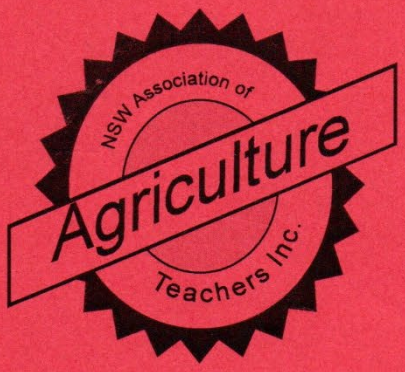
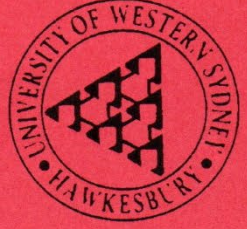


Winter 2002 Edition 21

BAAT

Bulletin of the NSW Association of Agriculture Teachers

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NSW Agriculture

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Inside BAAT

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Editorial

Well, that term went quickly!
The count down to the HSC begins.....
Yet another great Junior Ag Camp has run and much fun was had by all. Thanks again, to all staff who gave of their valuable time and expertise, making this annual event possible. Watch out for the report in the next BAAT.

This edition of BAAT contains quite a few resources and information on current technologies and research. Hopefully some members will find this information useful. A copy of what we believe to be the current constitution of the NSW AAT has also been included for comment. A suggestion that an 'update' is warranted has been made- it would be interesting to hear and publish other members' views on this issue.

Several articles have been provided by the Kondinin Group and the CSIRO. The CSIRO website is quite a good place to start looking for information on new techniques and research concerning Agricultural production. Since the demise of the Rural Research publication, the Kondinin group have been publishing CSIRO research studies in a user-friendly format, in their "Farming Ahead" magazine. They are a very 'school-friendly' organisation who produce a vast amount of information and fact sheets on all aspects of Agricultural production. Information about subscription costs to the magazine and also to the new "Insite" information bank, are included in this issue.

Items from two free publications, John Deere's "The Furrow", and the Meat & Livestock Australia's "Prograzier" magazine, have been included, as well as details regarding subscription.

Thanks to Charlie Cassels for the photos and feedback on the Manning Valley Beef Week. It sounds an extremely worthwhile experience.

Until the next edition.....Ed.

Stuff to send:

School or Show Reports	Letters
Teaching Resources	Classifieds (ie Buy/Swap/Sell, etc)
AAT Branch Updates	Student Successes
Committee Reports	Upcoming Events
Inservice/ practical Ag info	Interesting Bits.....etc. etc.

e-mailed material in MS Word (pc) format, works best.
Pictures/photos in .jpg or .gif, if possible.

Contact or send material to the editor of your choice

Presidents Report, September 2002

Welcome to the second edition of BAAT for 2002.

Firstly I would like to thank Brigitte and her team for all the effort they put into BAAT, I am sure that all our members would be happy to extend thanks for all the hard work and effort that goes into getting BAAT out. It is a very time consuming and often thankless job which I am sure many of our members do not understand the amount of time and effort that goes into getting an edition of BAAT out.

The conference committee headed by Ivan Gant is busy in the organisation of the 2003 conference, which will be held at "Tocal" Paterson on the 12th to 15th January 2003. The conference includes sessions on both Agriculture and Primary Industries courses, value adding of wine, cheese and olives as well as a number of short courses in areas such as management of internal parasites in sheep, organic farming, fencing, tractor safety and soil testing. I am sure it will be one of the best conferences yet and I suggest you jot down and reserve these dates for January 2003 now.

I would like to thank in advance all the staff from "Tocal" in particular Principal Cameron Archer and Deputy Principal Bill Kinsey for all the support they have given the association in the organisation of the conference. Tocal is an ideal place to take students in particular Primary Industries students to do a range of courses including Tractor Operation and Maintenance, SMARTtrain chemical course, fencing and Beef Cattle Handling and Management. If you would like to take you students to "Tocal" get in contact with Bill Kinsey and he will do all he can to accommodate you and your students.

The application forms and flyers for the conference were included in the previous edition of BAAT. It would be appreciated by Ivan and all his team organising the conference if they could start to get replies as well as money as soon as is possible. This helps in the organisation and planning of the conference as well as allowing the committee to have money available to get the conference up and running.

In the previous edition of BAAT you would have found the nomination forms for the JA Sutherland award and for Life membership of our association. There are countless members of our association who give up literally hundreds of hours of their own time to represent Agriculture teachers in a large numbers of areas and in large number of ways. The J.A Sutherland award and Life membership are ways in which we can, in a formal way acknowledge and thank members of our association for the hard work and effort they have put in over many years. I am sure we all know of many worthy recipients of these awards so I urge you to nominate any member of our association who you feel deserves to receive the JA Sutherland award and /or be bestowed life membership of our association.

The association has been kept busy over the last couple of months fighting on a new front in regard to stage 4 and 5 Agriculture. When the decision was made to re-write the Agriculture course it was decided that the Stage 4/5 Sheep and Wool course that was taught in a number of schools would be scraped. The initial thoughts of the BOS were that it might be able to be incorporated into the new stage 4/5 course.

After discussions with a number of members it was decided that we as an association would like to have a sheep and wool course separate to the stage 4/5-agriculture course. After a number of discussions with Mr John O'Brien Director of Curriculum at the BOS and Mr John Watkins Minister for Education and Training, it has been decided to write a Board Endorsed Course (BEC) in Wool Handling. This course once written and endorsed will then be made available to any school who wishes to teach it and all it will require is some paper work to be sent to the BOS indicating you are intending to teach it (so I have been told). I have included the proposed content for the new course:

Stage 5
Wool Handling (proposed content)

Unit Title	Indicative Hours
Sheep Production	10 - 15
Sheep Genetics and Reproduction	15 - 30
Sheep Nutrition	15 - 25
Sheep Health and Disease	10 - 20
Sheep / Fleece Presentation	25 - 35
Wool Biology	10 - 15
Wool Testing	10 - 15
Wool Harvesting	30 - 40
Wool Marketing / Processing	30 - 40
	180

Industry Study
Student need to choose ONE elective

Lamb production / marketing	20
Stud production / marketing	20
Sheep milk production / marketing	20
Carpet Wool production / marketing	20
Ultra Fine Merino production / marketing	20
	20
Total Hours	**200**

A team of writers for the course in the process of being put together and a draft of the course hopefully will be available for comment early in 2003.

The course will only suit a small number of schools but we felt in very important that schools have the opportunity if they wish to offer a further 200 hours of study in

Agriculture. Due to our continued discussions and letter we have now enabled schools if they wish to offer up to 400 hours in stage 4/5 Agriculture and a further 200 hours in Wool Harvesting.

Our next battle is going to be a long and hard one but we are now attempting to get all students the chance to access VET in Stage 5, in particular Year 10.

Agriculture is a unique subject in that we have many students, particularly in country areas and in schools, which attract large numbers of country students, who already possess a very high level of skills in many rural tasks. As an association we believe that these students should be given the opportunity to have these skills recognised in a formal way and feel that the best way to do this is through the VET system by allowing them to access competencies from the Rural Training package.

The new stage 4/5 Agriculture course is currently being written and should be ready in its draft form for discussion at the conference in January. It was disappointing that the BOS received only 18 replies to the consultation on the Draft writing brief. I realise that most Agriculture teachers are up to their eyeballs in work, but the only way that you can have a say in the new syllabus is to make comment. If you are unable to make it to the conference, I urge you to fill in a consultation of the draft syllabus and have your say. It is no good complaining about the new syllabus when it comes out if you could not find the time to express your views in the consultation.

The new Draft Stage 4 Technology syllabus should be out in term 4 for consultation, I would also urge you to ensure you fill out an evaluation of this new syllabus. We were lucky enough to have a member of the association on the syllabus writing team to put the agricultural perspective into the new syllabus. It must be remembered that in the majority of schools, Stage 4 Technology is the only Agriculture the students get to experience and as such we want to ensure we have a syllabus that suits us in our teaching Stage 4 Technology to students in years 7 and 8.

I was recently invited to attend a 2-day conference at the Australian College of Educational Research (ACER) in Melbourne on the Development of teaching standards for the teaching profession. Prof Angelo Collins ran the conference from the USA. The aim of the conference was to provide an overview of recent research on the development of teaching standards and the assessment of these standards in the USA and the UK and link this to what may occur in Australia.

The Ramsey review, which looked as a wide range of factors in its review of teacher Education in NSW, outlined a number of ways in which the teaching profession could be enhanced in the future.

One of the recommendations of this review was the development of an Institute of Teachers, as part of this institute, all teachers will need to registered to teach in all NSW schools, public, private and independent. It is proposed that each state will require their teachers to be registered. The plan is that all states will develop a similar set of standards, if all the political restraints can be solved, and as such, once registered will allow a teacher to teach in any state or territory of Australia.

The standards and the way they will be assessed is still a long way down the track with a large amount of debate and consultation with the various stake holders in each state and territory to be held before any final decisions are made.

An example of two of the standards that is in place in the USA are: -

The teacher understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.

The teacher plans instructions based upon knowledge of subject matter, students, the community and curriculum goals.

The major hurdle I believe is going to be in the assessment, in the USA teachers are required to submit a quite detailed portfolio (which includes videos of them teaching,) which is more like a Masters or PhD thesis. The general consensus of the major stakeholders around Australia is that we do not want to go this way, the preferred option being based on peer and student assessment.

I may be spending another 3 days in Melbourne over the holidays another conference on Building Teacher Quality and will keep members informed of any future developments on the issues of teacher registration, teaching standards and assessment.

As an association we have been looking at the constitution of the Association and have realised that it is due for a number of amendments, a copy of our current constitution is included in this edition of BAAT. If there are any changes that you feel need to be made could you please send them me at: -
St Joseph's College
Mark Street
Hunters Hill 2110

The amendments need to be sent to all members before the AGM in January so they can be discussed. Can any amendments that you would like to propose be sent to me by the 14th November 2002 so they can be collated and sent out before the end of the school year.

Remember the Conference in January and get in contact with Ivan and his organising committee, if you wish to attend what I am sure will be a very enjoyable and rewarding conference.

A reminder that BAAT is only as good as the contributions it receives. Please send submissions of any articles, resources, worksheets, programming ideas, and reports on your school or show results to Brigitte or Milton for inclusion in the last BAAT for this year, which will be out in November.

Wishing you and your Year 12 students all the best for the up coming HSC exams.

Patrick McCann

CONSTITUTION

NSW ASSOCIATION OF AGRICULTURE TEACHERS

1. **NAME** -

The name of the Association is the NSW Association of Agriculture Teachers (hereinafter called the Association).

2. **OBJECTS** -

The objects for which the Association is established are,

a) to encourage an interest and excellence in Agriculture.
b) to foster the teaching of Agriculture and Associated activities.
c) to arrange and assist in arranging, meetings, conferences, and other activities in keeping with the objects of the Association.
d) to co-operate with other bodies, within NSW and elsewhere, which share an interest in Agriculture.
e) to publish a Journal and other such material as is consonant with the objects of the Association.

3. **MEMBERSHIP** -

a) Ordinary - The Association is open to anyone with an interest in Agriculture. Applications for membership shall be made in writing.

All subscriptions shall become due and payable on the thirty first day of December for the following be ennium.

b) Affiliate - The Executive may arrange affiliate membership with other Associations which share objects similar to those of the Association, and which engage in activities that do not conflict with those of the Association. In arranging the Affiliate membership fee the Executive is to set the rate to cover the entire cost of al of the printed material for the current year and the postage involved. Affiliate members enjoy all the rights of ordinary members when they attend meetings of the Association.

c) Student - The Executive may accept student members at 50% of full fee.

d) Life -
   i) Nomination by present financial members of the Association will be required on the nomination form enclosed in this BAAT.
   ii) Support materials must be provided together with referees, to enable a full resume to be developed and presented in BAAT.
   iii) A summary of the resume is to be posted prior to the AGM at the biennial conference.
   iv) Voting will be decided on a 2/3 majority of the *Members* voting.
   v) Successful members will become life members as of the date of the meeting, and be invited to receive their life membership at the following Biennial Conference.
   vi) In all cases of membership ordinary, affiliate, and student, any rejection of a application for membership must be considered by the Executive.

4. **CESSATION OF MEMBERSHIP** -

a) If a member does not pay the biennial subscription when it falls due, or does not pay within sixty days any other sum falling due to the Association, such membership shall thereupon cease and no rights of membership may be exercised until default in payment has been remedied.

5. **GENERAL MEETING** -

a) General meetings have the power to determine the policy of the Association.

b) The Association may, where possible, hold a general meeting once every two years.

c) Special general meetings may be called in term time by the President of the Association at the written request of any ten members.

d) The Quorum at a general meeting shall be Four (4) members and no business shall be transacted at any general meeting unless a quorum of members is present. Thirty minutes is to be allowed from the notified time of the commencement of the meeting for a quorum to be present.

e) Section (c) does not preclude any general meeting passing a recommendation for the Executive's consideration either by vote or acclamation. Executive is bound to consider such motions but not to accept them.

f) The constitution of the Association may be amended by a special resolution of half or more of the members of the Association who are present at a general meeting of which at least 21 days written notice has been given.

g) The Association membership subscription rates shall be determined by the Executive.

6. **BIENNIAL GENERAL MEETING** -

a) The biennial general meeting shall receive the Executive report of the activities of the Association for the previous term. On adoption, this report becomes the **Biennial Report** of the Association.

b) The biennial general meeting shall receive the Treasurer's audited statement for the previous financial term. On adoption, this report becomes the **Biennial Financial Report** of the Association.

c) The Biennial General meeting shall elect the Auditor for the next term.

d) The Biennial General Meeting shall elect the following honorary officers of the Association.

* The President
* The Secretary
* The Treasurer
* The Publications Officer
* Two Biennial Conference Organisers.

e) Returning Officer and Elections -

The Biennial General Meeting shall elect a returning officer for the conduct of the elections at the next ensuing Biennial General Meeting. Nominations of members for the various positions shall be called for in the notice convening the Biennial General Meeting. If no or insufficient nominations have been received for a position prior to the General meeting, nominations may be accepted from the floor of the meeting.

All nominations, whether prior to the meeting, or from the floor, must be seconded. Only financial members may nominate or second. Voting shall be by secret ballot and in person at the meeting.

Where there is a single position to be filled, votes shall be cast and counted with the preferential system; where there is more than one position to be filled, each member voting may cast as many votes as there are positions to be filled and votes shall be counted in accordance with the first-past-the-post system. In all cases the conduct of the elections shall be in the hand of the returning officer whose decisions shall be final.

7. **THE EXECUTIVE** - shall consist of

a) The 3 elected officers of the Association, and

b) The Elected Editors(up to 2 in number) of the ..*Bulletin of the NSW Association of Agriculture Teachers.... (BAAT).*

8. **THE ADVISORY COUNCIL AND BRANCHES OF THE ASSOCIATION** -

a) The Executive may call a meeting of an Advisory Council. The advisory council shall be free to advise the Association about any matter connected with Agriculture, or the future development of the Association, but it has no power to make binding resolutions.

b) Ten or members of the Association may apply to the Executive for permission to form a Branch of the Association. If the Executive grants such permission it may do so on such terms as it sees fit and it may at any time in its absolute discretion vary those terms or suspend recognition until the next biennial meeting.

In exercising these powers the Executive shall have regard to the interests of the Association at large, and of its members generally, and the need to both encourage and co-ordinate the activities of the Association, its members and all branches.

Although branches shall finance their won activities any may not commit the Association to any expenditure without prior specific approval of the Executive or the Treasurer, the Executive may make grants, either general or specific, to Branches to assist in their activities. Branches shall keep the Executive full informed of their plans, activities and financial position by regular communication, and in a report which the Branch should submit to the Biennial General Meeting.

9. POWERS AND DUTIES OF THE EXECUTIVE

a) The business of the Association shall be manager by the Executive which may authorize all payments on behalf of the Association, which are not prerogative of a general meeting, in conformity with the objects of the Association.

b) The Executive may require an officer of the Association to report to it about activities which he has conducted on behalf of the Association and may request him to cease these activities until the next general meeting, when any matter under dispute may be referred to the members.

c) The Executive shall cause minutes to be made,

* of all payment of officers of the Association,
* of the names of all members of the Executive present at all meetings of the Association and of the Executive, and.
* of all regular motions at all meetings of the Association and the Executive.

d) The Executive may invite members to assist in all or part of its deliberations. Such co-opted members may vote on formal motions.

e) The Executive shall have the power to fill any vacant office. Offices may be declared vacant if no nomination is accepted by the Biennial General meeting or if an officer resigns or fails to accept the Presidents invitation to be present at three successive meetings of which due notice has been given.

f) The Executive may empower an assistant treasurer to take some or all of the duties of the Treasurer if the Treasurer requests assistance or, if, owing to any cause, the Treasurer is unable to fulfil part or whole of his duties.

g) The Executive may nominate a past President to act in place of the President if, by any chance, the president is unable to fulfil his duties.

h) The Executive may request the Secretariat to implement decisions or it may grant discretionary powers to deal with certain matters.

10. FUNCTION OF THE SECRETARIAT -

a) The Secretariat may meet in the months between the meetings of the Executive to review,

* correspondence
* accounts
* progress of officers in fulfilling the motions of the Executive.
* to resolve matters delegated to it by the Executive, and in general, to provide for continuity of action.

11. THE PUBLICATIONS EDITOR/S -

The Publications Editor/s shall be responsible for the handling of all routine matters connected with the issue of publications which have been established by the Executive.

