes were to change the unit cost to produce fuelwood, to enable provision of essential tree products to people living on peasant farms, to reduce pressure on indigenous forest in communal lands and to rehabilitate degraded land.

An economic evaluation assumed adoption and estimated the net present value of this research to be $27.3 million.

Evidence of outcomes was not documented.

Information availability

- 600-word summary
- Lubulwa et al. (1995)

Source

- Centre for International Economics, based on documents provided by ACIAR

Casuarina for fuelwood and nitrogen fixation

- FST/1983/057

Commissioned organisation

- CSIRO Division of Soils, Australia

African and Australian collaborators

- Zimbabwe Forestry Commission, Zimbabwe

Budget and timing

- $533,544
- 13/08/84 to 31/12/87

Outputs

Outputs included progress in producing *Frankia* inoculants in liquid cultures using chemically defined media and techniques to isolate *Frankia* strains from nodules. The research also increased scientific knowledge on:

- using isolates to achieve reproducible results
- the importance of adequate levels of phosphorus for *Frankia* to function effectively.

Adoption

Adoption was limited because after completion of the 3-year project period there was still a lack of information necessary to successfully exploit this symbiosis. No evidence of adoption was documented.

Outcomes

- Evidence of outcomes achieved was not documented.

Information availability

- Economic evaluation study
- 100-word summary
- Lubulwa et al. (1995)

Source

- Centre for International Economics, based on documents provided by ACIAR

Improvement in tree establishment for tropical dryland conditions in east Africa

- FST/1991/026

Commissioned organisation

- Queensland Forest Research Institute, Australia

African and Australian collaborators

- Kenya Forest Research Institute, ASALS Division, Kenya
- Zimbabwe Forestry Commission
- Roslin Institute, Edinburgh, Scotland
- University of Queensland, Department of Agriculture, Australia
- Australian National University, Department of Forestry, Australia

Budget and timing

- $1,014,871
- 01/01/93 to 30/06/98

Outputs

- Increased scientific knowledge on nursery techniques; for example, improved nursery techniques for seedling development

Adoption

- Evidence of adoption by next and final users was not documented.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- Review of review report FST/91/26 (July 1996)
- Report prepared for the review of ACIAR project 9126 (February 1996)

Source

- Centre for International Economics, based on documents provided by ACIAR

High-performance eucalypts and interspecific hybrids for marginal lands in south and eastern South Africa and south-eastern Australia

- FST/1996/124

Commissioned organisation

- Australian National University, Department of Forestry, Australia

African and Australian collaborators

- CSIR Environmentek, South Africa
- CSIRO Forestry and Forest Products, Australia
- Stellenbosch University, South Africa
- State Forests of New South Wales, Australia

Budget and timing

- $1,024,637
- 01/07/2002 to 31/03/2007

Outputs

Technical outputs included:

- software for genetic analysis of hybrid populations
- three prototypes of low-technology portable propagation systems suitable for use by community-based or small-scale enterprises.
  - Outputs also included increased scientific and genetic knowledge:
  - on suitable eucalypt hybrids for marginal lands
  - reproductive biology.

Individual and organisational capacity was built in reproductive biology, and experience using software developed as part of the project.

Adoption

Agencies and organisations involved in breeding eucalypts in South Africa and Australia have adopted genetic knowledge output, for example:

- CSIRO and associated companies involved in tree improvements have adopted the genetic knowledge from the project in design and implementation of breeding strategies. It is expected the advanced breeds generated will be adopted by smallholders, but adoption by the final users had not occurred and was not expected for at least 5 years.
- Evidence of adoption by final users had not occurred at the time of writing the adoption study because of inherent time lags involved in biological testing and breeding experiments.
- Farmer-based tree planting in South Africa and Australia has not yet expanded in the marginal lands targeted by the project, and this has limited the immediate adoption of project outputs, although this is expected to change in the medium term.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- ACIAR 600-word summary
- ACIAR adoption Study (Kanowski and Verryn 2011)
- ACIAR annual report 2005–06 (ACIAR 2006)

Source

- Centre for International Economics, based on documents provided by ACIAR

Assessment of eucalyptus rust as a pathogen of *Eucalyptus* species and other Myrtaceae, and development of sensitive methods for its detection in germplasm

- FST/1996/206

Commissioned organisation

- CSIRO Forestry and Forest Products, Australia

African and Australian collaborators

- University of Pretoria, South Africa
- CSIRO Plant Industry, Australia

Budget and timing

- $598,373
- 01/07/2000 to 30/06/2003

Outputs

- Increased scientific knowledge of the pathogen *Puccinia psidii* and its threat to eucalypt and melaleuca plantations and species
- Draft pest risk analyses were incorporated into a national diagnostic standard of Plant Health Australia
- Increased scientific knowledge of host range—three races of *P. psidii* were identified
- Developed a draft National Diagnostic Standard for *P. psidii*
- Developed diagnostic DNA sequences.

Adoption

Evidence of adoption of research outputs was use of the diagnostic DNA sequences by CSIRO to test a consignment of wood from Brazil for AQIS.

Outcomes

The expected outcomes are economic and environmental benefits from preventing incursion of pathogen into Australia and other countries where Myrtaceae are present.

Information availability

- 600-word summary
- Adoption study

Source

- Centre for International Economics, based on documents provided by ACIAR

Development and evaluation of sterile triploids and polyploid breeding methodologies for commercial species in *Acacia* in Vietnam, South Africa and Australia

- FST/2003/002

Commissioned organisation

- University of Tasmania
- Cooperative Research Centre for Sustainable Production Forestry, Australia

African and Australian collaborators

- CSIRO Forest Biosciences, Australia
- CSIR Environmentek, South Africa
- Sylvatech Ltd, Australia
- University of Adelaide, Australia

Budget and timing

- $506,504
- 01/01/2004 to 30/06/2009

Outputs

- Increased scientific knowledge on breeding programs to manipulate ploidy to improve effectiveness
- Technical outputs included:
  - less time-consuming identification tools of ploidy from successful employment of near infrared spectrometry (NIR)
  - capacity outputs
  - individual and organisational level advances—e.g. developed organisational capacity at FSIC and CSIR to continue polyploidy breeding and associated technologies without direct support from Australian scientists.