12. SUBCOMMITTEES -

a) It is the policy of the Association to foster active work of voluntary sub-committees and to see that this work receives authorised support and due notice in the publications of the Association.

b) The Executive may set up subcommittees to prepare business for the Executive meeting or to carry out worthwhile activities for the Association.

c) Convenors of such sub-committees must report all meetings of their committees to the next meeting of the Executive.

d) No proposals involving the expenditure of the moneys of the Association shall be effected without the approval of the Executive.

e) The name of the Association must not be used by a sub-committee for any public action except with the prior approval of the Executive.

f) The President, the Secretary and the Treasurer of the Association have the right, ex officio, to attend any sub-committee meeting, and the Executive may nominate on of its members to attend meetings.

13. DUTIES OF OFFICE BEARERS -

a) The President -

1. Shall represent and stand for the Association during his/her term of office.

2. Shall provide over public and general meetings of the Association, the meetings of the Executive, and of the Advisory Council.

3. Shall be in charge of the business of the Association, and the other officers of the Association shall provide him with material necessary to direct the course of meetings and to represent the Association.

b) The Secretary -

The Secretary shall be responsible for,

1. receiving, filing and preserving all correspondence of the Association.

2. notifying the President of its contents in time for general meetings and Executive and Secretariat meetings as authorised by the President.

3. sending out notices and agenda for general meetings and Executive and Secretariat meetings as authorised by the President.

4. acknowledging or answering all correspondence as required by the Executive.

5. gathering and preparing materials for reports including the Executive's report of the activities of the Association

c) The Treasurer

The Treasurer shall be responsible for,

1. the receipt and expenditure of all monies of the Association and maintaining the balance of the same.

2. the financial records of the Association.

3. preparing a balance sheet for audit prior to the Biennial General Meeting.

4. maintaining a list of financial members.

5. notifying personnel responsible for mailing, re, new members.

6. preparing budget estimates for income and expenditure at about October of each Biennium.

7. supervising the financial arrangements for all publications and the issue of complimentary copies of Journals and other publications.

14. <u>THE EDITOR/S</u> -

The Editors shall be responsible as part of the Executive for, maintaining the standard of the Associations Journal in accordance with the objects of the Association and in consultation with the Executive.

Was this the latest copy of the Constitution?

Are there any changes required?

We've thought of some- can you pick them?

Send your comments/ suggestions etc to Pat McCann so that they can be included for discussion in the next BAAT and hopefully used to refine our constitution.

Attention DET teachers:

FREE MONEY

FOR YOU !

The funding form from the State Agricultural Advisory Group and the Schools Financial Support Unit should be hitting your school now.
Please keep a look out for it and get it back ASAP.

Remember: no return - no funding for next year.

Part A of that form asks for student numbers who study Agriculture. Teachers are reminded that they should include only the agricultural component of any DAT studies. The State Agricultural Advisory Group cross references school information with Board of Studies enrolment information as well as compulsory curriculum study patterns. It is a waste of time fudging figures.

Further Information:

Peter Jones at Chifley College - Mt. Druitt Campus)

Planning Ahead? Do you Require Show Dates September 2002 to June 2003?
Details can be obtained by contacting the

Agricultural Society Council of NSW
PO Box 1047, Hunters Hill 2110 , phone 02 9704 1111

for a booklet OR to go on the mailing list
OR Visit Internet site www.agshowsnsw.org.au

The internet site is updated regularly and also includes information on shows and secretaries. machinery field days, interstate contacts and Royal Shows.

SHOWS in 2002

OCTOBER

Wagga Wagga 3-4	Culcairn 5	Singleton 4-6
Bribbaree 5	Berrigan 6	Trunkey Creek 6
Griffith 6-7	Morongla 7	Walbundrie 7
Norfolk Island 7	Grenfell 11-12	Leeton 11-12
Casino 11-12	Taree 11-13	
Illabo 12	Picton 12-13	Lismore 16-19
Barham 18-19	Cootamundra 19	The Rock 19
Alstonville 26-27	Carcoar 27	Junee 27

NOVEMBER

Albury 1-3	Murwillumbah 1-2	Frenchs Forest 2-3
Bellinger 8-9	Dungog 8-9	Mullumbimby 8-9
Holbrook 9	Minto 9-10	Bangalow 15-16
Bulahdelah 16-17	Queanbeyan 16-17	Dorrigo 22-23

2003

JANUARY

Bowral 4-5	Pambula 11-12	Albion Park 11-12
Bundarra 17-18	Dapto 17-18	Candelo 19
Eurobodalla 24-25	Kiama 24-25	Tarago 25
Bungendore 26	Berry 31-1 Feb	Uralla 31-1 Feb

FEBRUARY

Rydal 1	Morriset 1-2	Nimmitabel 1
Cobargo 7-8	Corowa 7-8	Nowra 7-8
Tenterfield 7-8	Luddenham 7-9	Camden Haven 8-9
Crookwell 8-9	Glen Innes 13-15	Kangaroo Valley 14-15
Maitland 14-16	Bega 14-16	Gunning 15-16
Dunedoo 15		Gundagai 21-22
Guyra 21-22	Cessnock 21-22	Milton 21-22
Delegate 22	Rylstone 22	Ashford 22-23
Dalgety 23	Jerilderie 23	Sofala 23
Inverell 27-1 Mar	Canberra 28-2 Mar	Newcastle 28-2 Mar
Mudgee 28-1 Mar		

MARCH

Deniliquin 1-2
Barraba 7-8
Gresford 7-8
Tumut 8
Taralga 8-9
Armidale 14-15
Baradine 15
Cumnock 15
Bemboka 16
Walcha 21-23
Goulburn 22-23
Batlow 29
Yass 29-30
Comboyne 15

Jingellic 2
Blayney 7-8
Boorowa 8
Wakool 8
Koorawatha 9
Blacktown 14-16
Bombala 15
Henty 15
Coonabarabran 21-22
Nabiac 22
Castle Hill 28-30
Binnaway 29

St Ives TBA
Gulgong 8
Cooma 8
Oberon 8-9
Robertson 7-8
Moss Vale 14-16
Braidwood 15
Adelong 15-16
Manilla 21-22
Tumbarumba 22
Tamworth 28-30
Wingham 29-30

APRIL

Camden 4-5
Muswellbrook 4-5
Jerrawa 21
Campbelltown 25-27

Gloucester 4-5
Mendooran 5
Stroud 25-26
Kempsey 29-30

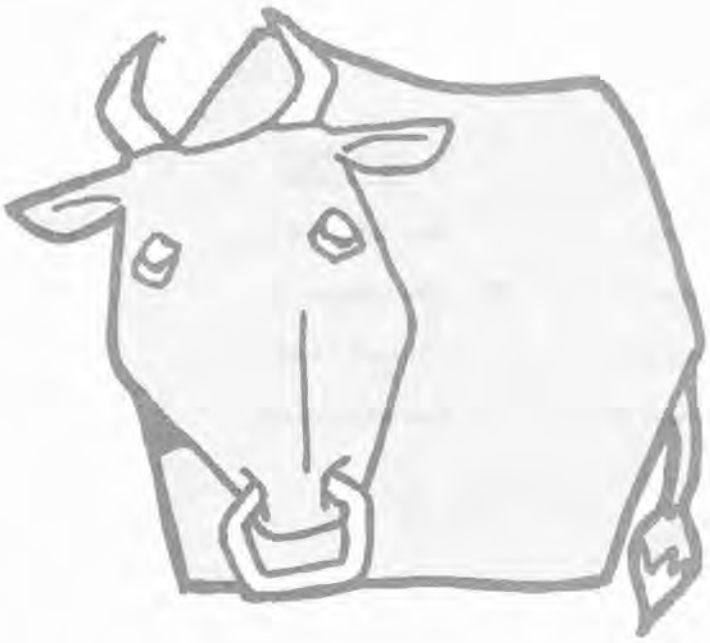
Lithgow 4-5
Sydney 11-24
Wauchope 25-26

MAY -

Bonalbo 2-3	Macksville 2-3	Bathurst 2-4
Hawkesbury 2-4	Narrabri 2-4	Brewarrina 3
Woodenbong 4	Maclean 6-7	Grafton 9-10
Gunnedah 9-11	Bourke 10	Gosford 10-11
Orange 10-11	Walgett 10-11	Yeoval 13
Warialda 15-17	Cobar 16-17	Wellington 16-17
Coffs Harbour 16-18	Wee Waa 16-18	Nyngan 18-19
Gilgandra 20-21	Bellinger River 23-24	Dubbo 23-25
Bingara 24-25	Coonamble 27-28	Mungindi 29-3
Gulargambone 31		

JUNE

Moree 6-8



What's New in AQIS?

HON WARREN TRUSS MP
MINISTER FOR AGRICULTURE, FISHERIES AND FORESTRY

M E D I A R E L E A S E

10 September 2002

Quarantine halts four agricultural risks

The vital importance of Australia's strong border protection has again been demonstrated by the Australian Quarantine and Inspection Service (AQIS), which this week intercepted four serious invaders with the potential to threaten our environment and agriculture industries, Federal Minister for Agriculture, Fisheries and Forestry Warren Truss said today.

Over the past week:

- AQIS officers in Melbourne have found Asian tiger mosquitoes in a consignment of 'lucky bamboo' plants from China;
- AQIS officers in Perth have found birds' nests, eggs and plant contamination in agricultural machinery from the United States;
- AQIS officers in Brisbane have found exotic crazy ants in used crane equipment from Thailand; and
- AQIS plant scientists in Victoria have found an exotic fungus on imported conifer plants at Melbourne's Knoxfield plant quarantine station.

"Each of these four detections averted a potential disaster for Australia's agriculture industries or native plants and animals and I congratulate AQIS officers on their vigilance," Mr Truss said.
"The Asian tiger mosquitoes found at the border in Melbourne are carriers of a number of diseases, including dengue fever.
"The birds' nests, eggs, seeds, leaves and straw found on balers from the USA could have introduced exotic weed seeds, fungus spores, bacteria or viruses. The birds' nests and eggs could have carried exotic strains of Newcastle disease or avian influenza — which could devastate our native birds as well as our poultry industries.
"The crazy ants found in border inspections in Brisbane are serious pests which are highly competitive and could take over the habitats of native Australian ants.
"And the *Gymnosporangium* fungus found at Knoxfield plant quarantine station is a highly important detection. This rust is a serious threat to a range of fruit trees including apples, pears and quinces, as well as ornamental species such as cedar and juniper.
"Coming in the same period as a national emergency disease simulation to test our readiness to deal with foot and mouth disease, these detections confirm the need to maintain Australia's freedom from serious plant and animal pests and disease — freedom that's essential to protecting our $29 billion agriculture export industries," Mr Truss said.

Fruity find for Quarantine

17 July 2002

The Australian Quarantine and Inspection Service (AQIS) hit the mother lode recently when a detector dog sniffed out an amazing ***24 kilograms*** of tropical fruit at Perth International Airport.

The fruity haul, which had been declared by a passenger from Thailand and was intended as gifts for family, included limes, bean pods, dukoo, rambutan, mangosteen, mangoes and bananas.

Although they looked harmless enough, the exotic fruits posed a real risk to Australia, threatening native flora and agriculture industries worth billions of dollars a year because they turned out to be infected with a smorgasbord of exotic pests and pathogens.

Quarantine entomologists and plant pathologists discovered a number of serious nasties. Entomology officer Rebecca Graham says, "We're still examining insects, but so far we have discovered almost 20 species, including several types of ants, mealybugs, mites and thrips that are exotic to Western Australia and that could cause big problems for local fruitgrowers."

Quarantine plant pathologist Alison Mackie adds, "The range of fruit is highly unusual; there are some varieties we've never seen in WA.

"The bananas, which could carry panama, freckle, moko and blood diseases, and the limes, which are showing signs of being infected with citrus canker, are of particular concern -- any of these diseases could potentially devastate Australia's valuable banana and citrus industries."

AQIS now screens a minimum of 80 per cent of passengers arriving at Australia's international airports for quarantine risk items, more than treble the number screened at this time last year. Currently, an average of 38,000 items of quarantine concern are seized at international airports per month — an increase of 74 per cent since early 2001.

"Every Australian has a part to play in helping AQIS protect our unique environment — and the agriculture industries on which thousands of jobs depend — from exotic threats," says Rebecca.

To find out what can be brought into Australia, visit the AQIS website at www.aqis.gov.au

Further inquiries:

Jen O'Reilly - AQIS Public Relations (08) 9311 5350 (w) 0412 341 143(mobile) .

INFORMATION FOR HIGHER SCHOOL CERTIFICATE (HSC) STUDENTS

What is quarantine?

To protect Australia from human diseases, and exotic plant and animal pests and diseases, (i.e. pests and diseases from other countries) the Australian Quarantine and Inspection Service (AQIS) works closely with the Australian community.

AQIS provides quarantine inspection services for the arrival of international passengers, cargo, mail, animals and plants (or their products) into Australia. The men and women who work for AQIS are on duty 24 hours a day, every day of the year – whenever people, plants and animals arrive at Australian airports and seaports.

AQIS's role in protecting Australia is vital for the health and sustainability of our environment, our unique plants and animals, and our agricultural industries (worth $22 billion a year in agricultural exports).

Australia's isolation from the rest of the world used to mean that keeping out unwanted pests and diseases was easier than it is today. However, globalisation has made quarantine's job much more challenging – as the world gets 'smaller', protecting our shores requires ever more vigilance.

The scope of the problem

Each year, more than seven million passengers and about 20 million tonnes of cargo pass through quarantine on arrival at Australian airports and seaports. Also, about 170 million items of international mail enter Australia every year. All of these arrivals pose a risk to human health, our agricultural industries and our natural environment because they could carry hidden pests and diseases.

In addition to personal items (e.g. gifts and souvenirs) carried by passengers or sent by mail, cargoes of animals, plants, foodstuffs and other items that are important for our international trade could also introduce pests or diseases.

Prohibited Items

Many countries have pests and diseases that could have a disastrous effect on Australia's animals and plants. So far, we've managed to keep most of these pests and diseases out of Australia.

Pests and diseases could be carried into Australia by: people, animals, animal products (such as meat), plants, plant products (such as timber), or in soil on machinery. This is why AQIS prevents prohibited items (items that are forbidden by law because they are a quarantine risk) from entering Australia and why other items must undergo quarantine inspections, and plants and animals must be isolated at quarantine stations (so that any pest or disease can be isolated and prevented from spreading).

For more information on pests and diseases of quarantine concern you can find the following publications on the AQIS website www.aqis.gov.au:

Are You Alert to Quarantine?

Forests and Timber: A field guide to exotic pests and diseases

Northern Australia Quarantine Strategy (NAQS) Handbook

Types of quarantine

In Australia, quarantine works in a number of different ways: border controls look after the clearance of passengers and cargo into Australia, while animal, plant and human quarantine look at the scientific risks of particular pests and diseases and what actions need to be taken to prevent them entering Australia.

1. Border Control

Border controls are carried out at checkpoints at international airports, seaports, mail exchanges and container depots. Passenger and cargo clearance are the two types of quarantine control at the main entry points into Australia. Quarantine officers use a range of screening techniques including computers, detector dogs, X-ray machines, surveillance, scientific support and visual inspection.

2. Animal quarantine

Animal quarantine applies to all kinds of animals from insects, fish and birds, to larger animals. Animals coming into Australia must spend time at specially equipped quarantine stations when they arrive to ensure that they are free of disease before entering the country.

Websites relating to animal health (for reference):

AFFA's Animal and Plant Health	www.affa.gov.au
Animal Health Australia	www.aahc.com.au
Office Internationale des Epizootie	www.oie.int
Australian Animal Health Laboratory	www.csiro.gov.au

3. Plant quarantine

All plants or parts of plants, such as fruit, seeds, cuttings, bulbs and corms, as well as things made from wood or bamboo, must be examined, and if necessary, treated by Quarantine officers. Living plants must be kept at plant quarantine stations to make sure they're not carrying pests or diseases.

Websites relating to plant health (for reference):

AFFA's Animal and Plant Health	www.affa.gov.au
Weeds Australia	www.weeds.org.au

4. Human quarantine

Quarantine officers monitor reports about the health status of passengers arriving in Australia to ensure that they are not suffering from infectious diseases like yellow fever.

A number of infectious diseases can be spread to other people by insects such as mosquitoes. If these diseases were allowed into Australia it would be very difficult to eradicate them. As such, all international airports in Australia have a surveillance-monitoring program to ensure that known insect carriers of human disease are quickly detected and destroyed.

Other related websites (for reference):

Department of Health and Aged Care www.health.gov.au

World Health Organisation www.who.int/home-page

(includes information on vaccination requirements and health advice for international travellers and details on disease outbreaks)

We all play a part in protecting Australia

Protecting Australia from unwanted pests and diseases requires the joint effort of:

- Australian citizens;

- visitors to Australia;
- Australian Quarantine and Inspection Service (AQIS);
- Commonwealth and State Governments;
- Department of Agriculture, Fisheries and Forestry Australia;
- State and Territory departments of agriculture or primary industries, or their equivalent;
- other government bodies such as the Australian Customs Service, sea and air transport staff (including customs agents, shipping companies, stevedores, airline companies and their staff), Environment Australia, Commonwealth and State police authorities, and the Australian Defence Forces; and
- private companies and organisations such as sea and air transport (including customs agents, shipping companies, stevedores, airlines and their staff).

Our Commonwealth and State Parliaments have passed special laws that set out the roles and responsibilities of all people in protecting Australia from pests and diseases. The Commonwealth law is called the Quarantine Act. 'Act' is another name for a law passed by Parliament. A law is a set of rules. All Australians and all people who visit Australia are expected to obey the Commonwealth and State quarantine rules.

State Quarantine Acts set out special rules for protecting the State or Territory where you live. If you live in Tasmania, for example, then two sets of quarantine rules apply; the Commonwealth rules on national quarantine, and the State rules that protect Tasmania.

All visitors to Australia are required to obey national quarantine rules and any rules that are specially designed for the State or Territory they are visiting.

Everyone has a role to play in relation to quarantine compliance. Some groups may have an official role, but others have a community or increased quarantine awareness role, such as a reporting activity.

For more information on interstate quarantine regulations and issues within Australia:

NSW Agriculture
http://www.agric.nsw.gov.au/home.html.

Queensland Department of Primary Industries: http://www.dpi.qld.gov.au/home/default.html

VIC Department of Natural Resources and Environment
(under Plant and Animals section)
http://www.nre.vic.gov.au/

Agriculture Western Australia
http://www.agric.wa.gov.au/

Department of Primary Industries,
Water and Environment Tasmania
http://www.dpiwe.tas.gov.au/

Primary Industries and Resources
South Australia (under their Agriculture site)
http://www.pir.sa.gov.au

Department of Primary Industry and Fisheries NT
http://www.nt.gov.au/dpif/

Effectiveness of Quarantine

AQIS recognises that natural movements such as those of migratory birds and wind-borne organisms, as well as massive influxes of people, aircraft, cargo, vessels and mail, means that pests and diseases of animals, plants and people will inevitably cross our borders, notwithstanding AQIS's best efforts to prevent it.

A comprehensive review of Australia's quarantine issues, and animal and plant quarantine policies and programs (and their effectiveness) was conducted in 1996. The report – Australia Quarantine: A Shared Responsibility – was presented to the Government with 109 recommendations.

History of the administration of quarantine

The *Quarantine Act 1908* derives its authority from Section 51(ix) of the Constitution. It was introduced as a result of the States' perception of the need for a comprehensive set of national laws governing the control of infected persons, vessels, goods, animals and plants entering the country from overseas.

Before proclamation of the Commonwealth Act, the States had enacted uniform quarantine legislation, generally known as the Federal Quarantine Acts. The Commonwealth Act, which was given effect on 1 July 1909, tended to follow the principles embodied in the State legislation. Under the Administrative Arrangements Order of the day, the Act was to be administered by the Department of Trade and Customs. While under Customs administration, the position of Director of Quarantine was created to assume responsibility for policy development in quarantine matters.

With the creation of the Commonwealth Department of Health in 1921, quarantine policy was vested in the health portfolio. Service delivery aspects of animal and plant quarantine continued to be carried out by State departments (as was the case before Federation), while human quarantine services were gradually taken over by the Commonwealth.

The quarantine function remained under the Department of Health's administration until being transferred to the Department of Primary Industry (now the Department of Primary Industries and Energy) in December 1984. The States continued to deliver operational services for quarantine under formal agency arrangements with the Commonwealth until 1995.

In 1995, the Agriculture and Resource Management Council of Australia and New Zealand agreed to transfer service delivery functions from the States to direct Commonwealth control. Operational services in the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria have been transferred. Service delivery functions in the care of the other States remain unchanged.



The above history is taken from

"Australian Quarantine - a shared responsibility".

M.E. Nairn, P.G. Allen, A.R. Inglis and C. Tanner Department of Primary Industries and Energy Canberra 1996 © Commonwealth of Australia 1996 ISBN 0 642 25971 2

7

New technologies

Sandy McClintock

Introduction

Genetic improvement in dairy cattle has relied mainly upon the selection and extensive use of superior sires through artificial insemination (AI), as explained in the introduction to *Chapter 6: Existing Technologies.*

The use of embryo transfer has remained at a low level overall, but is common in those stud herds where bulls are produced for AI centres. This has the effect of increasing the selection pressure on those cows used to breed bulls.

Developments in biotechnology and embryology may provide the basis for large changes to the way we make genetic progress but the scientists involved in these areas are not making rash promises about big changes in the near future. Some of the new technologies, while only remote possibilities at present, would be of enormous benefit if they could be successfully developed.

Embryo multiplication and transfer

Embryo multiplication and transfer (EMT) has the potential to revolutionise the cattle industries, providing it can be done cheaply (e.g. $30 per embryo), with a reasonable pregnancy rate when frozen (e.g. 50%) and with a large number of copies per starting embryo (clone family size of about 100,000).

Figures 7.1 to 7.4 depict various possible scenarios involving EMT. *Figure 7.1* shows that EMT by itself would offer very little.

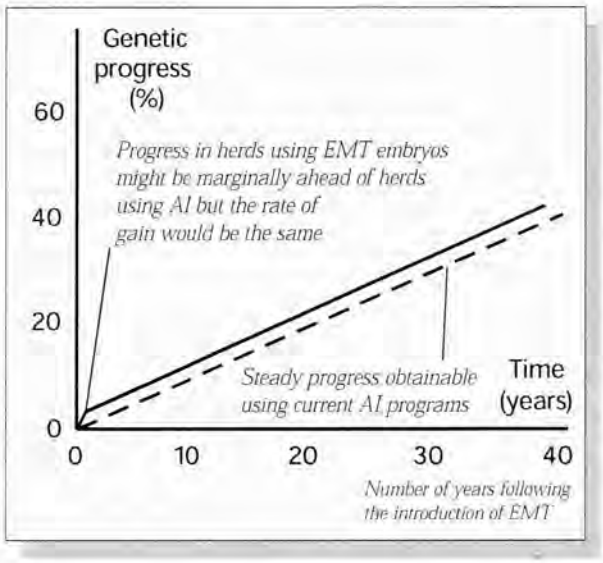


Figure 7.1: EMT by itself will be of marginal benefit, but when selection *of the best embryo families is practised, then this situation will change. (See EMT dairy testing system in Figure 7.2.)*

Figure 7.2 shows that an EMT testing program could generate dramatic gains, but thereafter the annual increases would be less than what we have currently with artificial insemination. The assumption is that AI programs would become less attractive as EMT became more attractive; eventually there would be too little interest in AI to be able to run conventional progeny testing.

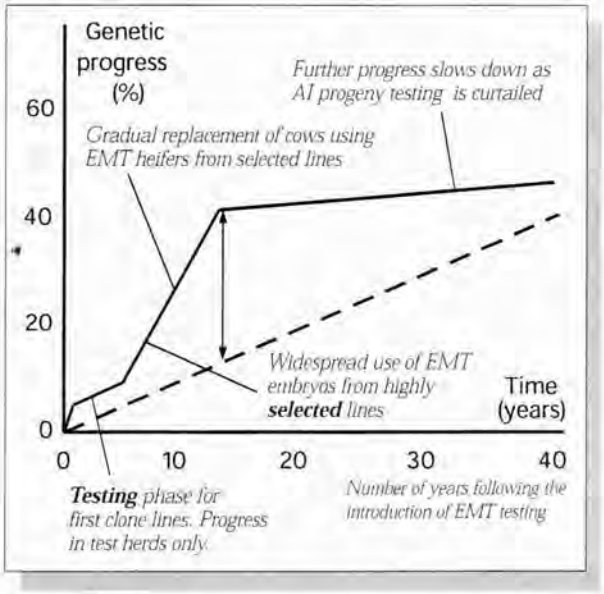


Figure 7.2: Effect of introducing an EMT dairy testing system. One could expect an initial jump of about 30% in per cow production. If one assumes that AI progeny testing were severely curtailed as a consequence, then genetic progress would slow down dramatically.

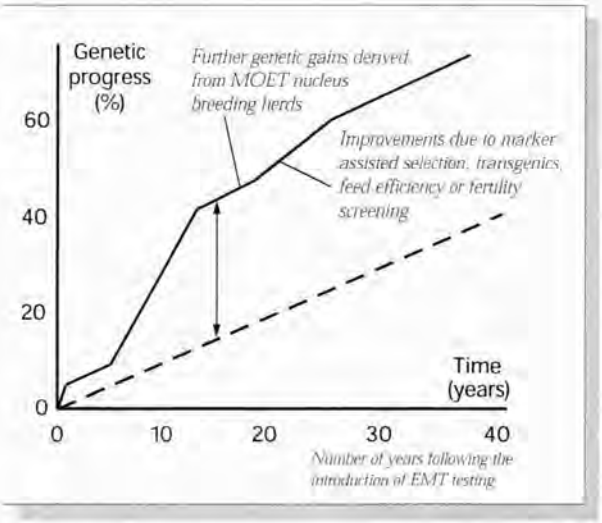


Figure 7.3: Effect of introducing an EMT dairy testing system and a MOET nucleus testing program. It is assumed here that a MOET nucleus breeding scheme (e.g. the Dutch Delta Program) would become the driving force for further genetic progress. Yet further gains could be expected if marker assisted selection, transgenics or selection on traits such as feed efficiency were introduced.

Figure 7.3 shows that the introduction of MOET nucleus testing herds could replace our current AI progeny testing programs as the genetic engine that drives further genetic change. At present MOET nucleus testing schemes are very expensive to run and for this reason do not compete well with bull progeny testing schemes. The Dutch farmer cooperatives have set up what they call their Delta Program, costing some $4,000,000 per year. Genetics Australia has formed an alliance with Holland Genetics, so this may be a useful source of elite female embryos for family testing in Australia.

Figure 7.4 shows the complete picture, combining all new reproductive and genetic technologies.

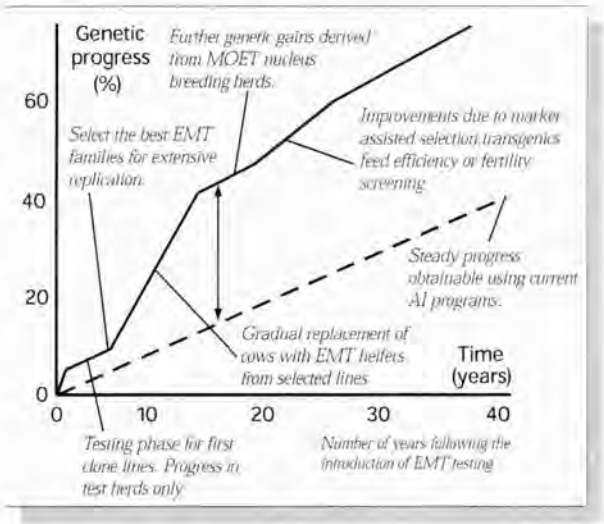


*Figure 7.4: **The complete picture**. EMT dairy testing, MOET nucleus breeding scheme, marker assisted selection, transgenics, or selection on traits such as feed efficiency.*

Relevance of EMT to the dairy industry

EMT would become relevant to the dairy industry if large numbers of female clone families (about 100 per year) are tested by distributing 100–200 sexed embryos from each family into test herds. This is like the progeny testing of AI bulls, but takes two years less time to complete and offers a higher genetic

standard. *Table 7.1* compares the timing and steps in conventional progeny testing programs with the EMT approach.

This may be less expensive than bull progeny testing programs and will eliminate the cost of maintaining bulls. Once the first batch of clone families completes their test, the top five would be replicated on a large scale and sold.

Year	Conventional AI testing program	EMT testing program
0	Mate best bulls with best cows	Mate best bulls with best cows. Distribute female EMT embryo lines.
1	Bulls born	EMT test heifers born
2	Bulls produce test semen	EMT test heifers mated
3	Progeny born	EMT test heifers calve
4	Progeny performance recorded Sire gets a progeny test for dairy traits	EMT lines get an ABV
5	Daughters calve	Main crop of EMT heifers born
6	Sire gets a progeny test for maternal traits	Main crop of EMT heifers mated
7	Second crop daughters born	Main crop of EMT heifers calve
8	Second crop daughters mated	
9	Second crop daughters calve	

Table 7.1: Comparison of conventional AI and EMT bull testing programs.

Relevance of EMT to the beef industry

In the beef industry a different mechanism is envisaged. Male embryos would be multiplied and tested for suitability as natural service (NS) bulls. Ideally this will involve fertility measures, the bull's own performance traits, progeny growth and carcass traits, and for some breeds, maternal traits. Despite the high cost of recording feed efficiency, EMT would make it worth screening for feed efficiency. Specialist maternal and terminal beef breeds could be produced. A return of $2000 per NS bull is a reasonably conservative figure so assuming that there are perhaps 100,000 beef bulls being used each year in Australia, then the annual benefits might be $2000 x 100,000. While the number of bulls could be much less than this if uptake was slow, the $2000 per bull might be a low estimate, particularly because a bull's potential can be expressed through 150–200 progeny.

Marker Assisted Selection (MAS)

Ideally we would like to know all the genes that affect profitability of farm animals and be able to detect them cheaply. For the moment this is not possible so in the meantime scientists are looking for marker genes that can be detected easily and may be linked to genes of importance. It seems unlikely that markers will be of great value in animal breeding, but they may assist, hence the current terminology of *Marker Assisted Selection* (MAS).

Most geneticists believe that a number of genes are involved in controlling the productivity of farm animals, so it will be difficult to find one single gene that makes a big difference.

MAS could lead to more accurate ABVs and could provide a way to discriminate between OPU oocytes taken from foetuses or young calves before they have records of their own.

Semen sexing

There seems little prospect of any commercial semen separation system gaining popularity. Considerable effort has been expended over the last 30 or 40 years with no useful results. However the use of *Fluorescence*

Activated Cell Sorting (FACS) holds the prospect of partial separation of small quantities of semen which would be ample for *In Vitro Fertilisation* (IVF) use.

Under these circumstances, FACS separated semen would almost double success rates and hence greatly reduce costs. The prospect of embryonic mortality due to mutations caused by the FACS process is not attractive. It is possible that the unviable embryos produced using FACS semen could be screened during culture but, if mutation was too much of a problem, there would be no point in using FACS semen. For further information on this topic, see *Chapter 14: Semen and Embryo Sexing.*

Oocyte Pick-Up (OPU)

OPU seems unlikely to become used on a large scale to produce embryos for use by commercial farmers. However the technique could improve the effectiveness of other important technologies.

- In conjunction with MAS, there is a real prospect for a dramatic acceleration in the rate of genetic gain. This is particularly true if oocytes can be extracted from mid-term foetuses.
- OPU could reduce the time required to test transgenic individuals.
- OPU offers AB centres the opportunity to use an outstanding new sire more rapidly than is possible with conventional breeding or ET. The attractiveness of this will vary from year to year and breed to breed. While OPU is of borderline attractiveness with current success rates, it is reasonable to anticipate much higher efficiencies and hence lower costs.
- OPU offers the prospect of more rapidly multiplying up the number of offspring from a rare transgenic individual than would be expected from ET alone.

If young calves could be screened cheaply (but with limited accuracy) using genetic markers, then it would become attractive to select them at, or before, birth.

Conclusion

There are a number of new technologies currently being researched, which may one day be of benefit to dairy farmers. Most of these potential technologies will simply make existing breeding programs a little better. However, Embryo Multiplication and Transfer (EMT), if it were to become a viable technology, would cause a revolution in breeding systems.

Further reading

McClintock A.E. and Nicholas F.W. (1991), *The Implications of Advanced Breeding Techniques*, Australian Meat and Livestock Research and Development Corporation, Sydney, US.016.

Nicholas F.W. (1996), *Introduction to Veterinary Genetics*, Oxford University Press, UK.

Conventional embryo transfer

Ian Lewis

Background

The first successful embryo transfer (ET) in animals was performed last century in rabbits. However it is only in the last 15 to 20 years that commercial techniques have become available for applying these procedures in cattle on-farm.

The technique basically involves stimulating cows to have multiple ovulations instead of just the one (or occasionally two) that occurs naturally. After the cow is mated and the ovulated eggs are fertilised, a number of embryos develop that can then be recovered and transferred into recipient cows, which carry the pregnancies to term. Hence the term Multiple Ovulation and Embryo Transfer (MOET) or just 'ET'.



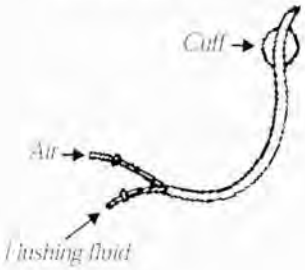
Superovulation of donor with hormones



Artificial insemination (5 days after initiating superovulation)



Non surgical recovery of embryos (6-8 days after mating) using a Foley catheter



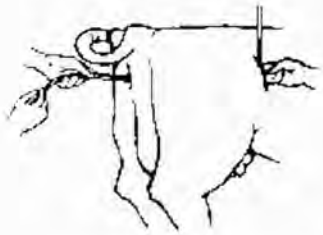
Foley catheter for recovery of embryos



Isolation and classification of embryos



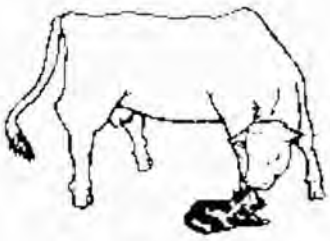
Storage of embryos indefinitely in liquid nitrogen or at room temperature for a few hours



Transfer of embryos to recipients surgically or non-surgically



Pregnancy diagnosis by palpitation through the wall 1-3 months after embryo transfer



Birth (9 months after embryo transfer)

Figure 9.1: Embryo transfer

Introduction

Genetic gain in cattle is limited on the female side by:

a. the low reproductive rate with only one, or occasionally two, offspring per year.
b. the relatively long interval between generations, since cows are two to three years old before they have their first calf.

MOET attempts to improve these natural limits to genetic gains in cattle by obtaining many more offspring in a shorter time frame from elite females than is normally possible. The process of embryo transfer is shown on the previous page in *Figure 9.1*.

Fertility drugs used in MOET

When a heifer is born, each of her ovaries contains between 50,000 and 100,000 eggs (oocytes). By the time she is two years of age most of these have died and only about 5,000 eggs remain in each ovary. Why this loss occurs is not known, but it happens in most species, including humans. Out of the 10,000 remaining eggs, only 5 to 10 will normally result in calves on the ground.

As previously described in *Chapter 2*, follicles develop in 'waves' in the ovary during a normal cycle, but usually only one follicle (or two in the case of non-identical twins) sheds an egg at ovulation.

In MOET the aim is to stimulate a number of follicles to continue growing and to ovulate. This is achieved by giving an excess of the naturally-produced hormone Follicle Stimulating Hormone (FSH). Using a series of FSH injections over a number of days an average of 10 or more follicles develop on the ovaries (although the range is large, between 0 to 100).