Adoption

- Evidence of adoption by next and final users was not documented.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- Project final report 2009

Source

- Centre for International Economics, based on documents provided by ACIAR

Livestock production systems

Developing profitable beef business systems for previously disadvantaged farmers in South Africa

- LPS/1999/036

Commissioned organisation

- Cooperative Research Centre for the Cattle and Beef Industry, Australia

African and Australian collaborators

- Agricultural Research Council, South Africa
- Animal Improvement Institute, South Africa
- Animal Nutrition and Animal Products Institute, South Africa
- Meat and Livestock Australia/Livecorp Joint Program, Australia
- The Northern Pastoral Group of Companies, Australia

Budget and timing

- $1,451,916
- 01/07/2001 to 31/03/2008

Outputs

Outputs included improved knowledge about ability to commercialise beef from emerging and communal farmer herds:

- growth rates and feed efficiencies of steers from emerging and communal farmer herds paralleled those from commercial herds
- cattle from emerging and communal farmer herds have the ability to meet the specifications of South Africa's commercial beef markets
- better marketing strategies—use of on-farm auctions, enabling farmers to join together and pre-weigh their cattle, allowing them to negotiate close-to-market rates for larger numbers of animals
- built capacity of project's farmers with the knowledge and skills to market animals
- Also built capacity of project's extension staff, technical staff, scientists and managers.

Adoption

- At the end of the project, adoption had expanded to five new South African provinces as well as the initial Limpopo and North West provinces.
- Outputs were also adopted by the National African Farmers Union, which has developed a proposal to establish a new feedlot system based on cattle reared by resource-poor farmers. Members of the South African Feedlot Association have established buyers in the region.

Outcomes

The outcomes from the project include increased sale incomes and improved financial position and welfare of final users (emerging farmers).

Information availability

- 600-word summary
- Final report
- Review
- ACIAR annual report 2002–03 (ACIAR 2003)

Source

- Centre for International Economics, based on documents provided by ACIAR

Development of emerging farmer crop–livestock systems in northern RSA

- LPS/2002/081

Commissioned organisation

- CSIRO Sustainable Ecosystems, Australia

African and Australian collaborators

- Department of Agriculture, South Africa
- University of the North, South Africa
- University of Venda, South Africa
- Progress Milling, South Africa

- JodemsAgriPioneers, South Africa
- Bushveld Environmental Services, South Africa

Budget and timing

- $853,825
- 01/01/2005 to 31/12/2009

Outputs

Technical outputs included development of a prototype model—Limpopo Emerging Farmer Model (LEFarM) calibrated with data sourced from local agribusiness enterprises. Introduced practical and low-risk technologies and legume–crop livestock technologies.

Outputs also included improved knowledge of:

- transforming low-productivity maize-based farming systems into more-profitable enterprises by incorporating grain legume cash crops into rotations with maize
- identifying and implementing new systems to assist the 'emerging' farmer sector
- identified limitations to success in terms of farmers' skill, effectiveness of the extension services and constraints of land distribution policies
- capacity of farmers was built, with 70 new farmers learning new skills to better manage soil and pasture resources and their beef businesses. Capacity was also built among local extension staff and farmers.

Adoption

Final users (emerging farmers) adopted legume crop–livestock technologies, including sustainable grazing practices such as decreased stocking rates and rotational grazing

- Evidence of adoption includes successes in marketing beef, and farmers who are packaging, storing and selling high-value legume products.
- Adoption by crop farmers in the project was limited because they could not emerge into commercial production without expansion of the areas they farm

Outcomes

- Outcomes include higher farm productivity and crop production for crop farmers and increased revenues from higher value products.

Information availability

- 600-word summary
- Review
- ACIAR annual report 2008–09 (ACIAR 2009)

Source

- Centre for International Economics, based on documents provided by ACIAR

Can we segment the South Africa market for beef palatability?

- LPS/2008/013

Commissioned organisation

- Cooperative Research Centre for Beef Genetic Technologies, Australia

African and Australian collaborators

- Marrinya Pty Ltd, Australia
- Cosign Pty Ltd, Australia
- Meat Standards Australia
- Agricultural Research Council, South Africa
- University of Pretoria, South Africa
- University of Venda, South Africa
- Limpopo Department of Agriculture, South Africa

Budget and timing

- $150,000
- 01/05/2008 to 31/08/2009

Outputs

Improved knowledge about beef market:

- only subtle differences between rural and urban consumers in RSA and also between RSA and Australian consumers
- cuts from older pasture-finished bulls from the indigenous breeds could still produce an acceptable product for rural and urban consumers
- capacity to create a new supply chain for indigenous breeds.

Knowledge gained from the project may underpin a subsequent supply chain project to develop a niche market based on product from indigenous cattle to specifically target RSA consumers.

Adoption

- Outputs were adopted in the development of branded beef products based on indigenous cattle.

Outcomes

- Development of branded beef products based on indigenous cattle

Information availability

- 100 -word summary
- Report of external reviewer
- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Sustainable use of natural resources

Measurement and prediction of agrochemical movement in tropical sugar production

- LWR1/1994/046

Commissioned organisation

- Queensland Department of Natural Resources, Australia

African and Australian collaborators

- Mauritius Sugar Industry Research Institute, Mauritius

Budget and timing

- $1,124,923
- 01/01/97 to 30/06/2001

Outputs

- Improved scientific knowledge on:
  - the influence of hydrological properties of the landscape and the significant role of the temporal and spatial variability of rainfall on the movement of pesticides and nutrients
  - the management of water losses using trapping and recycling tailwater to minimise more mobile compounds
  - the effectiveness of timing to avoid wet season applications in minimising losses
  - the movement of nutrients is linked to both naturally occurring nutrient sources as well as from added fertiliser
  - agrochemical movement in tropical conditions.
- Outputs also included capacity building at individual and organisational level.