Shortly after heat, most of these follicles release an egg which, after fertilisation in the oviduct (following AI or natural mating), moves into the uterus as an embryo. A typical MOET hormonal stimulation program is shown below in *Table 9.1*.

Date	Day	Donors	Recipients
30/10/96	Wednesday	Inject first prostaglandin	
10/11/96	Sunday	Inject second prostaglandin	
13/11/96	Wednesday	Presynchrony heats	
17/11/96	Sunday	Insert CIDR*	Insert CIDR*
19/11/96	Tuesday	Inject Oestradiol 17B	
23/11/96	Saturday	First FSH injection (a.m.) Second FSH injection (p.m.)	
24/11/96	Sunday	Third FSH injection (a.m.) Fourth FSH injection (p.m.)	Inject prostaglandin (noon)
25/11/96	Monday	Fifth FSH and third prostaglandin injection (a.m.) Sixth FSH and fourth prostaglandin injection (p.m.) Remove CIDR* (p.m.)	Remove CIDRs* (noon)
26/11/96	Tuesday	Seventh FSH injection (a.m.) Eighth FSH injection (p.m.) Heat check/artificial insemination	Heat check
27/11/96	Wednesday	Heat check/artificial insemination	Heat check
28/11/96	Thursday		Heat check
4/12/96	Wednesday	Flush date	Fresh embryo transfer date or embryo freezing date

AI donors 12 hours and 24 hours after standing heat first seen
Inject donors with prostaglandin 2 days after flushing

Table 9.1: Typical hormonal stimulation program for donors and heat synchrony program for recipients

Recovery of embryos

The embryos can be flushed out of the uterus about seven days after heat. A rubber tube called a **catheter** with an inflatable balloon on it, which holds the catheter in place, is inserted into the uterus via the cervix (see *Figure 9.2*). A special salt solution, in which embryos are known to live for 10 hours or more, is then flushed into and out of the uterus and collected through a fine filter which captures the embryos. Each uterine horn is flushed with fluid 5 or 6 times using a total of half to one litre of fluid. By this time all the embryos have been washed out of the uterus and captured on the filter.

The filter is then washed into a dish and the embryos located under a microscope.

Not all of the eggs released from the ovary are fertilised (for a number of reasons) and not all of those that are fertilised develop into embryos. On average about 60% of the eggs released from superovulated ovaries develop into transferable embryos.

Of these transferable embryos, some are of good quality (A Grade or 1st quality) while others are poorer in quality and give lower pregnancy rates after transfer. A decrease in quality of embryos is due to the death of some cells during development. However, in poorer quality transferable embryos, enough cells remain alive and dividing to give at least a chance of establishing pregnancy. Calves resulting from poor quality embryos have an equal chance of developing into good quality calves as those resulting from top quality embryos.

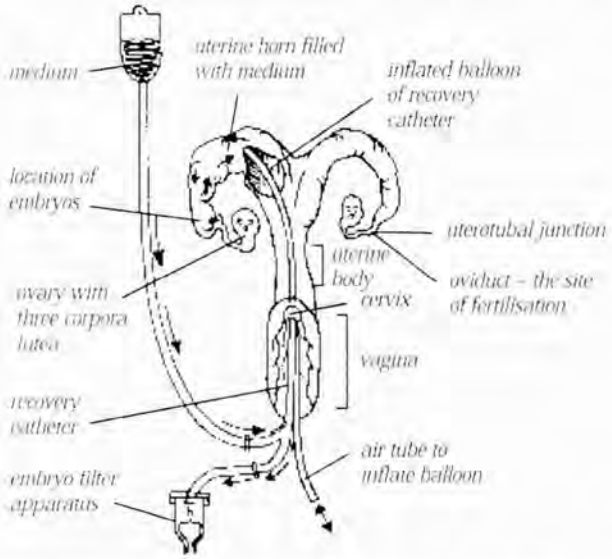


Figure 9.2: Non-surgical recovery of embryos using a gravity feed system

Transfer of embryos

When they are found under the microscope, the embryos are loaded into straws and implanted into recipient cows. The cow that 'donated' the embryos is called the donor cow. The recipient cows normally receive one embryo each, carry the pregnancy through to term and rear the resultant calf. They therefore act as surrogate mothers, although they have absolutely *no* genetic input into the calf.

The recipient cow is induced to have a heat around the same time as the donor. The egg released from the recipient cow's ovary remains unfertilised. Acceptable pregnancy rates are achieved if the recipient and donor have a heat within a day of each other.

There are two ways to implant an embryo into a suitably prepared recipient female: non-surgical transfer and surgical transfer.

Non-surgical transfer

The embryo is placed into the uterine horn via the cervix, using a long metal 'gun' very similar to the one used for AI. During AI, semen is deposited just in front of the cervix, whereas embryos must be placed much deeper inside the uterus. AI is performed around the time of heat whereas embryos are implanted one week later. Most embryos are now transferred non-surgically.

Surgical transfer

A hole is made in the flank of the animal under local anaesthetic. A section of the uterus is brought to this incision and a small hole is made in the wall of the uterus through which the embryo is deposited.

Freezing embryos

If there are not enough recipients available, excess embryos can be frozen and stored for later use. Recent improvements in embryo freezing and thawing techniques makes this an attractive option. Only top quality embryos should be frozen. Poor quality embryos should be transferred fresh (non-frozen) as they give poor results when frozen and thawed.

Results obtained

Number of embryos

While it is possible to obtain up to fifty or more transferable embryos from one treatment (flush) these cases are rare. In fact, a large retrospective study of many thousands of cows flushed indicated that 25 to 30% of cows gave one or less transferable embryos. Thus while the range is large, an average of 8 embryos and eggs are recovered per donor cow flushed when large numbers of flushes are taken into account. Of these eight embryos and eggs, five embryos suitable for transfer are usually obtained.

Pregnancy rates following transfer of embryos

Pregnancy rates of 60–70% can be expected from all embryos transferred fresh (that is not frozen and thawed). The pregnancy rates for frozen and thawed embryos are slightly less than those of fresh embryos (50–60% on average).

While it is possible to get much better (or worse) results than these, the average over many farms and many programs will be close to the figures given here.

Management of donors and recipients for ET programs

Proper management

Proper management of donors and recipients is critical to the success of any ET program. *Nutrition is probably the most important single factor for both donors and recipients.*

Disease control

All animals should be healthy and free from disease. Diseases such as Pesti Virus (also known as Bovine Virus Diarrhoea, BVD, or Mucosal Disease) and leptospirosis can adversely affect results, as can other diseases. Vaccination with 5-in-1 and leptospirosis vaccines is essential and should be discussed with your embryo transfer operator, or local veterinarian.

Heat detection

Proper heat detection is vital for both donors and recipients.

Tail paint, Kamars etc. are useful to assist in heat detection but should not replace visual heat checking to pick animals in standing heat. These aids can give misleading results.

Animals should be heat checked at least four times daily - early morning, midday, dusk and around 11 p.m.

Donors

Condition and nutrition

Donors should be a minimum of two months post-calving.

They should be in forward-store condition ie. neither too fat, nor too thin. Animals which are too fat should be 'locked up' in a yard or bare paddock until they lose weight, as over-fat animals usually perform poorly in ET programs.

However, irrespective of the condition of the animals, they should be on good to excellent feed for five or six weeks prior to flushing. If the pasture is inadequate for this purpose then supplementary feeding will be required with good quality hay and grain.

The amount of supplementary feeding required depends on the quantity and quality of the available pasture and on the animals. As a rough guide, if *no* pasture is available then 5–6 kg of good quality hay and 2–4 kg of grain per animal per day would be required. A rising *energy* plane is the key. Grains such as barley and oats are high in energy and low in moisture, and are ideal for increasing energy levels.

Vitamin and mineral supplementation

In general, if the feed is adequate in quantity and quality then the vitamin/mineral status of the animal should also be adequate. However, in certain situations, supplementation with vitamins and minerals may be required.

It is a good idea to give donors an injection of Vitamin A, D and E three to four weeks before flushing. There is also evidence that selenium may become limiting in some circumstances, so supplementation either by injections or preferably a rumen bullet (which lasts for up to 18 months) may help. Copper, either as a deficiency or an excess, can also be a problem.

Vitamin and mineral deficiencies tend to be regional and/or seasonal and should be discussed with either your local veterinarian or Department of Agriculture.

Age of donors

Cows from 3 to 8 years of age generally give the best results. While heifers can perform very well on occasions, they give slightly fewer embryos on average than cows between 3 to 8 years old. Likewise older cows can sometimes give large numbers of viable embryos but in general do not do as well as younger cows.

Cows on their first calf are always a challenge because they are still growing as well as lactating, and their nutrition must be excellent to achieve good results in embryo transfer.

Number of inseminations

Generally two inseminations are recommended, the first one around 12 hours after the start of heat and the second one 12 hours later.

With good quality semen and much experience with ET programs, one insemination can be sufficient. If one insemination is to be used, it is important to heat check frequently and inseminate 10 to 20 hours after the beginning of standing heat (ideally, at around 18 hours). One problem that can arise with single inseminations in ET is that when a large number of eggs are released from the ovary, ovulation can be spread over 24 hours or more. By the time the last eggs are shed from the ovary there may not be enough live sperm left to fertilise them. It is critical that correct AI procedures are followed exactly and that only very experienced AI technicians are used.

Genetic factors between and within breeds

Some cow families are better embryo donors than others, and this trait can be passed on between generations. While there are some isolated differences between breeds, most breeds perform well as embryo donors if they are well managed, with special emphasis given to nutrition.

Stress

Any undue stress will adversely affect the number of viable embryos recovered. Extremes in weather conditions (either too hot or too cold) can greatly affect results and lead to a high percentage of unfertilised eggs and degenerate embryos being recovered.

When it is hot, the donors should be in shaded paddocks. The distance that they must travel to be handled should be minimised. In cold conditions ensure shelter is available, increase feed levels and again minimise the distance they must walk to the yards.

One option is to avoid flushing during the worst of the summer and winter months.

The importance of avoiding nutritional stress, having rising energy planes and properly conditioned cows cannot be over-emphasised in ET. There are many variables that must be considered. These include:

- Stage of lactation
- Time of year

- Available feed
- Quality of supplementary feed
- Available shelter
- Distance of yards
- Body condition of animals

Recipients

The costs associated with recipients in ET programs are large and should not be underestimated. Maximising pregnancy rates and minimising the number of empty recipients and calving losses are all important considerations.

Nutrition

As with donors, nutrition is the single most important factor affecting pregnancy results following embryo transfer to recipients. Animals should not be over-fat. However, irrespective of their body condition, animals should be on a rising plane of nutrition (*energy* is the critical factor, *not* protein) for 3 to 4 weeks before the transfer date and kept on the same feed for at least 3 weeks post-transfer.

Occasionally it is difficult to avoid having overweight animals because of seasonal conditions, etc. These animals actually require more feed for the lead-up period to get them onto a rising energy plane than thinner animals.

As a rule of thumb if no pasture is available then 5-7 kg of hay and 2-4 kg of grain are required per head per day for adequately rising energy planes. Even when adequate pasture is available feeding around 2 kg of grain provides increasing energy levels prior to the program. In spring, when pasture is lush but lacks bulk, feeding hay is essential to add fibre.

Depending on locality and seasonal factors, vitamins and mineral supplementation may be required. For example, during long dry spells Vitamin A may be required, and in certain areas minerals such as Selenium, Copper, etc. may be limiting. These should be discussed with your local veterinarian, Departments of Agriculture and ET technician.

Age of recipient, calving status, etc.

Heifers or cows are suitable recipients providing they are healthy, and disease and parasite free. If cows with calves are to be used as recipients the calves should be at least two to three months old. These cows with young calves are only acceptable if they have calved in good condition and are on high quality nutrition. First-calf heifers with young calves are generally less fertile than other classes of breeding females. It must be emphasised that an animal feeding a calf requires much more feed than a heifer or dry cow.

Any animal that has had the opportunity to get in calf, but which has not done so, should not be used as a recipient. If there is any suspicion that an animal may be a non-breeder, or a late breeder, she should not be used as a recipient. All recipients should be pregnancy tested empty before going into an ET Program.

Heifers have the advantage of being easier to manage (no calf at foot), require less feed, less risk of uterine infections and cost less to buy.

However, the disadvantage is that heifers will have more calving problems than cows. They should therefore be 'roomy' and well grown (over 300 kg at implantation).

Identification

It is critical that recipients are properly identified for both accurate heat checking and to avoid confusion after transfer. A large easy to read tag in each ear is best. Hair should be clipped from the ears and the tags cleaned prior to the program so that the tags can be easily read.

If identification is not easy then errors will occur at heat checking which will result in reduced pregnancy rates.

Synchronisation of recipients

For best results in ET, the donors and recipients should come into heat as close together as possible. Embryos should only be transferred into recipients which have had heats within 36 hours (and preferably within 24 hours) of the donor.

Therefore, the method of heat synchronisation is important. Two injections of prostaglandin 11 days apart will bring most recipients into heat about three days after the second injection. However, with this method there is often quite a spread of heats over two to three days.

The use of a CIDR® (without the capsule) with a prostaglandin injection before CIDR® removal is an excellent method for achieving a tight spread of heats in a herd of recipients. For example, having a CIDR® in for 8 days with a prostaglandin injection on the morning of Day 7 brings a high percentage of recipients into heat 48 hours after the CIDR® is removed (on Day 8). This leads to a high utilisation of recipients.

Alternatively ear implants (Crestars®) can be used in a similar way to CIDRs®. Both CIDRs® and Crestars® have the hormone progesterone in them.

Whatever method is used, results will be poor if recipient management, especially nutrition, is not optimum.

Heat checking is important. Only animals seen in standing heat should be used. Heat checking should be done 4 times daily – early morning, midday, dusk and around 11 p.m. (some heifers have short standing heats during the night). Tail paint and Kamars are useful aids, but should not replace regular heat checking.

No more than 40 cattle in a herd can be adequately heat checked when they are synchronised.

A snap of cold weather nearly always delays heat, and reduces the number of animals showing heat.

Re-using recipients

If a recipient has received two or three good quality embryos (in successive programs) and has not become pregnant, she should be culled.

If a recipient has been lined up on more than three occasions and has not received an embryo, either because she has not had a heat or because she had a heat but did not develop a corpus luteum on her ovary, she should be culled.

Further reading

Hafez E.S.E. (Ed.) (1987), *Reproduction in farm animals*, 5th edition, Lea and Febiger, USA.

Production of cattle embryos in the laboratory (in vitro)

Ian Lewis

Definition

In vitro means outside the animal, in the laboratory (i.e. in test tubes). *In vivo*, on the other hand, means inside the animal.

The *in vitro* production of embryos therefore means the production of embryos (including fertilisation) in test tubes in the laboratory. *In vivo* embryos are those that are fertilised and grown inside the animal such as those that are collected and transferred in traditional embryo transfer (ET).

History

The techniques for fertilising cattle eggs and growing (culturing) the resulting embryos in the laboratory were discovered during the 1980s. The first calf produced by *in vitro fertilisation* (IVF) was born in 1982, whereas the first human 'IVF' baby was born in 1978.

One major breakthrough in cattle IVF involved understanding how to treat bovine sperm with chemicals. This enabled the sperm to fertilise eggs in the test tube, instead of inside the cow where naturally produced chemicals give sperm the ability to fertilise eggs.

Techniques used for the *in vitro* production of embryos

Once oocytes (eggs) are collected from the ovaries of valuable animals, there are three separate techniques that must be used to produce embryos: *in vitro maturation*, *in vitro fertilisation* and *in vitro culture*. Once these embryos are about seven days old, they are transferred into suitably prepared recipient (surrogate) cows or frozen for later transfer. These cows carry the pregnancy to term although they have no genetic input into the calf.

In Vitro Maturation (IVM)

The eggs that are collected from the ovaries are immature. This means they are not 'ripe' and cannot be fertilised until they have been matured (ripened).

This maturation process takes 24 hours and is done in a special salt solution which contains hormones. This solution attempts to mimic the events that occur naturally in the cow's ovary in the 24 hours prior to ovulation.

In Vitro Fertilisation (IVF)

Once they are ripe the eggs can accept the sperm and so become fertilised. However before this can happen the sperm themselves must be treated with a special chemical called heparin.

Normally when a cow is mated, either using AI or a bull, the sperm must spend 6 to 8 hours in the reproductive tract of the cow before they can fertilise the egg released from the cow's ovary. During this time natural chemicals (similar to heparin) 'mature' the sperm so that it can penetrate the egg. However in IVF heparin must be added.

Between 2,000 and 20,000 individual sperm are required to fertilise each egg, depending on the bull. Different bulls differ in their fertilising ability in IVF.

In Vitro Culture (IVC)

The sperm are left with the eggs for around 24 hours, after which time the fertilised eggs (now called *zygotes*) are placed into a different salt solution where they develop. *Culture* is the name given to the process of growing the embryos in the special salt solutions.

After fertilisation, when the sperm enters the egg, the zygote is still only one cell. It then divides and after 24 hours a two-cell *embryo* results. Cell division (or *cleavage*) continues, and once every 12 to 24 hours each newly formed cell divides again, so that about seven days after fertilisation the embryo contains 100 to 140 cells (see *page 8* for diagrams). At this stage (*blastocyst* stage) it is ready to be transferred into a recipient cow which showed signs of heat seven days earlier.

The *in vitro* production of embryos therefore involves a series of complex steps. If any one of these steps is not optimum then few or no embryos will result.

One of the most critical components of the whole procedure is the media or special salt solutions used for maturation, fertilisation and culture. The exact composition of these solutions is vital for success.

The present results from the *in vitro* production of embryos are still a long way from optimum. From every 100 eggs put into the system, ten to fifteen calves should result if everything goes smoothly.

This technology is still very new and the techniques and media are constantly being refined. Results will steadily improve making the technology more and more commercially attractive.

The development of techniques to grow embryos in the laboratory from eggs taken from the ovaries of valuable animals (either calves or adult cows), has opened up several new reproductive technologies for commercial use.

The whole process of producing embryos in the laboratory, including IVM, IVF and IVC is referred to as the *In Vitro Production* (IVP) of embryos.

Oocyte Pick Up (OPU)

OPU from adult cows

Oocyte Pick Up in adult cows is carried out using a special ultrasound machine inserted into the vagina. The procedure can be performed several times per week and is described in more detail in *Chapter 11*.

Animals that are large enough to undergo rectal examination can have eggs harvested from their ovaries using this technique. It can be used in older animals that have become sterile and which cannot produce a calf either naturally or through conventional ET techniques. It can also be used on pregnant animals and calves as young as five months old.

OPU from young calves

Over the last three years techniques have been developed for collecting eggs from the ovaries of calves as young as two months old.

In calves which are too small to allow rectal manipulation, the oocytes must be collected by exposing the ovaries by surgery or laparoscopy.

These eggs can be then used to produce embryos *in vitro*. About 20 to 30% of oocytes recovered can develop into embryos. After transfer the calves are born at a time when their genetic mothers are only 11 months old.

In certain circumstances this technology allows significant genetic gains to be made (see *Chapter 7: New technologies*).

The advantage of this technology on young calves compared to conventional ET in older animals is shown in *Table 10.1*.

Oocyte recovery post-mortem

If a valuable female dies, eggs (and subsequently embryos and calves) can be recovered from her ovaries providing the ovaries can be transported to a suitable laboratory within 6 to 12 hours of death.

Generation (G)	*Age (mths)*	*OPU*	*Conventional ET (heifer flush)*
G1	2	OPU from elite heifers and embryos transferred to recipients	
G2	11	Calves from G1 embryos born	
	12		G1 heifers flushed and their embryos transferred to recipients
	13	OPU from 2 month old G2 heifers and embryos transferred to recipients	
	21		Calves from G1 embryos born
G3	22	Calves from G2 embryos born	
	24	OPU from 2 month old G3 heifers and embryos transferred to recipients	

Table 10.1: Comparison of Oocyte Pick Up (OPU) and conventional Embryo Transfer (ET)

Further reading

Gordon I. (1994). *Laboratory production of cattle embryos*, CAB International, Wallingford, UK.

The Genetics Australia 'Eureka' breeding program

John Owens

Introduction

Eureka is the basis for Genetics Australia's embryo programs and is used predominantly to produce bulls for progeny testing and elite heifers which are sold each year. These bulls and heifers are produced from the most advanced genetics worldwide. The name Eureka was chosen for the program as it signifies 'discovery' and 'a new beginning' and is distinctly Australian.

The Genetics Australia Eureka program involves the implantation of over two hundred frozen and fresh embryos, and a similar number of research and development (R & D) embryos, into a large recipient cow herd each year.

The herd allows for the continuous introduction of the world's best Holstein and Jersey genetics using imported frozen embryos. Embryos are also produced in Australia through Genetics Australia's breeding programs, including Multiple Ovulation and Embryo Transfer (MOET) and Oocyte Pick Up (OPU) programs on juvenile heifers. The Eureka herd also provides recipients for testing embryos produced in other R & D programs with which Genetics Australia is involved, such as the Embryo Multiplication and Transfer (EMT) project (see *Chapter 12*).

Having its own recipient herd gives Genetics Australia the flexibility to implant embryos at any time of the year. This suits the needs of the company and its overseas partners to produce bulls for progeny testing when required.

It also enables overall control of the management of the recipient herd, especially nutrition, which produces consistent pregnancy rates on all frozen/thawed embryos of around 60%. Calving and rearing of the genetically valuable calves is under careful management, thereby reducing neonatal losses.

The overall scheme of the program is shown in *Figure 18.1*.

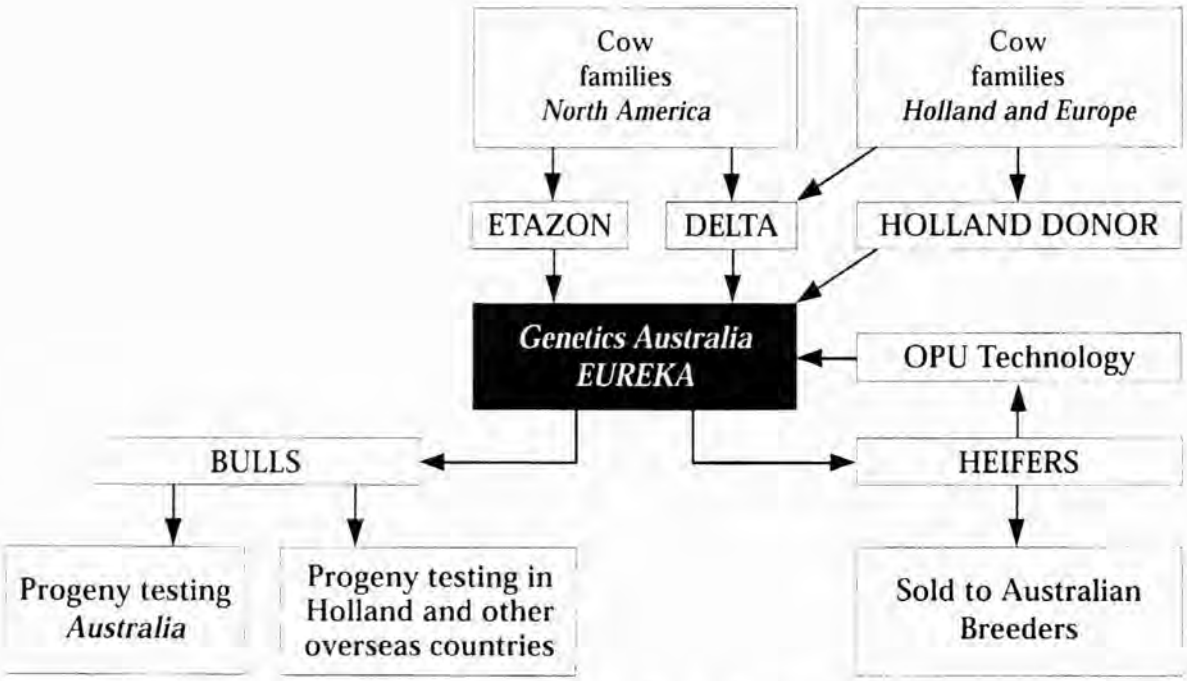


Figure 18.1: The Eureka Program

The Eureka program

Recipient herd

The herd consists of over 300 beef and beef-cross cows that are maintained at 'Rupertswood', Salesian College at Sunbury, Victoria, and at Genetics Australia, Bacchus Marsh. The college has excellent embryo, calf rearing and cattle handling facilities and is situated close to Genetics Australia. Students at the college are involved in all aspects of the program as part of their agricultural curriculum.

Beef cows are used as recipients because of cost and management factors.

Disease control

Only cows that are negative for Johne's Disease (JD) and Enzootic Bovine Leucosis (EBL) are used as recipients. The herd is part of the National Johne's Disease Market Assurance Program and the EBL Control and Eradication Program. The disease and management control measures are at the forefront of such programs in Australia.

Implantation

The imported embryos are originally produced from desired pedigrees in such countries as the USA and Holland. Embryos are flushed and frozen in these countries using ET and embryo freezing methods. To satisfy Australia's importation requirements, the dam and sire have to undergo strict quarantine and health testing.

Embryo harvesting and handling also have to meet strict guidelines, which are now becoming standardized internationally.

After arrival in Australia the embryos are thawed and implanted into the Eureka recipient cows and pregnancy tested at around 30 days by ultrasound and again at three months. Embryos are also produced in Australia from unique pedigrees and implanted into the Eureka recipients.

Recipient cow management is vital at this stage if good pregnancy rates are to be achieved. The cows must be on a rising plane of nutrition for four weeks prior to implantation and maintained on good levels of nutrition for four weeks post-implantation.

An example of a hormone synchronisation program is shown in *Table 18.1*. This program uses prostaglandin and a progesterone intravaginal device (CIDR®).

Number of embryos to be transferred = 50
Number of recipients to be programmed = 80

Date	*Day*	*Event*	*Time*
3/11/96	Sunday	Insert CIDR®	9.00 a.m.
10/11/96	Sunday	Inject prostaglandins	9.00 a.m.
11/11/96	Monday	Remove CIDR®	9.00 a.m.
12/11/96	Tuesday	Heat check and record eartag	a.m. and p.m.
13/11/96	Wednesday	Heat check and record eartag	a.m. and p.m.
14/11/96	Thursday	Heat check and record eartag	a.m. and p.m.
20/11/96	Wednesday	Transfer embryos into recipients, insert CIDR®	
2/12/96	Monday	Remove CIDR®	a.m.
3/12/96	Tuesday	Heat check and record eartag	
4/12/96	Wednesday	Heat check and record eartag	
5/12/96	Thursday	Heat check and record eartag	

Table 18.1: Example of an oestrus synchronisation and implantation program

This program is a very effective method of getting a high percentage of recipients on heat around 48 hours after CIDR® removal.

CIDRs® are used in the recipients after implantation to give an early indication of pregnancy. Those cows showing standing heat after CIDR® removal 12 days post-implantation can be re-used. This allows for efficient use of recipients.

Calving

Recipients are induced with prostaglandin and cortisone one to two weeks prior to the expected time of calving. This is taken as the average gestation length for the breed of the embryo, as it is the embryo not the recipient that dictates calving length (279 days for Holsteins). If the birth canal of the recipient is dilated sufficiently, then the calf may be assisted and pulled. Otherwise the cows undergo elective caesarians 30 to 50 hours after induction. There is no contact between the recipient and her calf after delivery. Calves are reared in a rearing unit (see calf rearing below). This technique of induced calving has the following advantages:

- It reduces the risk of dystocia and difficult birth
- It ensures correct identification
- It reduces the risk of disease transmission from recipient to calf.

An example of an induction program is shown in *Table 18.2.*

Expected calving date			28/11/96	Tuesday
Expected date of Caesar operation			14/11/96	Thursday
Number of cows to be induced			21	
Date	***Day***	***Time***	***Event***	***No. of cows***
29/10/96	Tues		Veterinary examination and palpation	
11/11/96	Mon	10:00–12:00pm	Inject cortisone and prostaglandins	7 – Group 1
12/11/96	Tues	10:00–12:00pm	Inject cortisone and prostaglandins	7 – Group 2
13/11/96	Wed	10:00–12:00pm	Inject cortisone and prostaglandins	7– Group 3
13/11/96	Wed	9:00am	Assist calving or Caesar	7 – Group 1
14/11/96	Thurs	9:00am	Assist calving or Caesar	7 – Group 2
15/11/96	Fri	9:00am	Assist calving or Caesar	7 – Group 3

Table 18.2: An example of a calving induction program

When inducing calving up to two weeks prior to the due date, it is critical that the cow receives a cortisone injection a minimum of 24 hours before birth to ensure adequate lung development in the calf. The use of cortisone and prostaglandins together tightens up the time and spread of calving.

After calving, the recipients are treated with antibiotics and monitored for any metritus (uterine infection). Most recipients are returned to a heat synchrony program for embryo implantation within four months of calving.

Pregnancy rates in recipients following Caesarians have been the same as in recipients receiving their first embryo.

Calf rearing

Calves are given frozen/thawed colostrum within six hours of birth. This colostrum is collected from disease-free cows and is tested for antibody levels using a colostrometer. Only top-quality colostrum is used. This is important to ensure calves are protected from disease (immune).

Calves are placed in an artificial rearing unit and immediately taught to drink from buckets. They are given four litres of fresh milk once a day and an *ad lib* supply of calf concentrates and hay.

Calves are weaned when they are eating ¾ to 1 kg of concentrates per day. This occurs at around at eight weeks of age.

Oocyte Pick Up (OPU)

(For a description of OPU techniques, see *Chapters 10 and 11.*)

Selected heifers undergo an OPU operation at around eight weeks of age with resultant embryos being implanted into the recipient cows. The advantage of this is that unique pedigrees can be developed using the latest imported pedigrees (ie. from the juvenile heifer) and recently proven Australian or overseas bulls. The resultant heifer progeny from this first OPU program can also undergo OPU at juvenile age.

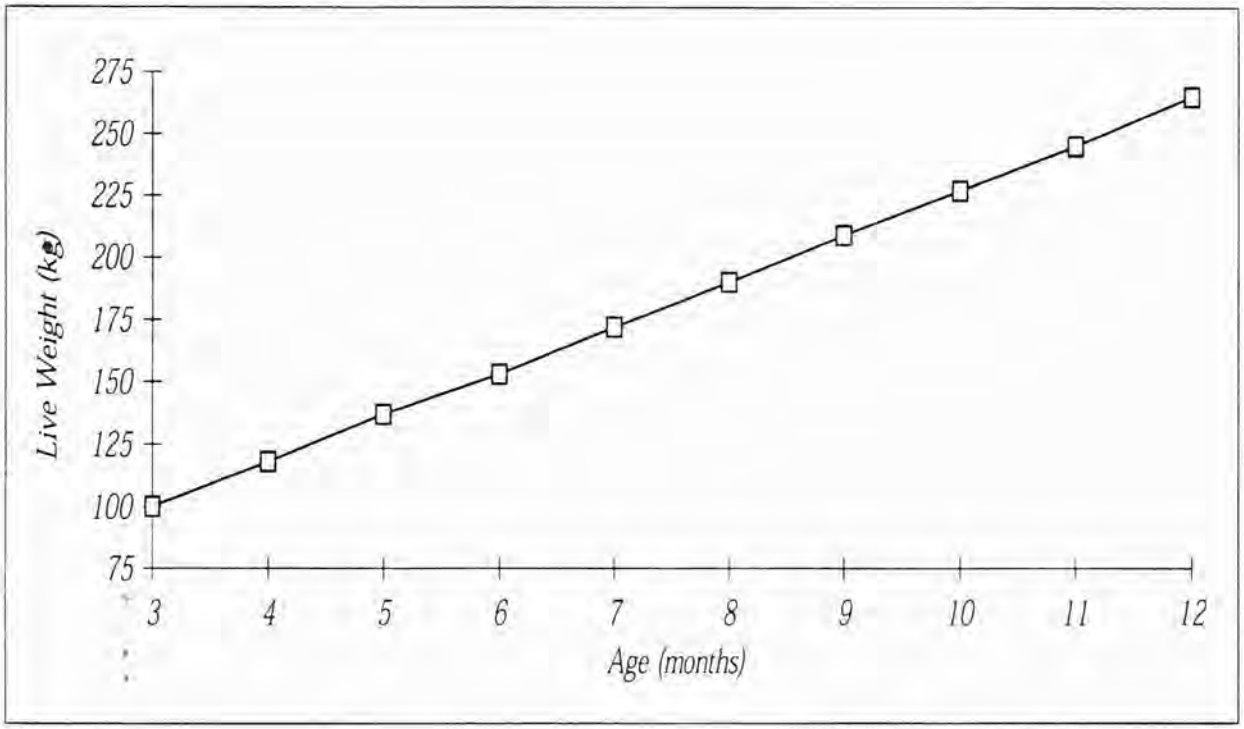


Figure 18.2: Holstein heifer target live weight

Post weaning

After weaning the heifers are grown out to a set target growth rate (see *Figure 18.2*) and are offered for sale each year.

- Bull calves are grown out and put into Genetics Australia's progeny test program.

Conclusion

The Genetics Australia Eureka program is unique in that it uses JD and EBL tested-free recipient cows to implant imported and Australian produced embryos. These embryos are from the best genetic sources in the world. The program gives dairy farmers the opportunity to purchase heifers and have access to Australian proven semen in the future.

genetic research

Marker Assisted Selection

A new genetic tool could help identify the best sires for future progeny testing.



Genetics Australia Admissions Manager Bill Shanahan takes a blood sample from a daughter of SHOTIME. The blood is used to analyse DNA for Genetic Markers that might help identify the best sires for progeny testing.

Using DNA technology to sel the next generation of sires

A collaborative research project that holds the promise of providing a new tool to help select the best sires for progeny testing is about to commence. The tool is *Marker Assisted Selection*.

We are rapidly improving our knowledge of the genetic makeup of cattle, but this does not mean we know what each gene does, and what to select for. Instead, we have a series of marker genes that have been identified.

'These marker genes are sections of DNA that are easy to identify in the laboratory. They have no value in themselves, but they point to the presence of desirable genes', explained *Genetics Australia* Consulting Geneticist, Dr Sandy McClintock.

'The principle is that if a marker gene is next to (or close to) a gene that is highly valuable, then we can select for that valuable gene by finding cows with the marker gene. In this research *Genetics Australia* and our partners are interested in markers that are associated with genes found in high ASI bulls', he said.

To investigate the application of *Marker Assisted Selection* to dairy breeding, an industry collaboration has been formed between Agriculture Victoria and the University of Melbourne, with *Genetics Australia* as commercial collaborator, and with funding from the DRDC.

Research scientist at Agriculture Victoria's Institute of Animal Science, Amanda Chamberlain, explained that the first stage of the project involves searching herds for daughters of six bulls (see the table below).

'One hundred of the highest ASI daughters of each bull will be compared to one hundred of the poorest ASI daughters of the same bull. The aim is to identify genetic markers that are present in the highest ASI daughters, and absent in the poorest ASI daughters.'

The daughters have been identified from the ADHIS database used in the calculation of ABVs. *Genetics Australia* is responsible for organising collection of blood samples from the cows identified with high ASIs and low ASIs. The samples will be analysed at the VIAS laboratories, with analysis of the results done by a PhD student at Melbourne University under the supervision of Professor Mike Goddard.