Adoption

- Extension workshops were held in Mauritius and Australia.
- Information was fed into the ComPass Program which has approximately 1,000 participants
- Farmers in Mauritius had already adopted recommended farming practices but the research confirmed the benefits of what they were already doing.

Outcomes

- Potential benefits to sugar and tourism industries from changing communities' perception by finding that current practices in the sugar industry are not resulting in unacceptable levels of pollution

Information availability

- ACIAR 600-word summary
- Final report
- Adoption study

Source

- Centre for International Economics, based on documents provided by ACIAR

Competitive interaction of trees and crops for water by agroforestry systems

- FST/1995/107

Commissioned organisation

- International Centre for Research in Agroforestry (now the World Agroforestry Centre), Component Interactions Programme, Kenya

African and Australian collaborators

- University of Western Australia, Australia
- Agriculture, Western Australia, Australia
- CSIRO Division of Plant Industry, Australia

Budget and timing

- $137,350
- 01/03/96 to 31/10/98

Outputs

Increased scientific knowledge and techniques:

- the redistribution of water from the surface to deeper soil horizons by the root systems, using heat pulse probes, of *Grevillea robusta* and *Eucalyptus camaldulensis*
- the fractal branching technique held little promise for estimating the root distribution of trees in the current project.

Outputs also included built capacity of Kenyan partner institutions through adapting the Australian model to Kenyan conditions.

Adoption

The outputs from this project led onto further research, but there was no evidence of on-farm adoption in the project documents.

Outcomes

- There is no evidence of outcomes in the project documents.

Information availability

- 100-word summary
- Final report, project FST/1995/107

Source

- Centre for International Economics, based on documents provided by ACIAR

Enhanced resource-use planning for tropical woodland agroecosystems

- LWR2/1996/163

Commissioned organisation

- University of Queensland, Australia

African and Australian collaborators

- Cooperative Research Centre for Tropical Savannas Management, Australia
- Balkanu Cape York Development Corporation P/L, Australia
- Department of Agricultural Technical and Extension Services, Zimbabwe
- CAMPFIRE Association, Zimbabwe
- University of Zimbabwe, Zimbabwe

Budget and timing

- $851,338
- 01/01/99 to 31/10/2002

Outputs

- Improved understanding of processes and inputs required to evolve the land planning systems in communal lands to a more equitable and participatory system
- Guidelines for agency implementation in using decision-support tools in participatory land use planning in Zimbabwe
- Outputs from project not clear; some difficulties experienced during the project.

Adoption

- Evidence of adoption was not documented.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- 600-word summary
- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Capturing the benefits of seasonal climate forecasts in agricultural management

- LWR2/1996/215

Commissioned organisation

- Queensland Department of Primary Industries, Australia

African and Australian collaborators

- Zimbabwe Meteorological Services, Zimbabwe
- University of Western Sydney, Australia
- Bureau of Meteorology, Australia
- Matopos Research Station, Zimbabwe
- Queensland Department of Natural Resources, Australia

Budget and timing

- $1,085,851
- 01/01/99 to 31/12/2002

Outputs

Outputs included improved scientific knowledge of:

- climate and seasonal forecasts
- value of seasonal forecasts in agriculture, to increase production, reduce degradation risks and manage drought
- daily forecasts to help summer planting decisions in Zimbabwe
- effects of ENSO on climate and alternative seasonal forecast methods.

Technical outputs included:

- database of climate information for Zimbabwe
- improved seasonal climate forecast scheme for Zimbabwe based on a combination of GCM and statistical approaches
- validation of the GRASP pasture model in Zimbabwe.

Adoption

- Anticipated adoption is of changes in farm management decisions to better adapt to climate variability, and prepare for climate change. Adoption possible for cropping systems because of shorter lead times and flexibility, but adoption not possible for grazing systems because of the longer lead times required.
- Evidence of adoption was not documented.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- 600-word summary
- Review

Source

- Centre for International Economics, based on documents provided by ACIAR

Pasture development for community livestock production in the Eastern Cape Province of South Africa

- LPS/2004/022

Commissioned organisation

- Murdoch University, Centre for Rhizobium Studies, Australia

African and Australian collaborators

- Agricultural Research Council, South Africa
- Department of Agriculture, Western Australia, Australia
- Eastern Cape Department of Agriculture, South Africa
- National Wool Growers' Association of South Africa, South Africa

Budget and timing

- $765,252
- 01/06/2006 to 30/06/2013

Outputs

Outputs include identification of:

- several species of annual and perennial legumes that have potential to increase forage quality and thus animal production on the arable lands in the Eastern Cape
- potential to locally commercialise some legumes identified in this project.

Adoption

- Project expected to finish in 2013

Outcomes

- Project expected to finish in 2013

Information availability

- 100-word summary
- LPS/2004/022 annual report 2010

Source

- Centre for International Economics, based on documents provided by ACIAR

Potential incentives for sustainable farming for food and water security, and poverty reduction in southern Africa

- LWR/2011/015

Commissioned organisation

- Australian National University, Centre for Water Economics, Environment and Policy, Australia

African and Australian collaborators

- University of Zimbabwe, Zimbabwe
- University of Sydney, Australia
- Association for Water and Rural Development, South Africa
- CSIR, South Africa

Budget and timing

- $133,968
- 16/06/2011 to 31/12/2011

Outputs

- Not clear what outputs were from project documents.

Adoption

- Evidence of adoption was not documented.

Outcomes

- Evidence of outcomes was not documented.

Information availability

- ACIAR 100-word summary

Source

- Centre for International Economics, based on documents provided by ACIAR

Soil management and crop nutrition

System modelling at ICRISAT: Increasing the effectiveness of research on agricultural resource management in the semi-arid tropics by combining cropping systems simulation with farming systems research

- LWR2/1996/049

Commissioned organisation

- International Crops Research Institute for the Semi-Arid Tropics, Kenya
- International Crops Research Institute for the Semi-Arid Tropics, Zimbabwe
- International Crops Research Institute for the Semi-Arid Tropics, India.