VIAS Research Scientist Amanda Chamberlain at work in the laboratory where DNA samples are analysed. The aim is to identify genetic markers that are present in the highest ASI daughters, and absent in the lowest ASI daughters.

Searching for daughters of:

NASIS	Name
74HO142	Meadow Bridge Manhattan
8H1915	Pickard-Acres Vic Kai
8H2085	Singing-Brook N-B Mascot ET
9H1401	Bis-May S-E-L Mountain ET
SHOTIME	Shoremar Perfect Star ET
WINLUKE	Strathaire Southwind Luke ET

genetic research

A potential revolution in animal
Cloning and other g

The publicity surrounding the birth of Suzi and Mayzi has swept us into a new awareness of what might be possible in the future. These calves are recognised as Australia's first cloned calves being produced from developed or differentiated cells (see *diagram*). Both calves are of elite dairy genetics.

Genetics Australia is playing an active role in developing this new artificial breeding technology in a partnership with our research partners (Monash University's Institute of Reproduction and Development, the Victorian Institute of Animal Science, the DRDC and the MLA).

What is on the horizon? How will animal breeding change in this new century? Dr Ian Lewis, *Genetics Australia* s Manager of Technology Development, and Consulting Geneticist, Dr Sandy McClintock, describe a vision of how cloning technology might complement progeny testing and breeding for the next generation of cows.

Will identical cows produce the same milk?

Sandy McClintock says that if a farmer was milking a whole herd cloned from his top producing cow, he would still see a difference in their milk production figures. 'It is for this reason that cloned lines of genetically identical animals will be tested, as with progeny test today, and only the best of these lines used to produce cloned embryos for sale', he said.

The same genes do not mean the same milk characteristics. This is because for many production traits such as milk, heritability is only 25% at best. That means 75% of the difference between individual animals is due to the environment (and the effect of environment on genetics).

Will we have herds of identical cows?

Dairy farmers today understand the problems associated with having too many cows in their herd with very similar genetics (inbreeding).

'As with their bull selection when you do not use just one bull for AI, you will not have a herd all from one clonal line. Instead we expect to see herds made up from a number of different cloned lines, these lines will be performance tested just as we now progeny test bulls', explained Sandy.

What will happen to progeny testing and breeding the next generation of animals?

'It will be important that there are breeders using traditional breeding techniques to produce bulls and cows that make up the superior genetics of the next generation', says Sandy.

'Rather than selecting the best bull calves we might select the superior daughters, preferably after performance testing. These daughters could then be cloned and their offspring would form a new cloned line for progeny testing.'

'We will require fewer daughters to accurately do the performance testing. To accurately assess the genetic merit of a progeny test bull today, milk records of a minimum of 80 daughters are required. To accurately assess the genetic merit of a cloned line of cows (which are all genetically identical to each other and to the animal from which the cells originally came) only 30 or so daughters would be required.'

'In this scenario, the best 5% of cloned lines would be selected for that year's "genetic team" in the same way as we now select a few bulls as proven bulls following progeny testing are chosen today', suggests Sandy.

What is *Genetics Australia's* vision for cloning technology?

Genetics Australia considers it is vitally important that Australia develops these emerging animal biotechnologies in its own right. 'Australian dairy farmers do not want to be in the situation of having to buy in these technologies (and the associated genetics) from multi-national companies for whom Australia's requirements might be only a minor consideration', says *Genetics Australia's* Chief Executive, Bernie Harford.

'We now understand that a good bull overseas does not necessarily translate into a good bull for Australian conditions. *Genetics Australia* is committed to developing the latest breeding technology which helps us identify superior genetics specifically suited to Australian conditions.'

How close is cloning?

Dr Ian Lewis suggests that, while there is encouraging progress being made, commercial application of cloning is 'some way off'.

'*Genetics Australia's* goal for cloning is to be able to substitute cloned embryos for semen. To be competitive with elite semen the cost needs to be around $30–40 per embryo, taking into account the benefits of sexed female embryos and higher genetic value. We also need to be able to achieve pregnancy rates comparable to those achieved through AI.'

'If these hurdles are overcome we envisage that thousands of cloned embryos from performance tested lines would be generated for sale. Farmers would select the lines they wanted in their herds, using similar criteria to those they use today to select bulls for AI.'

'These cloned embryos would then be implanted into their cows by trained technicians in much the same way as semen is inseminated today.'

However, Ian suggests that it could be at least 10 years before the required level of efficiency is reached with the cloning technologies for cloning to replace AI.

What are the other technology possibilities?

Genetics Australia Chief Executive, Bernie Harford, points out



Mazi and Suzi, Australia's first cloned calves, pictured here with Dr Ian Lewis, Genetics Australia's Manager of Technology Development, and Vanessa Hall from Monash Institute of Reproduction and Development.

breeding enetic technologies

that cloning is only one of the possible applications of the new genetic technologies being pursued by *Genetics Australia* and our research partners.

Other possibilities exist with 'genetic modification', which offers the potential to more rapidly enhance genotypes of animals than is possible by conventional breeding.

'Genetic modification is controversial and acceptance by Australia and overseas consumers is uncertain. However, the impact on breeding programs is potentially substantial. Involvement with developing these technologies, within the regulatory framework required by government, ensure Australia has the "option" of access to these technologies as they are developed, and as consumer acceptance becomes clearer', said Bernie.

'One of the significant potential applications of genetic modification is in the production of pharmaceutical protein in cows. Although of less widespread benefit to the dairy industry, development of pharmaceuticals may be one way of off setting the costs of investment in genetic technology.'

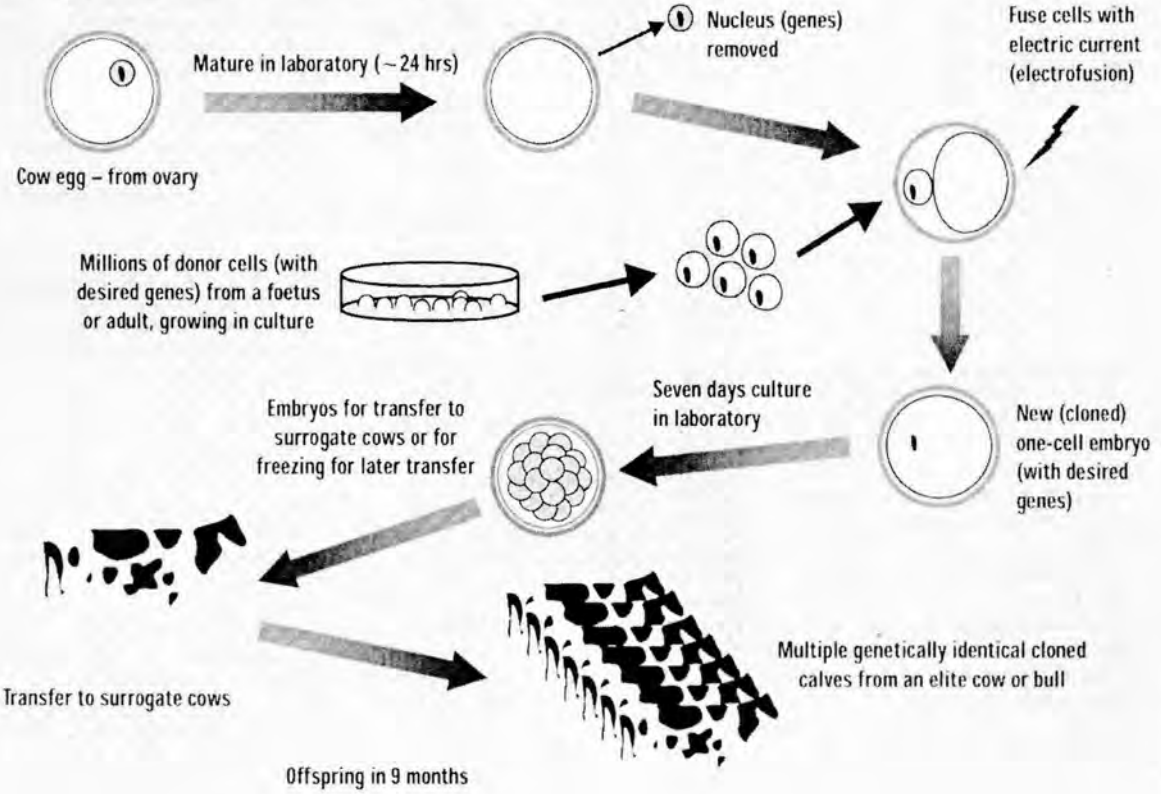
'The recent completion of the human genome project will also have spin-offs for animal breeding. Animals and man share about 80% of their genomes. There is only a 20% difference in the 100,000 or so genes that make up the genetic component of all cells in animals and man. Much of the human work will asist in mapping the cattle genome, and to indentifying the function of genes.'

'In fact, detailed knowledge of specific cattle genes and their function may well be the foundation of advances in genetic technologies that are at present unimaginable.'

However, knowledge of genes and their function will only be useful if we can use the information to select a better dairy cow. 'Cloning is the technology that will allow us to create new lines of superior dairy cows. So as cloning technology and gene technology are developing simultaneously. A revolution in animal breeding is approaching', Bernie suggests.

For more information on any aspect of Genetics Australia's research, you can call our freecall number 1800 039 047 for details.

Cloning from differentiated cells



LIVESTOCK

Breeding

DNA fingerprints increase pedigree accuracy

CSIRO Livestock Industries researchers Ian Franklin and SignaGen business development manager Tom Watson explain how unique DNA fingerprinting technology, now available commercially in the Merino industry, will provide increased accuracy for pedigree records and stock management savings.

DNA fingerprinting technology could speed production improvements in the Merino industry by up to 25 per cent, allowing selective breeding of sheep with desirable traits such as fine, high quality and high yielding wool.

The DNA (deoxyribonucleic acid) fingerprinting test allows the parents and bloodlines of a lamb to be traced accurately. This means wool growers can identify rams and ewes which are passing on undesirable genes and pedigree sheep identified with favourable traits.

The test has been developed by CSIRO Livestock Industries with support from the Australian Wool Research and Promotions Organisation (AWRAP) and the Co-operative Research Centre for Premium Quality Wool. The DNA service is now commercially available exclusively through New Zealand-based company SignaGen Molecular Breeding Solutions.

As pressure for finer wool increases, in response to strong market signals, breeders can expect demand for rams with low micron and heavy cutting fleeces to increase dramatically.

DNA fingerprinting will play an important role in identifying and evaluating these rams and ensuring they are used to maximum advantage.

Breeding advantages

According to researchers, the primary benefits of DNA fingerprinting are increased rates of genetic improvement and the ability to better monitor the rates of genetic progress.

Accurate maternal and paternal records can increase the genetic gains when combined with performance recording and other modern breeding analyses.

DNA fingerprinting will also enable other applications, including the ability to identify carriers of undesirable recessive genes such as metabolic disorders or pigmentation genes.

Although a DNA test for black wool still remains elusive, parentage analysis is commonly used by breeders to identify carriers of recessive black genes.

In addition, as the use of artificial insemination becomes more widespread and breeding programmes become more intense, genetic diseases such as metabolic disorders may become more common.

Other applications include the monitoring of statistical data in flocks, especially levels of in-breeding which can reduce productivity and genetic progress.



Kylie Wright, Inset: SignaGen

DNA fingerprinting in the Merino industry will enable wool growers to identify rams and ewes which are passing on favourable traits to their lambs such as finer wool and increased production as well as identifying sheep which are passing on undesirable traits such as black wool. Inset: Each sheep is assigned a 'baa code' and the lamb's parents can be identified by comparing the codes.

Stock management

Accurate DNA tests also provide wool growers with alternatives for cost-effective stock management.

The parentage test is ideally placed to support various operations, simplifying mating and lambing. For example, growers developing and mating more fertile ewes to make genetic advances can use fingerprinting to support and authenticate pedigree records.

Wool and lamb producers using, or contemplating the use of, intensive mating and lambing practices can also take advantage of the accuracy and simplicity of the DNA parentage service.

Traditionally Merino breeders who want pedigree information have used single sire mating management which requires a system of tagging newborn lambs according to their apparent mothers and fencing small paddocks for single sire joinings.

When all these inputs are accounted for, single sire mating is estimated to cost breeders about $15 per lamb.

Growers using DNA testing in conjunction with syndicate mating may be able to increase recording accuracy as well as reduce costs and labour inputs by replacing the need for single sire mating.

Where syndicate mating is used, ram performance can be determined accurately so non-performing rams can be identified and removed from the next service.

According to CSIRO and AgResearch in both Australia and New Zealand, errors due to mis-mothering, ewe adoption and cross-fostering is estimated to be as high as 10–20%.

inbrief

- DNA fingerprinting technology for the Merino industry is now commercially available through New Zealand-based company SignaGen.
- Developed by CSIRO, the DNA technology allows the parents and bloodlines of a lamb to be traced accurately.
- DNA fingerprinting offers increased accuracy for pedigree records and researchers predict it could speed the rate of genetic gain by 25 per cent.
- Wool growers can identify rams and ewes which are passing on favourable traits to their lambs such as finer micron or higher wool cut, while undesirable traits such as black wool can be eliminated from the flock.

Breeding...

Using DNA fingerprinting could provide significant savings as breeders will no longer need to set up single mating paddocks and can evaluate rams under syndicate mating conditions.

Similarly 'mothering-up', which is labour intensive and error-prone, can be replaced with more accurate technology.

Breeders can now provide commercial wool growers with the assurance of accurate pedigree and bloodline information.

Growers can have parentage of animals, and embryos verified and certified to meet customer needs and semen can be positively attributed to specific sires.

Simple testing

The fingerprinting technology is based on a simple blood test to isolate and characterise the animal's DNA.

On-farm collection of the blood sample for DNA analysis can be carried out by the grower who needs only to prick the sheep's ear and then soak the blood onto a special card, supplied by SignaGen.

Growers need to take care to record each sample accurately and not contaminate the card.

The samples are then sent to the SignaGen laboratory where a simple method is used to extract the DNA from the blood sample.



After growers have carried out the on-farm collection of blood for DNA analysis, the samples are sent to the SignaGen laboratory where a simple method is used to extract the DNA.

Each sheep is then assigned a bar code — or 'baa code'(as it has been nicknamed) and the lamb's parents can be identified by comparing the codes — even when the sire is unknown or the lamb has been adopted by a different ewe.

Economics

Financial analysis carried out by CSIRO has suggested the cost-benefit to growers for uptake of the DNA technology would require the price of DNA testing to be less than $20.

Adoption of the baa code DNA parentage by growers, as with similar new technology in other industries, will be price sensitive.

The current price for the service through SignaGen has been set at $18.95 per sample plus GST. The test cost $25 while under development.

Further technological advances will be required to move the price significantly lower.

SignaGen has entered into the licence agreement with CSIRO and AWRAP which includes the availability of future research to provide growers with the most cost-effective and reliable tool for DNA testing.

The most effective way of ensuring the service is delivered at the lowest price possible is large-scale adoption by the entire sheep industry.

For more information contact SignaGen Molecular Breeding Solutions, by email on info@signagen.com, freephone 1800 127 446 or visit their website: www.signagen.com or contact Ian Franklin, CSIRO Livestock Industries, by email on Ian.Franklin@li.csiro.au, phone (02) 9840 2700 or fax (02) 9840 2940.

DNA technology identifies superior breeders

After seeing the benefits of DNA fingerprinting in a demonstration trial, Graham Wells, One Oak, Jerilderie, New South Wales, has decided to use the technology in his stud.

Graham is the chairman of the Falkiner Memorial Field Station Project Group property, Deniliquin, NSW, owned by CSIRO and the Woolmark Company and this is where he first became involved with the DNA technology.

A grade comparison trial is being run from 1999-2001 using 12 carefully selected rams — three high-index bred rams, three low-index bred rams, three high-grade rams and three low-grade rams. These 12 sires were DNA typed and then joined in their groups to 145 randomly selected ewes.

The progeny were DNA fingerprinted so they could be easily traced back to their sire and measurements of fleece weight, bodyweight and micron are being taken each year.

According to Graham, the results are clearly showing the performance of each individual ram in each group and highlighting the type of desirable and undesirable traits specific rams were passing on to their progeny.

On-farm use

Graham has always used micron measurements in his annual sire selection but has never selected on indexes because of the inaccuracies of different paddock effects, age of the ewe, twin effect and mis-mothering.



New South Wales Merino breeder Graham Wells, One Oak, Jerilderie, believes DNA fingerprinting will increase the accuracy of his stud breeding programme.

He believes the use of DNA fingerprinting will reduce the discrepancies found in many Merino stud breeding programmes.

This year Graham will DNA fingerprint the top 200 ewes in the One Oak and One Oak No. 2 studs which will be artificially inseminated to three DNA typed sires. The ewes will lamb together and each lamb will be DNA tested to identify its sire.

Graham said DNA fingerprinting will increase the accuracies of his breeding programme and help to improve the stud's genetic gain.

He believes pedigree information is important but it is even more important to be confident the stud records are accurate. The history of each ewe and sire will be known which will build on the tests already carried out for micron, bodyweight and wool cut per head.

Economical option

Graham considered the cost of the DNA sample to be commercially viable in his situation.

The highest cost will be this year when he tests 400 ewes and their progeny, but from then only 20 per cent of young ewes and their lambs will be tested each year. Graham believes the cost is less compared with the cost of index measuring his entire flock.

He is confident the DNA test will assist in identifying the superior breeders in the top end of his ewe flock which he hopes to use in an embryo transfer breeding programme.

Most of One Oak's future sires are also selected from the elite flock which means they will already have accurate pedigree information for joining.

LIVESTOCK

Breeding...

Simple blood test offers quick sire trace-back

New South Wales Merino breeder Jim Litchfield, Hazeldean, Cooma, has been using DNA fingerprinting in his stud operation for more than three years to speed the rate of genetic improvement in his flock.

Initially the fingerprinting test was used to detect rams carrying the recessive black gene.