African and Australian collaborators

- Kenya Agricultural Research Institute, Kenya
- CSIRO Sustainable Ecosystems, Australia

Budget and timing

- $1,550,000
- 01/01/96 to 30/04/2001

Outputs

- Developed an agricultural production simulation tool by enhancing APSIM for better simulation in the semi-arid tropics. Enhancements included

modules for pearl millet, pigeon pea, the dynamics of phosphorus in soil (although more work was required), manure decomposition and nutrient release, and improved modelling of weed competition.

- Attempted to build capacity by training researchers within ICRISAT and NARES in the use APSIM. However, the capability of ICRISAT was not raised to the extent that it would be able to support other partners.
- Developed a database management system to input, store and retrieve climatic data and to perform certain routine computations of relevance to agricultural system modelling.

Adoption

- Adoption of outputs by smallholder farmers is unlikely.
- Modelling outputs have been used by aid agencies.

Outcomes

- No change of practice is evident for most final user groups, including smallholder farmers, aid agencies and agribusiness companies.
- ICRISAT and the UK Department for International Development provided aid by distributing fertiliser based on the modelling outputs.

Information availability

- Review report
- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Risk management in southern African maize systems

- LWR2/1997/038

Commissioned organisation

- International Maize and Wheat Improvement Center, Natural Resources Group, Mexico

African and Australian collaborators

- University of Zimbabwe, Zimbabwe
- Bunda College of Agriculture, Malawi
- CSIRO Sustainable Ecosystems, Australia

Budget and timing

- $900,000
- January 1998 to June 2001

Outputs

- Provided a tool to assess farm management strategies in environments subject to significant climate variability and risk, by adapting APSIM for use in Malawi and Zimbabwe. This enhances the capacity of African researchers, NGOs and other purveyors of improved agricultural practices to provide advice to farmers.
- Limited capacity was built in the use of APSFRONT (a user-friendly variate of APSIM) through a series of training courses.
- Identified some improved crop management strategies, including:
  - improved knowledge in fertiliser applications (how much and when)
  - legume and animal manures as alternative sources of nitrogen
  - grain legumes as alternative sources of food
  - use of drought-tolerant maize varieties.

Adoption

- Limited evidence of adoption

Outcomes

- Some farmers in Malawi have started experimenting with some soil fertility technologies and there are indications of positive potential impacts.

Information availability

- 600-word summary
- Project review

Source

- Centre for International Economics, based on documents provided by ACIAR

Integrated nutrient management in tropical cropping systems: Improved capabilities in modelling and recommendations

- SMCN/1999/003

Commissioned organisation

- International Center for Tropical Agriculture, Laos

African and Australian collaborators

- CSIRO Sustainable Ecosystems, Australia
- University of Zimbabwe, Zimbabwe
- Kenya Agricultural Research Institute, Kenya
- Tropical Soil Biology and Fertility Programme, Kenya

Budget and timing

- $493,930
- July 1999 to June 2005

Outputs

- Capacity to undertake research and provide advice to farmers and policymakers through the adaptation and further development of the APSIM simulation tool
- Capacity to set up scenarios, run APSIM and interpret results built through training and support in the use of APSIM for integrated nutrient management practices of national collaborators in east and southern Africa.

Adoption

- Insufficient evidence on adoption

Outcomes

- No outcomes identified. The practical application of the models has not yet been demonstrated to farmers and other potential users.

Information availability

- Review

Source

- Centre for International Economics, based on documents provided by ACIAR

Improving phosphorus availability in cropping systems in Sub-Saharan Africa

- SMCN/1999/004

Commissioned organisation

- International Institute of Tropical Agriculture, Nigeria

African and Australian collaborators

- CSIRO Plant Industry, Australia

Budget and timing

- $393,572
- January 2001 to June 2004

Outputs

- No new scientific principles emerged from the project. Nevertheless, the project contributed to greater scientific understanding as follows:
  - A number of phosphorus(P)-deficient sites in Nigeria, Togo, Niger, Cameroon and Kenya were identified and characterised. However, the researchers stopped short of a full appraisal of the soil factors that might limit the ability of grain legumes to make efficient use of soil P or respond to applied P.
  - The performance of different lines of soybean and cowpea in different soils and the response to P fertilisation were measured.
  - The project team also studied mechanisms for P efficiency to identify features that could make screening for P efficiency quicker and more certain. No clear understanding emerged of what makes one cultivar more P-efficient than another. The team therefore concluded that direct selection for grain yield at well-characterised sites with low P would be a reasonable approach for developing adapted P-efficient and responsive cultivars.
  - Rock phosphate or superphosphate applied to a legume crop had a residual value for a following cereal and, in addition, there was a benefit arising from extra nitrogen fixed, but little evidence of a P benefit from the legume.
  - The project provided basic information for quantifying the risks to crops, by calculating nutrient budgets for cropping systems and the

carbon cycle contribution to the acidity budget, based around the yields obtained and the extent of removal and recycling of organic material. Soil acidification was identified as a serious threat to the sustainability of legume-based cropping in the SSA.

- The capacity of developing-country scientists through training and scientific interactions was enhanced. In particular, two IITA scientists received training in CSIRO laboratories, although one researcher was lost to the project immediately after training in Australia, which was a serious blow to the project.

Adoption

- The findings are likely to lead to further research. However, adoption by final users is unlikely.

Outcomes

- No outcomes were identified.

Information availability

- 600-word summary
- Final report
- Review

Source

- Centre for International Economics, based on documents provided by ACIAR

Development and scaling out of targeted recommendations for smallholder maize systems in Southern Africa through integrating farmer participatory research and simulation modelling

- SMCN/2001/028

Commissioned organisation

- International Maize and Wheat Improvement Center, Natural Resource Group, Mexico

African and Australian collaborators

- CSIRO Sustainable Ecosystems, Australia
- Department of Research and Specialist Services, Zimbabwe
- Department of Agricultural Technical and Extension Services, Zimbabwe
- University of Zimbabwe, Zimbabwe
- CARE International, Zimbabwe
- Department of Agricultural Extension and Services, Malawi
- Chitedze Research Station, Malawi

Budget and timing

- $994,380
- July 2001 to December 2004

Outputs

- Improved scientific understanding of the biophysical processes that underpin the maize system productivity in drought prone areas of southern Africa
- Tools to enhance decision making—further enhancement of APSIM model for use in scenario analyses for whole farms
- Decision-making tools for farmers, including:
  - resource allocation maps
  - decision trees and rules of thumb
- Identification of the best farming strategies in various regions, which included an analysis of risk
- Methods to integrate research, farmer participation and simulation modelling, as well as methods to scale out these practices to larger areas.

Adoption

- Evidence of adoption by final users:
  - In the Chisepo area of Malawi, over 40% of farmers adopted research outputs.
  - In the areas surrounding Chisepo, diffusion has largely been through farmer-to-farmer interchange, Adoption rates were lower, with around 20% of farmers adopting research outputs.
  - Over 90% of farmers from Ekwendeni in northern Malawi adopted research outputs concerning production of pigeon pea
  - In Zimuto in Zimbabwe, adoption of the technologies was considerably lower, with only around 9% of farmers having adopted research outputs.

Outcomes

- Smallholder farmers growing non-traditional legumes based on project recommendations

Information availability

- 600-word summary
- Project proposal
- Final report
- Review

Source

- Centre for International Economics, based on documents provided by ACIAR

Improved fertiliser recommendations and policy for dry regions of southern Africa

- SMCN/2000/173

Commissioned organisation

- International Crops Research Institute for the Semi Arid Tropics, Zimbabwe

African and Australian collaborators

- CSIRO Sustainable Ecosystems, Australia
- Department of Agriculture, Northern Province, South Africa
- Progress Mills, South Africa

Budget and timing

- $525,397
- July 2003 to September 2007

Outputs

- Increase in scientific knowledge — on-farm trials demonstrated that small inputs of N can increase yield by around 50%, with little increase in risk. However, the on-farm trials were not replicated. Very high variability at field sites shows that there is uncertainty about the validity of any conclusion that small doses of N increases yields. The review report also notes there is even more uncertainty about conclusions at any individual site.
- Developed a tool for simulating the response of crops to various fertiliser regimes through further enhancement of APSIM—however, APSIM was unable to accurately predict biomass and grain yield. The model also failed to simulate any differential response to N treatments.
- Enhanced capacity of various stakeholders, including:
  - farmers engaged in the on-farm trials as well as LPDA extension officers, through increased understanding of N and crop agronomy
  - LPDA extension officers to conduct surveys on farmers' fertiliser purchases.

Adoption

- The low-dose fertiliser regime promoted by the project was adopted by next users, such as input suppliers and LPDA officials. This was despite the lack of sound scientific evidence.
- There is also evidence of final users (farmers) adopting research outputs.
  - It is estimated that around 2,800 farmers adopted low-dose fertiliser and a further 1,440 were exposed to low-dose fertiliser regimes and improved agronomy.

Outcomes

- A key outcome is farmers using fertiliser at low doses. However, as the recommendation was not based on sound scientific evidence, it is possible that these farmers will not necessarily experience improved yields.

Information availability

- Final report
- Review report

Source

- Centre for International Economics, based on documents provided by ACIAR

Improvement of dryland crop and forage production in the semi-arid tropics

- EFS/1983/026 and LWR2/1987/035

Commissioned organisation

- CSIRO Division of Tropical Crops and Pastures, Australia

African and Australian collaborators

- Kenya Agricultural Research Institute, Kenya

Budget and timing

- $3,829,700 and $2,699,371

- March 1984 – June 1987 and January 1988 – June 1993

Outputs

- Improved scientific knowledge:
  - modest applications of phosphorus fertilisers on soils with low P fixation are viable and profitable
  - efficiency in using farmyard manure
  - the role of grain legumes
  - planting density to improve maize yields
  - management practices including use of KCB maize cultivar, desired level of nitrogen application and the plant population required for optimal crop production.
- Improved understanding of the sequence of adoption of innovative management practices and the priorities in allocation of household income.
- New version of the CERES–Maize crop model.
- Capacity of African researchers built through formal training in Australian universities and collaboration with Australian researchers.

Adoption

- The report of the external reviewer noted 'there remains a need for an enhanced extension effort to transfer the findings to the famers and the incorporation of the results in improved farming systems'.

Outcomes

- No outcomes documented.

Information availability

- 600-word summary
- Report of external reviewer

Source

- Centre for International Economics, based on documents provided by ACIAR

Tropical forage and ley–legume technology for sustainable grazing and cropping systems in Southern Africa

- AS2/1996/149

Commissioned organisation

- CSIRO Sustainable Ecosystems, Australia

African and Australian collaborators

- Department of Agricultural Technical and Extension Services, Zimbabwe
- University of the North, South Africa
- Towoomba Research Station, South Africa
- Queensland Department of Primary Industries, Australia
- University of Zimbabwe, Zimbabwe
- Department of Research and Specialist Services, Zimbabwe
- Agricultural Research Council, South Africa

Budget and timing

- $1,164,971
- January 1999 to December 2003

Outputs

- Improved scientific understanding—new insights into forage legume adaptation and productivity, soil nitrogen and soil organic matter dynamics and the impact of forage or dual-purpose legumes on cereal and animal production.
  - N fertiliser or significant N input from legumes were needed to obtain grain yields in excess of 1 tonne per hectare. Some dual-purpose legumes have special attraction in these systems, providing human food as a vegetable or pulse crop and feeds for the small number of animal present.
  - The decline in maize yield can be avoided by sowing legumes after maize establishment.
  - In Zimbabwe and south-eastern Queensland, velvet beans and lablab both provided considerable benefits to farmers via increases to subsequent maize yields, especially if the legumes were incorporated as a green manure.