But this year Jim has DNA typed all 80 sires used for Hazeldean matings plus 110 reserve rams which have the potential of becoming either stud sires in their own right or stud sale prospects.

Detailed pedigree records

Previously, Hazeldean gathered sire identification on the progeny of only 12 rams each year, single mated mainly for progeny testing purposes and these can be traced easily. But the remaining rams are joined in syndicates making it impossible to determine the sires of most ram lambs.

According to Jim, DNA fingerprinting all their sires and reserve rams will have many positives. Hazeldean will be able to identify the sire ID of all the rams it wishes to use in its breeding programme, and — in case a ram jumps the fence — it will have a second check on the sire ID of rams resulting from the single mating progeny test programme.



Jim Litchfield, Hazeldean, Cooma, New South Wales, is planning to DNA type 190 stud sires and stud sale prospects this year.

Jim believes it will increase the scope of the progeny testing programme. Superior sires, which may have missed being included in the single mating groups, will now be identified through their progeny, as they will be more likely to produce reserve rams.

As knowledge of pedigree is crucial to speeding genetic gain, the increased knowledge of sire identity will accelerate genetic progress. Jim said DNA fingerprinting would also enable the stud to offset any potential inbreeding problems that might have otherwise gone unnoticed through lack of pedigree knowledge. In addition to identifying black gene carriers, the technology has the potential to identify other genes, both positive and negative, in the future.

Stud evaluation

Hazeldean annually mates about 12,000 ewes and the DNA typing will be carried out at the Cooma stud, before expanding to include the Litchfield family's South Australian-based Merino flock, Hazeldean SA, at Mount Bryan and East Bungaree, at Booborowie, SA.

Although the service is not cheap when viewed on a per head basis, Jim believes the initial cost is more than offset by the potential genetic improvement and increased pedigree information.

As with any change in breeding programmes, it is viewed as a long-term benefit and will become a pivotal part of Hazeldean's routine evaluation of rams each year. Currently the Hazeldean ewe flock averages 20.5µm and the breeding aim is to lower the micron while improving fleece weight.

Jim believes the DNA fingerprinting technology will assist in this objective by allowing him to identify sires which are producing lambs with desirable traits such as finer wool and increased wool cut. It will also mean some undesirable characteristics such as black wool can be eradicated from the stud flock.

CSIRO

Grow greener with The Organic Alternative

Your Complete Guide to Organic Farming in Australia

The Organic Alternative takes the mystery and confusion out of organic farming.

This 88-page comprehensive manual includes more than 20 articles by industry specialists and 12 practical case studies from converting and certified organic producers. The manual is presented in an easy-to-read format and is ideal for both existing and prospective organic farmers.

The Organic Alternative will help you:

- Understand organic farming principles
- Work through conversion and certification procedures
- Identify markets for your organic produce
- Plan and develop marketing strategies to sell your product(s) at premium prices
- Assess the economic benefits of organic farming versus conventional farming
- Develop and maintain soil fertility and productive crops and pastures
- Improve disease resistance in livestock
- Determine the best methods for managing weed and pest control organically



KONDININ GROUP
FARMERS HELPING FARMERS AUSTRALIA WIDE

Nutrition

Protected feeds enhance lamb meat flavour

CSIRO Livestock Industries researchers explain how some of the protected feed options available to lamb producers can improve meat quality and flavour and change the types of sheep meat produced. This specialised feed technology could lead to an increase in consumer acceptance of lamb in export markets.

The adoption of protected feed technology could provide lamb producers with an opportunity to improve meat flavour and quality and potentially lead to an increase in lamb consumption.

CSIRO Livestock Industries research has found it is possible to make significant improvements to the flavour and odour of cooked sheep meat — which some consumers find unattractive — by using protected feed supplements.

The nutritional quality of fat in sheep meat can also be improved by feeding specialised protected feeds containing desired fatty acids such as omega-three.

Researchers are confident the future use of this technology on-farm will improve consumer perceptions of the healthiness of sheep meat and open up new niche markets for lamb producers.



Geoffrey Hamilton

Researchers are confident that farmer use of protected feed supplements in the lamb industry will improve meat flavour and quality, opening up new markets for lamb producers.

Sheep meat consumption

It is now well established that the consumption of red meat per person in the Western world is unchanged or declining, despite the educational and marketing attempts to halt this trend.

According to Meat and Livestock Australia sheep meat consumption and exports during the next two years are predicted to be static (see Figure 1).

This is partly due to import restrictions which occurred in the United States market during 1999. But there are other fundamental reasons, including the poorly perceived health image of red meat in Western society and the relative fatty nature of some red meat, particularly sheep meat.

Sheep meat is high in saturates and low in polyunsaturates while the flavour and odour of sheep meat are also blamed for declining consumption rates.

Enhancing flavour

The flavour of sheep meat is complex, consisting of many volatile components, some of which are produced as a result of cooking.

There are a variety of substances, known as alkylpyridines, which have been isolated from roast lamb which are thought to relate to the less-pleasant odour and rejection by some consumers.

The presence of some fatty acids produced as a result of feeding lambs cereal grain diets are also contributors to less desirable flavours in sheep meat. But it is generally accepted cooked meat from grain-fed animals is blander than that produced from pasture.

It is meat produced from a variety of pasture-based diets which evokes different responses when assessed by Australian taste panelists (see Table 1).

Age, sex and breed of animals will all influence the meat yield, carcass quality and growth rate but it is difficult to determine the influence of these factors on flavour and meat quality.

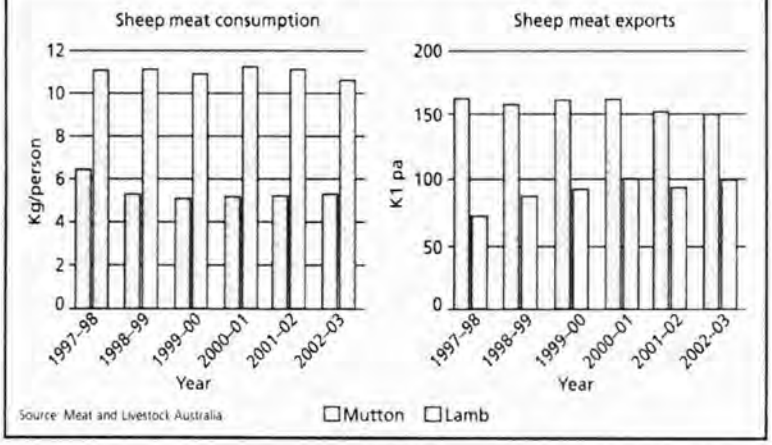
Protected feed supplements

CSIRO in collaboration with Rumentek Industries Pty Ltd has developed protected feed supplements that by-pass the rumen and create a range of different flavours in meat. This is due to the increase in the proportion of unsaturated fatty acids such as linoleic acid

in brief

- Sheep meat consumption and exports are predicted to remain static or decline due to its poorly perceived health image, flavour and odour.
- The adoption of new protected feeds technology can make significant improvements to the flavour and odour of cooked sheep meat.
- The nutritional quality of fat in sheep meat can also be improved by feeding special protected supplements containing desired fatty acids such as omega-three.
- Further research will establish production systems and feeding regimes for improved lamb meat flavour and quality.

FIGURE 1 Projected annual consumption and export of sheep meat



Nutrition...

TABLE 1 Description of cooked meat from sheep grazed on various diets

Grazed diet	Taste panel description
Lucerne (*Medicago sativa*)	Sharp and sickly compared with phalaris
Rape (*Brassica napus*)	Nauseating
Vetch (*Vicia dasycarpa cv. Lana*)	Intense meaty flavour
Oats (*Avena sativa cv. Acacia*)	Pungent odour and flavour
Glycine (*Glycine wightii*)	Characteristic and objectionable compared with native pasture

Source: CSIRO Livestock Industries

which are protected from the normal processes of ruminant digestion.

By feeding the specialised supplements to sheep, the amount of saturated fat in the meat can be reduced by 15–25 per cent and the amount of linoleic acid is increased, producing desirable flavours in cooked sheep meat.

Early CSIRO research showed feeding protected feed supplements to Merino cross lambs, made from either sunflower or safflower oil, decreased the conventional cooked lamb odour.

Other feed trials show quite dramatic changes can be made to the flavour of cooked lamb meat by feeding protected feed supplements for a short period and ensuring the linoleic acid content does not exceed 10%.

But on lengthy feeding regimes, if the levels of linoleic acid reach more than 20% the meat can contain an undesirable odour. Feeding protected oilseed supplements provides an opportunity to not only improve flavour but also enhance the nutritional properties of meat which may be of concern to some consumers.

Nutritionists are promoting the consumption of omega-three enriched food sources which are thought to have a variety of positive health effects for humans. Unfortunately ruminant meat contains relatively small quantities of these fatty acids compared with vegetable and fish oils.

Including protected omega oil feed supplements in sheep diets may increase the content of omega-three in cooked sheep meat without affecting the quality or flavour of the meat. This could increase consumers' perceptions of meat as being healthy.

Future potential

It is possible to make substantial changes to the flavour and odour of the meat by dietary changes such as feeding protected lipid supplements manufactured from a variety of oilseeds.

The perceived nutritional quality of fat in sheep meat can also be improved by feeding specific dietary protected fats and supplements containing desired fatty acids such as omega-three. If a 'healthy' lamb can be produced it potentially opens up new markets for sheep meat, primarily at the quality end. For instance, if the desired consumer flavour preference can be established in various markets it should result in increased sales of meat.

Further work will be carried out by CSIRO Livestock Industries to establish optimal production systems for improved lamb, by determining the preferred flavour modification and types of fatty acid changes required in domestic and Asian markets.

For more information contact Soressa Kitessa, CSIRO Livestock Industries, by email on soressa.kitessa@li.csiro.au, phone (08) 9333 6200 or fax (08) 9333 8991 or Suresh Gulati, CSIRO Livestock Industries, by email on suresh.gulati@li.csiro.au, phone (02) 9840 2781 or fax (02) 9840 2940.

Feed supplements

Genetically-modified lupins lift wool growth

CSIRO Livestock Industries scientist Colin White and CSIRO Plant Industry scientist TJ Higgins explain how feeding genetically-modified lupin seed to Merino sheep could offer significant production gains for wool growers.

New research has shown genetically-modified lupins can increase wool growth and liveweight in Merino sheep.

The lupins, containing a sunflower gene which stimulates production of a by-pass protein were fed to sheep in a CSIRO trial. The results showed an eight per cent increase in wool growth and a 7% increase in liveweight gain.

Researchers believe such an approach to plant breeding could offer a valuable boost to wool growers by reducing costs, increasing profit margins and improving productivity and efficiency.

Further improvements are being made to the transgenic lupin and consideration for commercial release is at least five years away.

Increased nutrient supply

Wool and muscle has a high demand for sulphur amino acids such as methionine and cysteine, which are absorbed through the sheep's small intestine but the sheep's first stomach, the rumen, tends to break down up to 40% of these essential nutrients before they reach the intestine.

Up to two-fold increases in wool growth have been reported in response to supplying supplementary methionine in feed to the small intestine.

It is difficult to increase the proportion of sulphur amino acids reaching the intestine by feeding normal dietary ingredients unless the protein containing the extra sulphur amino acids is protected against degradation in the rumen. Most fishmeals meet this requirement but they are too expensive to feed to sheep.



Researcher Colin White checks on sheep in a recent CSIRO feed trial using genetically-modified lupins, which increased wool growth and liveweight.

Therefore an ideal protein for sheep is one which is high in sulphur amino acids, resists degradation in the rumen and is inexpensive.

While lupins are the major grain legume fed to ruminants in Australia, their value as a source of undegraded protein is limited by high rumen degradability and low methionine content.

For example, Australian sweet lupins, *L. angustifolius*, on average contain only 7.4 grams of methionine per kilogram of crude protein compared with more than 14g/kg of crude protein for most cereal and oilseed proteins.

CSIRO Plant Industry scientists modified the Australian narrow-leaf lupin, *L. angustifolius*, cv *Warrah*, to contain a sunflower gene which produces a protein rich in sulphur amino acids (23g/kg of crude protein) that is also stable in the sheep's rumen.

The protein acts as an efficient package for delivering the extra sulphur amino acids to where they are needed to achieve higher growth rates.

The development of this modified lupin has taken more than 10 years of research, including a stringent environmental safety assessment.

All CSIRO gene technology research is carried out according to the strict guidelines of the Federal Government's Genetic Manipulation Advisory Committee.

Feed trial

The CSIRO Livestock Industries feeding trial compared the nutritive value of genetically-modified lupin seed, containing the sunflower seed albumin, with unmodified (parent) lupin seed.

The trial was also carried out to determine whether any differences between the modified and parent lupin seed were consistent with the modified lupin supplying extra rumen-protected methionine.

The trial was carried out over six weeks with 80 Merino wethers which were divided into two groups.

The wethers were fed 796g of dry matter per day of a cereal hay-based diet containing 350g/kg of either the modified or parent lupin seed, *L. angustifolius* cv *Gungurru*,

inbrief

- Genetically-modified lupin seed, containing a sunflower gene which stimulates protein production, can increase wool growth and liveweight gain in Merino sheep.
- A recent CSIRO feed trial resulted in an eight per cent increase in wool growth and a 7% increase in liveweight gain in sheep fed the modified lupins compared with sheep fed un-modified lupins.
- The sunflower gene incorporated in the modified lupin seed produces a protein which delivers extra sulphur amino acids where they are needed to achieve better growth.

TABLE 1 Effect of parent and modified lupin seed feed on liveweight and wool

Response	Parent lupin seed	Modified lupin seed
		Wool
Clean wool growth (days 1-21) (milligrams per square centimetre per day, mg/cm²/day)	0.718	0.772
Clean wool growth (days 22-42) (mg/cm²/day)	0.770	0.832
Wool sulphur (days 1-21) (g/kg)	35.9	36.6
Wool sulphur (days 22-42) (g/kg)	37.5	38.5
		Liveweight
Liveweight gain (days 0-42) (kg)	90	96
Final weight (kg)	36.2	36.5

Source: CSIRO Livestock Industries

LIVESTOCK

Feed supplements...

620g of oaten hay and 30g of Siromin mineral mix.

Wool growth and liveweight gain measurements were taken during the trial.

Scientists also took urine and faeces tests to measure the digestibility of organic matter and protein and urinary purine metabolites were measured as indicators of the amount of protein synthesised from the amino acids.

Blood samples were taken from all sheep at the start and end of the trial and analysed for amino acids and plasma metabolites.

Growth response

A chemical analysis of the grains showed there was little difference between them in terms of most nutritional components but the modified lupin seed contained a 2.3-fold higher methionine concentration and a 1.3-fold higher cysteine content compared with the parent seed.

There were no significant differences between grains in organic matter digestibility, rumen microbial protein synthesis or degradability of dry matter.

Sheep fed the genetically-modified lupin seed achieved significantly higher rates of liveweight gain and wool growth than those fed the parent — 7% and 8% respectively.

Wool sulphur concentration was also significantly higher in the sheep fed modified lupins (see Table 1). All sheep in the trial maintained good health.



Wool samples were analysed using an Optical Fibre Diameter Analyser 2000, which indicated an eight per cent boost in wool growth from sheep fed the genetically-modified lupins.

The observed responses in wool growth and liveweight gain in the trial are consistent with almost all of the extra methionine in the modified lupin seed being protected from breakdown in the rumen. This indicates it was the extra supply of sulphur amino acids to tissues which gave the growth response.

The results showed genetic modification of a feed grain can improve its nutritive value for ruminants.

Future potential

The breakthrough will yield lupins of higher nutritional value for livestock, with a resulting improvement in animal productivity. About 200,000 tonnes of the 1.2 million tonnes of lupins produced annually in south-western Australia are used on-farm as supplementary feed for sheep during the dry summer and early autumn period.

The increase in liveweight gain and wool growth from the transgenic lupins could be expected to improve weaner survival and reduce the incidence of tender wool, adding further to the value of the modified lupin seed. The grain could also be particularly beneficial for fine wool Merinos because of their susceptibility to tender wool.

Acknowledgement: This research project is partly funded by the Grains Research and Development Corporation. For more information contact Colin White, CSIRO Livestock Industries, by email on colin.white@li.csiro.au, phone (08) 9333 6692 or fax (08) 9387 8991 or TJ Higgins, CSIRO Plant Industry, by email on t.higgins@pi.csiro.au, on phone (02) 6246 5063 or fax (02) 6246 5320.

For information on healthy grazing see *Farming Ahead*, No. 109, page 58 and No. 52, page 60.

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Annual Ryegrass Toxicity (ARGT)

In Australia, tens of thousands of animals die from annual ryegrass toxicity each year and millions may be exposed or suffer clinical disease. Fatal poisoning can occur in sheep, cattle and horses. The disease occurs in areas of Western Australia, South Australia and New South Wales. CSIRO Livestock Industries scientists have developed an antidote to save poisoned stock and have demonstrated the effectiveness of a vaccine against ARGT.

How are animals poisoned?
Three grass species, annual ryegrass (*Lolium rigidum*), blow-away grass (*Agrostis avenacea*) and beard grass (*Polypogon monspeliensis*), bear seed-heads which can be infected with a bacteria. The bacteria produces toxins, called corynetoxins, which can inhibit the formation of glycoproteins in the animal grazing on the seed-heads. The glycoproteins are important in many body processes, such as nerve transmission.

The bacteria are carried from the soil onto the growing grass plants by a nematode (microscopic 'worm') in mid to late Autumn. The bacteria multiply rapidly in the seed-head and may be visible as yellow slime in Spring when the seed-head appears. As the pasture matures, the yellow bacterial slime dries to an orange appearance, and toxin levels reach a maximum.

Poisonous pasture remains toxic throughout Summer until Winter; and poisonous hay and harvested seed remains toxic for many years.