  - Removal of legumes for animal feed reduced the benefits to crops, but the legume hay then provided a viable substitute for high-cost feed concentrates, which are typically fed by dairy and beef-finishing farmers.
- Capacity of scientists and extension professionals in partner organisations enhanced through formal and informal training.

Adoption

- Some evidence of adoption. However, widespread and persistent adoption of better farming practices in this farming sector is not expected. The farmers in this community are amongst the poorest in the region and unlikely to be able to invest in significant inputs to their cropping practices.

Outcomes

- Farmers are using better farming practices.

Information availability

- Final report

Source

- Centre for International Economics, based on documents provided by ACIAR

Cropping systems and economics

Sustainable intensification of maize–legume cropping systems for food security in eastern and southern Africa

- CSE/2009/024

Commissioned organisation

- International Maize and Wheat Improvement Center, Zimbabwe

African and Australian collaborators

- Department of Employment, Economic Development and Innovation, Australia
- Murdoch University, Australia
- Ethiopian Institute of Agricultural Research, Ethiopia
- Agricultural Research and Technical Services, Malawi
- Ministry of Agriculture and Food Security, Tanzania
- Mozambique Agricultural Research Institute, Mozambique
- Kenya Agricultural Research Institute, Kenya
- Agricultural Research Council, South Africa
- Association for Strengthening Agricultural Research in Eastern and Central Africa, Uganda

Budget and timing

- $19,449,937 (subsequently increased to $21,649,935)
- 01/01/2010 to 31/12/2013

Outputs

- Project to finish in 2013

Adoption

- Project to finish in 2013

Outcomes

- Project to finish in 2013

Information availability

- Project document

Source

- Centre for International Economics, based on documents provided by ACIAR

Other projects

Cassava projects

Cassava cyanide: improved techniques for estimation and influence of environment on concentration

- CS2/1990/007

Cassava safety: development and evaluation of simple tests of the cyanogenic potential of cassava flour and cassava tubers

- CP/1994/126

Commissioned organisation

- Australian National University, Department of Botany and Zoology, Australia (CS2/1990/007)
- Australian National University, Division of Botany and Zoology, Australia (CP/1994/126)

African and Australian collaborators

- Ministry of Health, Mozambique (CP/1994/126)

Budget and timing

- $185,013 — 31/12/1993 to 30/06/1994 (CP/1990/007)
- $402,096 — 01/01/95 to 30/06/2004 (CP/1994/126)

Outputs

Key outputs from CS2/1990/007 include:

- development of cassava cultivars with low hydrogen cyanide potential
- methods to determine total cyanide in cyanogenic plants and strategies to eliminate konzo
- contribution to the low cyanide germplasm bank of the International Institute of Tropical Agriculture in Nigeria.

Key outputs from CP/1994/126 include:

- increased knowledge of the occurrence of konzo
- development of several kits for determination of total cyanide in:
  - cassava roots (kit A)
  - cassava products such as flour (kit B1)
  - leaves of various cyanide-containing plants including sorghum (kit E)
  - flax seed meal (kit G).
- development of a simple kit for determination of thiocyanate in urine.

Adoption

- No evidence of adoption of low-cyanide cultivars from project CS2/1990/007
- Evidence of adoption of the testing kits was a steady increase of demand to roughly 2 kits per week (100 per year) (CP/1994/126)

Outcomes

- No evidence of outcomes in project documents

Information availability

- 600-word summary CP/1994/126
- Project document CP/1994/126
- Final report CP/1994/126
- Lubulwa (1995)

Source

- Centre for International Economics, based on documents provided by ACIAR

References

ACIAR (Australian Centre for International Agricultural Research) 2003. Annual report 2002–03. ACIAR: Canberra.

— 2006. Annual report 2005–06. ACIAR: Canberra.

— 2007. Annual report 2006–07. ACIAR: Canberra.

— 2009a. Annual report 2008–09. ACIAR: Canberra.

— 2010. Annual report 2009–10. ACIAR: Canberra.

— 2009b. Southern Africa. Pp. 88–90 in 'Annual operational plan 2009–10'. ACIAR: Canberra.

— 2012. Africa. Pp. 100–103 in 'Annual operational plan 2011–12'. ACIAR: Canberra.

Carberry P. 2005. Increasing the effectiveness of research on agricultural resource management in the semi-arid tropics by combining cropping systems simulation with farming systems research (LWR2/1996/049). Pp. 13–24 in 'Adoption of ACIAR project outputs: studies of projects completed in 2000–01', ed. by V. McWaters, S. Hearn and R. Taylor. Australian Centre for International Agricultural Research: Canberra.

Kanowski P. and Verryn S. 2011. High performance eucalypts and interspecific hybrids for marginal lands in south and eastern South Africa and south-eastern Australia (FST/1996/124). Pp. 61– 66 in 'Adoption of ACIAR project outputs: studies of projects completed in 2006–07', ed. by D. Pearce and D. Templeton. Australian Centre for International Agricultural Research: Canberra.

Lubulwa G. 1995. The human health benefits of research to reduce the hydrogen cyanide potential in cassava cultivars in Africa—a completed project assessment of ACIAR project PN9007. Paper presented at the sixth symposium of the International Society of Tropical Root Crops—Africa Branch, 22–28 October 1995, Lilongwe, Malawi.

Lubulwa G., Gwaze D., Clarke J., Milimo P. and Mulatya J. 1995. Overcoming the shortage of fuelwood and poles through forestry research: estimates of benefits from three completed ACIAR forestry projects in Africa and Thailand. Economic Evaluation Unit Working Paper Series No. 22. Australian Centre for International Agricultural Research: Canberra.

Lubulwa G. and Hargreaves S. 1996. Estimates of realised and potential impacts of three ACIAR projects on the ecology, epidemiology and control of ticks and tick-borne diseases in Sub-Saharan Africa. Economic Evaluation Unit Working Paper Series No. 26. Australian Centre for International Agricultural Research: Canberra.

IMPACT ASSESSMENT SERIES

No.	Author(s) and year of publication	Title	ACIAR project numbers
1	Centre for International Economics 1998.	Control of Newcastle disease in village chickens	AS1/1983/034, AS1/1987/017 and AS1/1993/222
2	George P.S. 1998.	Increased efficiency of straw utilisation by cattle and buffalo	AS1/1982/003, AS2/1986/001 and AS2/1988/017
3	Centre for International Economics 1998.	Establishment of a protected area in Vanuatu	ANRE/1990/020
4	Watson A.S. 1998.	Raw wool production and marketing in China	ADP/1988/011
5	Collins D.J. and Collins B.A. 1998.	Fruit fly in Malaysia and Thailand 1985–1993	CS2/1983/043 and CS2/1989/019
6	Ryan J.G. 1998.	Pigeonpea improvement	CS1/1982/001 and CS1/1985/067
7	Centre for International Economics 1998.	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	FIS/1991/030
8	McKenney D.W. 1998.	Australian tree species selection in China	FST/1984/057 and FST/1988/048
9	ACIL Consulting 1998.	Sulfur test KCL–40 and growth of the Australian canola industry	PN/1983/028 and PN/1988/004
10	AACM International 1998.	Conservation tillage and controlled traffic	LWR2/1992/009
11	Chudleigh P. 1998.	Postharvest R&D concerning tropical fruits	PHT/1983/056 and PHT/1988/044
12	Waterhouse D., Dillon B. and Vincent D. 1999.	Biological control of the banana skipper in Papua New Guinea	CS2/1988/002-C
13	Chudleigh P. 1999.	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod R., Isvilanonda S. and Wattanutchariya S. 1999.	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh P. 1999.	Use and management of grain protectants in China and Australia	PHT/1990/035
16	McLeod R. 2001.	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell C. and Wilson C. 2001.	Breeding and feeding pigs in Australia and Vietnam	AS2/1994/023
18	Vincent D. and Quirke D. 2002.	Controlling *Phalaris minor* in the Indian rice–wheat belt	CS1/1996/013
19	Pearce D. 2002.	Measuring the poverty impact of ACIAR projects—a broad framework	
20	Warner R. and Bauer M. 2002.	*Mama Lus Frut* scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod R. 2003.	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer M., Pearce D. and Vincent D. 2003.	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod R. 2003.	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001
24	Palis F.G., Sumalde Z.M. and Hossain M. 2004.	Assessment of the rodent control projects in Vietnam funded by ACIAR and AUSAID: adoption and impact	AS1/1998/036

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
25	Brennan J.P. and Quade K.J. 2004.	Genetics of and breeding for rust resistance in wheat in India and Pakistan	CS1/1983/037 and CS1/1988/014
26	Mullen J.D. 2004.	Impact assessment of ACIAR-funded projects on grain-market reform in China	ADP/1997/021 and ANRE1/1992/028
27	van Bueren M. 2004.	Acacia hybrids in Vietnam	FST/1986/030
28	Harris D. 2004.	Water and nitrogen management in wheat–maize production on the North China Plain	LWR1/1996/164
29	Lindner R. 2004.	Impact assessment of research on the biology and management of coconut crabs on Vanuatu	FIS/1983/081
30	van Bueren M. 2004.	Eucalypt tree improvement in China	FST/1984/057, FST/1987/036, FST/1988/048, FST/1990/044, FST/1994/025, FST/1996/125 and FST/1997/077
31	Pearce D. 2005.	Review of ACIAR's research on agricultural policy	
32	Tingsong Jiang and Pearce D. 2005.	Shelf-life extension of leafy vegetables—evaluating the impacts	PHT/1994/016
33	Vere D. 2005.	Research into conservation tillage for dryland cropping in Australia and China	LWR2/1992/009 and LWR2/1996/143
34	Pearce D. 2005.	Identifying the sex pheromone of the sugarcane borer moth	CS2/1991/680
35	Raitzer D.A. and Lindner R. 2005.	Review of the returns to ACIAR's bilateral R&D investments	
36	Lindner R. 2005.	Impacts of mud crab hatchery technology in Vietnam	FIS/1992/017 and FIS/1999/076
37	McLeod R. 2005.	Management of fruit flies in the Pacific	CS2/1989/020, CS2/1994/003, CS2/1994/115 and CS2/1996/225
38	ACIAR 2006.	Future directions for ACIAR's animal health research	
39	Pearce D., Monck M., Chadwick K. and Corbishley J. 2006.	Benefits to Australia from ACIAR-funded research	AS2/1990/028, AS2/1994/017, AS2/1994/018, AS2/1999/060, CS1/1990/012, CS1/1994/968, FST/1993/016 and PHT/1990/051
40	Corbishley J. and Pearce D. 2006.	Zero tillage for weed control in India: the contribution to poverty alleviation	CS1/1996/013
41	ACIAR 2006.	ACIAR and public funding of R&D. Submission to Productivity Commission study on public support for science and innovation	
42	Pearce D. and Monck M. 2006.	Benefits to Australia of selected CABI products	
43	Harris D.N. 2006.	Water management in public irrigation schemes in Vietnam	LWR1/1998/034 and LWR2/1994/004
44	Gordon J. and Chadwick K. 2007.	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034
45	Turnbull J.W. 2007.	Development of sustainable forestry plantations in China: a review	
46	Monck M. and Pearce D. 2007.	Mite pests of honey bees in the Asia–Pacific region	AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
47	Fisher H. and Gordon J. 2007.	Improved Australian tree species for Vietnam	FST/1993/118 and FST/1998/096
48	Longmore C., Gordon J. and Bantilan M.C. 2007.	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher H. and Gordon J. 2007.	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck M. and Pearce D. 2007.	Improved trade in mangoes from the Philippines, Thailand and Australia	CS1/1990/012 and PHT/1990/051
51	Corbishley J. and Pearce D. 2007.	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. 2008.	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
53	Monck M. and Pearce D. 2008.	The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology	AH/1997/115
54	Monck M. and Pearce D. 2008.	Impact of improved management of white grubs in peanut-cropping systems	CS2/1994/050
55	Martin G. 2008.	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner B. and McLeod P. 2008.	A review and impact assessment of ACIAR's fruit-fly research partnerships—1984 to 2007	CP/1997/079, CP/2001/027, CP/2002/086, CP/2007/002, CP/2007/187, CS2/1983/043, CS2/1989/019, CS2/1989/020, CS2/1994/003, CS2/1994/115, CS2/1996/225, CS2/1997/101, CS2/1998/005, CS2/2003/036, PHT/1990/051, PHT/1993/87 and PHT/1994/133
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. 2008.	Management of internal parasites in goats in the Philippines	AS1/1997/133
58	Davis J., Gordon J., Pearce D. and Templeton D. 2008.	Guidelines for assessing the impacts of ACIAR's research activities	
59	Chupungco A., Dumayas E. and Mullen J. 2008.	Two-stage grain drying in the Philippines	PHT/1983/008, PHT/1986/008 and PHT/1990/008
60	Centre for International Economics 2009.	ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation	
61	Fisher H. and Pearce D. 2009.	Salinity reduction in tannery effluents in India and Australia	AS1/2001/005
62	Francisco S.R., Mangabat M.C., Mataia A.B., Acda M.A., Kagaoan C.V., Laguna J.P., Ramos M., Garabiag K.A., Paguia F.L. and Mullen J.D. 2009.	Integrated management of insect pests of stored grain in the Philippines	PHT/1983/009, PHT/1983/011, PHT/1986/009 and PHT/1990/009
63	Harding M., Tingsong Jiang and Pearce D. 2009.	Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness	
64	Mullen J.D. 2010.	Reform of domestic grain markets in China: a reassessment of the contribution of ACIAR-funded economic policy research	ADP/1997/021 and ANRE1/1992/028

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
65	Martin G. 2010.	ACIAR investment in research on forages in Indonesia	AS2/2000/103, AS2/2000/124, AS2/2001/125, LPS/2004/005, SMAR/2006/061 and SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165
67	Fisher H. 2010.	The biology, socioeconomics and management of the barramundi fishery in Papua New Guinea's Western Province	FIS/1998/024
68	McClintock A. and Griffith G. 2010.	Benefit–cost meta-analysis of investment in the International Agricultural Research Centres	
69	Pearce D. 2010.	Lessons learned from past ACIAR impact assessments, adoption studies and experience	
70	Harris D.N. 2011.	Extending low-chill fruit in northern Thailand: an ACIAR–World Vision collaborative project	PLIA/2000/165
71	Lindner R. 2011.	The economic impact in Indonesia and Australia from ACIAR's investment in plantation forestry research, 1987–2009	FST/1986/013, FST/1990/043, FST/1993/118, FST/1995/110, FST/1995/124, FST/1996/182, FST/1997/035, FST/1998/096, FST/2000/122, FST/2000/123, FST/2003/048 and FST/2004/058
72	Lindner R. 2011.	Frameworks for assessing policy research and ACIAR's investment in policy-oriented projects in Indonesia	ADP/1994/049, ADP/2000/100, ADP/2000/126, AGB/2000/072, AGB/2004/028, ANRE1/1990/038, ANRE1/1993/023, ANRE1/1993/705, EFS/1983/062 and EFS/1988/022
73	Fisher H. 2011.	Forestry in Papua New Guinea: a review of ACIAR's program	FST/1994/033, FST/1995/123, FST/1998/118, FST/2002/010, FST/2004/050, FST/2004/055, FST/2004/061, FST/2006/048, FST/2006/088, FST/2006/120, FST/2007/078 and FST/2009/012
74	Brennan J.P. and Malabayabas A. 2011.	International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia	
75	Harris D.N. 2011.	Extending rice crop yield improvements in Lao PDR: an ACIAR–World Vision collaborative project	CIM/1999/048, CS1/1995/100 and PLIA/2000/165
76	Grewal B., Grunfeld H. and Sheehan P. 2011.	The contribution of agricultural growth to poverty reduction	
77	Saunders C., Davis L. and Pearce D. 2012.	Rice–wheat cropping systems in India and Australia and development of the 'Happy Seeder'	LWR/2000/089, LWR/2006/132 and CSE/2006/124
78	Carpenter D. and McGillivray M. 2012	A methodology for assessing the poverty-reducing impacts of Australia's international agricultural research	
79	Dugdale A., Sadleir C., Tennant-Wood R. and Turner M. 2012	Developing and testing a tool for measuring capacity building	
80	Fisher H., Sar L. and Winzenried C. 2012	Oil palm pathways: an analysis of ACIAR's oil palm projects in Papua New Guinea	ASEM/1999/084, ASEM/2002/014, ASEM/2006/127, CP/1996/091, PC/2006/063, PC/2004/064, CP/2007/098

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
81	Pearce D. and White L. 2012	Including natural resource management and environmental impacts within impact assessment studies: methodological issues	
82	Fisher H. and Hohnen L. 2012	ACIAR's activities in Africa: a review	AS1/1983/003, AS1/1995/040, AS1/1995/111, AS1/1996/096, AS1/1998/010, AS2/1990/047, AS2/1991/018, AS2/1993/724, AS2/1996/014, AS2/1999/063, AS2/1996/090, AS2/1996/203, AS2/1996/149, AS2/1997/098, CP/1994/126, CS2/1990/007, EFS/1983/026, FST/1983/020, FST/1983/031, FST/1983/057, FST/1988/008, FST/1988/009, FST/1991/026, FST/1995/107, FST/1996/124, FST/1996/206, FST/2003/002, IAP/1996/181, LPS/1999/036, LPS/2002/081, LPS/2004/022, LPS/2008/013, LWR/2011/015, LWR1/1994/046, LWR2/1987/035, LWR2/1996/049, LWR2/1996/163, LWRS/1996/215, LWR2/1997/038, SMCN/1999/003, SMCN/1999/004, SMCN/2001/028, SMCN/2000/173

Australian AID

ACIAR

Research that works for developing countries and Australia

aciar.gov.au