Recognising poisoned animals
Corynetoxins build up over time in the animal. The time between initial exposure to annual ryegrass toxicity and any signs of poisoning can vary depending on the amount of toxin consumed. It may be as short as four to five days, or as long as several weeks.

After consuming a lethal dose of toxins over a short period, stock generally stop eating and may be reluctant to move. If exposure builds up slowly, some animals are uncoordinated and display tremors and other nervous signs, characteristic of the disease. Initially these nervous episodes may only be occasional, and generally only in the early morning. Often poisoned animals will be seen at the rear of the mob, moving with a stiff-legged gait. They may fall over and suffer convulsions, but then regain their feet and appear normal. More severely affected animals may collapse and convulse for longer periods before standing.

Saving poisoned animals
CSIRO Livestock Industries scientists have developed an antidote treatment for animals suffering from ARGT. The antidote is a chemical compound that reverses the effects of annual ryegrass toxicity by binding to and aiding excretion of the toxins. This aids the recovery of poisoned animals. Field trials of administering the antidote by injection in 1994-5 showed an average reduction in stock losses from 34 per cent if left untreated to nine per cent if treated. In addition to rescuing poisoned animals from death the ARGT antidote may have benefits for all animals in a poisoning outbreak by reducing accumulated toxins in their tissues. Treated animals that have only consumed a sub-lethal dose of toxins regain condition quickly and show improved weight gains compared to untreated survivors.

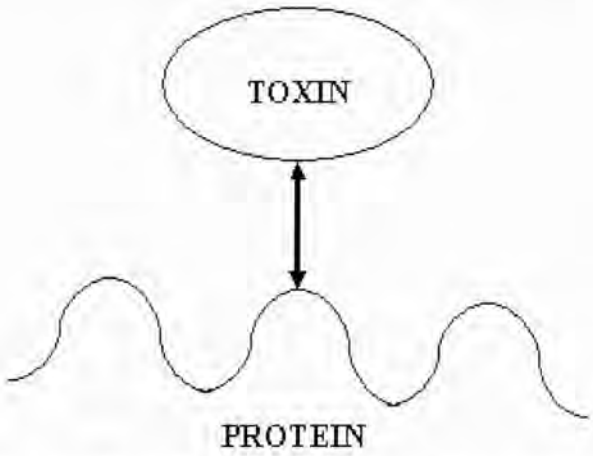
The antidote formulation has been licensed to an animal health company. Better means of administering it need to be developed. As yet the antidote is not suitable for extensive grazing systems.

Developing a vaccine for stock
Natural plant toxins have a common feature; they are too small to be recognised by the immune system of the animals that ingest them. For this reason, animals do not develop an immune response to them.

CSIRO Livestock Industries scientists created a trial vaccine by giving the immune system something to get to grips with - a larger 'carrier' molecule to which a fragment of the toxin is

attached. Antibodies induced following injection of this carrier toxin include some that recognise and bind to the toxins, conferring some degree of immunity. This technique has been used to develop an effective trial vaccine for ARGT. Industry support and funding is required to develop this technology into a commercial vaccine to use on-farm.

Utilising this technology, CSIRO scientists have developed a trial vaccine for another plant toxin disease, lupinosis. An animal health company is currently trialing this vaccine on farms in Western Australia.



The vaccine is produced by linking the toxin to a protein carrier- so the toxin is then recognised by the animal's immune system

Further reading

Agriculture Western Australia Farmnote 6-92: Identification of ryegrass diseases that distort seedheads By Ian Riley, Research Officer, Plant Pathology Branch
http://www.agric.wa.gov.au/agency/Pubns/farmnote/1992/f00692.htm

Agriculture Western Australia Farmnote 62-95: Avoiding ARGT in high rainfall areas By Ian Riley, Nematologist, Plant Protection Branch; Chris Mayberry, District Veterinary Officer, Harvey; Bevan Kingdon, Development Officer, Busselton; Peter Arkell, Senior Development Officer, Bunbury; and Bill Smart, Development Officer, Bunbury
http://www.agric.wa.gov.au/agency/Pubns/farmnote/1995/F06295.htm

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About Kondinin **Farming Ahead**

Kondinin Group has been working in partnership with farmers for more than forty years to research and deliver information to help improve the business of farming.

Farming Ahead - the monthly magazine produced by the Kondinin Group - is the primary means by which farmers can access independent research and the most up-to-date developments in agriculture Australia wide.

More than $20,000 of members funds is invested in Kondinin Group research for every issue of the magazine. The results are published in the form of evaluations and comparisons of equipment ranging from tillage machinery to welders, computer programs and animal health products. Each issue also includes time-saving ideas and innovations.

Other information in Farming Ahead includes the latest developments in agriculture from specialist researchers, state agriculture departments, the CSIRO and private consultants. This information is not simply reprinted from scientific papers.

Rural business
The rural business section of the magazine helps keep your farm business on track with articles covering areas including commodity marketing, succession planning, farm tax, superannuation

Technology
Farming Ahead provides insight into new technology affecting agriculture through articles on topics including precision farming, computers and genetic engineering

Livestock
The latest information on sheep and cattle management and husbandry, feeding and animal health. The articles are written by veterinarians with years of experience working with farmers.

Cropping
Useful information on all aspects of crop production - from spraying to variety selection and storage. Articles are contributed by specialist writers, co-operative research centres, agriculture departments and CSIRO

Health and Safety
Farming Ahead shares useful, practical information on health and safety issues which relate to agriculture

Ideas and Innovations
This is one of the most popular sections of Farming Ahead. Time and cost-saving ideas and innovations from farmers throughout Australia are published with detailed diagrams and photographs

Machinery
Each issue of Farming Ahead includes information to improve you machinery operation. Kondinin Group members enjoy:
- ***Evaluations*** - Independent Kondinin Group assessments of machinery which include a detailed survey of current owners
- ***From the Workshop*** - A Step-By-Step guide to workshop activities from servicing an alternator to diesel fuel injectors

Science for Tomorrow
This section contains news style information from the CSIRO designed to keep readers up-to-date with current research so the future of farming business can be sustained

Pasture
Practical information on varieties, disease and nutrition to help you get the most out of your pastures. The articles are linked with the livestock section to benefit your whole farm.

Research Reports
Every month the Kondinin Group invests $20,000 in a Research Report which examines a product, service or issue relevant to farming. Rather than employing you own investigator the Kondinin Group does the research and presents the independent information in 8-12pages within the magazine to make buying decisions easier

The keys to Farming Aheads success
As a Kondinin Group member you automatically receive Australia's leading rural magazine Farming Ahead, every month. Kondinin Group members recognise the value of information in the magazine and it was rated as excellent by 81 per cent of members surveyed during 1996.

There are many factors which combine to make Farming Ahead the highest rating rural publication in Australia.

- A whole farm approach
- The rural background of staff
- Involvement of farmers
- All material is practical
- Positive outlook
- Independent tests and evaluations
- Quality information and presentation

Another key to the success of the Farming Ahead is that is stays completely independent with strict separation of editorial and advertising content. No advertorial material is published.

'At a glance' and 'In brief' boxes summarise articles giving you the facts so you can read them in more detail at a later stage.

Authors are clearly listed and they can be contacted through the Kondinin Group.

Workboot Series



The Workboot Series is a collection of high quality, innovative books featuring Australian farming industries and the story of food and clothing from farm to supermarket.

The Workboot Series books take an educational and entertaining look at modern Australian farming. For the first time, farming is explained so people of all ages and walks of life can discover where our food and clothing comes from and why agriculture is so important to our daily lives.

Each Workboot Series book provides a balanced and comprehensive story of primary industry, including sections on The Source, The Farmer, The Product, The Consumer and The Environment. Current titles include Rice, Wool, Wheat, Dairy, Cotton, Honey and Timber.

The books mix a detailed and lively text with full colour photographs, delightful illustrations of the cheeky cartoon character, Blunnie the Workboot, graphs, charts, diagrams, flow charts, activites, a glossary and an index. Interesting snippets of information are featured in Fact and Did You Know boxes so readers of all levels can access information.

The Workboot Series resource kits complement the books and help teachers plan a term's work across the key learning areas with little preparation. Each kit contains detailed lesson notes, answers, activity pages to copy and product samples. Each kit also includes a copy of the relevant Workboot Series book

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Kondinin Group membership costs $163.90 per annum and this includes a copy of our monthly magazine Farming Ahead and significant discounts on our manuals and other services. See www.kondinin.com.au for full details of member benefits. Please note that Membership Plus is not available for institutional and corporate members.

For schools and colleges we are now offering annual subscriptions to our document delivery website, Kondinin Insite. Currently we have over 6,500 Kondinin Group articles, in pdf format, ready for download on Kondinin Insite.The Agsearch engine developed by Farmwide is also incorporated into the site to enable users access to the best Agricultural websites available.

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Welcome to Kondinin Insite.

Kondinin Insite is the latest service created by the Kondinin Group to enable Australian farmers access to the information they need, when they need it, through the convenience of the Internet.
There are two aspects to **Kondinin Insite**, **Kondinin Resources** and the **agSearch** engine. **Kondinin Resources** is the name we have given to the material indexed in our own information database. This database may be searched and excerpts of some of the articles may be viewed. Currently only articles published by **Kondinin Group** are available on **Kondinin Resources**. Many of these articles can be downloaded directly to your computer, others may be ordered directly from the **Kondinin Group**. Articles less than one A4 page can be downloaded free of charge. Articles of one page or more are charged for in Australian Dollars at the following rate:

THE FURROW

The following two articles have been taken from "The Furrow" (Edition No 1 2001), a free publication produced by John Deere & Company. It contains articles on new farming techniques, scientific developments and, of course, machinery.

Articles from around the world are featured, giving a bit of an insight into farming in other countries, however there are always some items from Australia.

As it is published by John Deere, it does contain quite a bit of advertising- which is useful when showing students the different types of farm machinery available.

Copies of "The Furrow" and subscription can be obtained FREE by contacting:

"The Furrow'
John Deere Limited
P.O. Box 2022
Crestmeade, Qld 4132



Controlled traffic farming

BY EMMA LEONARD



On the road to success

Are Australian farmers missing out on the benefits that can be gained by adopting controlled traffic farming systems? In many cropping districts, soil compaction by large machinery has been identified by researchers as a major problem.

Yield improvements of up to 15 percent have been recorded over a wide range of soil types by researchers and farmers. With results like this, they suggest it's time for more farmers to give controlled traffic farming (CTF) a go.

Other benefits from CTF are:

- Reduced costs - fuel, seed, fertiliser and sprays
- Lower tractor power requirements
- Improved timeliness of operations
- Greater accuracy of placing inputs
- Less operator fatigue
- Erosion and waterlogging control
- Improved efficiency and effectiveness of all operations

What is Controlled Traffic Farming?

CTF is a system where the wheel widths of heavy machinery are matched, allowing the tyres to run on the same permanent wheel tracks. Raised bed farming systems are a form of CTF specifically used in cropping soils prone to water logging.

CTF is most suited to continuous cropping systems which exclude livestock from the cropping area.

Researchers have found a key benefit of permanent wheel tracks is the elimination of soil compaction in the crop's root zone. Therefore, the paddock under CTF has two distinct areas — road beds and root beds. Road beds must be identified by not being cultivated or planted.

Compaction and Trafficking. Don Yule, of Natural Resources Queensland and his colleagues, have found that the first pass of a tractor causes 85 percent of the soil damage recorded by multiple passes. Therefore, to minimise soil compaction and structural degradation in the root zone, a system must be developed that maintains all heavy traffic wheels to the same place.



Above: Making hard work of it, bent roots struggle through compacted soil.
Left: The highly visible results of compaction shows up in stark layers following sheet erosion.

Compaction in the root zone has been found to limit root growth as roots will only grow easily where the soil strength is less than 3 Mega Pascals.

Compaction can also limit crop production by reducing rainfall infiltration and soil biological activity due to reducing the size and number of soil pores.

Growers can see these effects by pulling up plants and examining the soil and roots, and by looking for earthworms.

With traditional traffic systems, even in zero till systems, at least 50 percent of the surface will be run over by the tractor, implements and harvester wheels.

Therefore, at least 50 percent of the root zone will be compacted. With CTF the area trafficked can be reduced to 16 percent and root zone compaction caused by trafficking reduced to zero.

To achieve this, tractors, sprayers and harvesters need to run on the same permanent tracks. Implement width should be equal or multiples of harvester width.

Convenient widths are 2m or 3m wheel spacings and 6, 9 or 12m harvester width.

In practice it has been found, by Queensland research and extension teams, that most farmers adopting controlled traffic start by matching only the seeding and spray equipment.

At harvest soil damage is small, providing conditions remain dry. Researchers indicate damage can be substantial when harvest conditions are wet.

Yield Benefits. Reduced infiltration of water is one consequence of soil compaction. This can prevent crops from maximising potential water use.

Work from Gatton, University of Queensland, found an average 30 percent improvement for rainfall infiltration under controlled traffic systems.

This percentage was even larger where crop residues protected the soil surface.

Similar effects were seen in CTF trials on red brown earths in South Australia.

Improved infiltration results in more of the growing season rainfall being available for plant production. Following the rule of thumb that 50mm of available moisture equals 1 tonne of grain, then a 30 percent increase in infiltration offers significant opportunities for improved production.

Work in Western Australia in 1999 found wheat sown under CTF had a significant reduction in screenings.

This may relate to improved infiltration and availability of soil moisture.

CTF leaves 16-18 percent of a paddock unsown and used for wheel tracks.

This has resulted in the perception that paddocks under CTF will have a yield reduction of 16 to 18 percent. But this has not been found to be the case.

The table illustrates this graphically, showing results from Western Australia research into wheat yields under CTF and traditional traffic systems.

Despite the fact that 16 to 18 percent of the CTF paddock was under wheel tracks, yield improvements of between 8 percent and 13 percent were recorded.

Seeding rates for CTF are the same as for normal traffic, but the seed which would normally be spread behind the tyre may be diverted to the adjacent rows.

Researchers point out that the soil volume, nutrients and moisture available to the plants is the same with CTF.

It is only surface area which is affected by permanent tracks.

Other results from Western Australia also counteract the perception that CTF should

Table 1: Wheat yields in 1999 from controlled traffic and deep ripping trials in sands in WA (480mm in 1999). All treatments ripped in the same year were significantly different.

Treatment	Deep Ripped	Yield t/ha	% increase over NT
CTF for 3 years	1997	2.77	13 percent
CTF for 1 year NT for 2 years	1997	2.61	-
NT for 3 years	1997	2.45	
CTF for 1 year	1999	2.61	8 percent
NT for 1 year	1999	2.42	

NT= normal traffic

Controlled traffic farming



Above: Harvester and chaser bin at work, all on 3m wheel tracks.
Below: What a Controlled Traffic Farm looks like — the wheel tracks are obvious.

result in a reduced yield per hectare. This work looked at the impact of late spray and fertilizer applications on crop performance. Where crops were driven over at anthesis, 100 percent yield loss was recorded. Even with the widest spray booms and spreading width, 16 to 18 percent of the crop was trafficked.

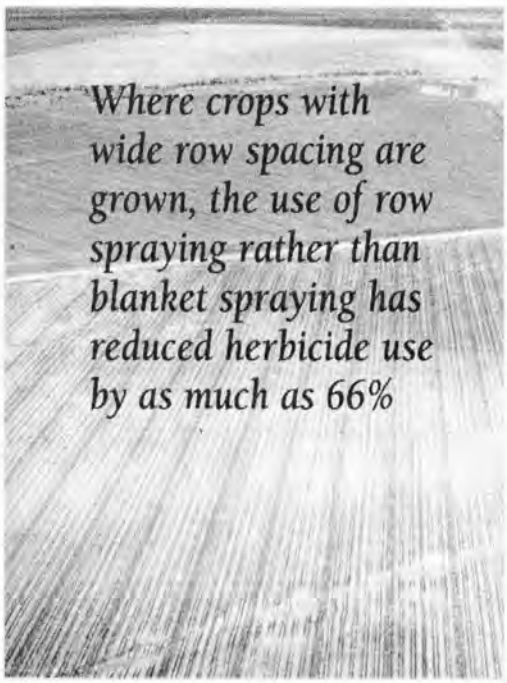
Energy Benefits. Controlled traffic farming can reduce tractor power requirements by 50 percent. This result comes from work carried out on heavy clay soils at normal tillage moisture.

This saving is due to CTF reducing the energy required to improve traction and eliminating the need to till compacted soil.

In heavy clay soils the energy required to produce traction is 25 percent of the total tractor draft.

Where tines follow behind the tractor tyre the power requirement will increase. This increase will be the same as the percentage of the implement width that is trafficked. Observations suggest that tractors fitted with pneumatic tyres will rarely traffic less than 25 percent of the implement width.

Together these increase the power requirement by about 50 percent. With CTF this power becomes available for productive use allowing larger implements to be pulled or increased work rates. Alternatively, it allows smaller tractors to cover larger areas. Reduced power requirements also resulted in reduced fuel consumption.



Cost benefits. A major benefit introduced by CTF is improved accuracy of all operations. Queensland farmers operating between contour banks have reported time and material input reductions of more than 15 percent when they changed to downslope controlled traffic and row cropping, together with reduced driver fatigue.

Western Australian trials have reported a 3 percent reduction in seeding overlap and a 4 percent reduction in spray overlap when CTF is used.

The addition of marker arms on seeding equipment, especially on equipment driven by novice drivers, was found to help reduce overlap significantly.

Where crops with wide row spacing are grown, eg beans and maize, the use of row spraying rather than blanket spraying has been shown to reduce herbicide use by as much as 66 percent.

In newly ripped sites in the Western Australian sands, spraying of herbicides was 10 percent faster with CTF due to reduced rolling resistance.

Other issues. Weed control in tyre tracks can be an issue and more work is being carried out on this in Western Australia.

Controlling woody weeds has been a problem in the northern districts as herbicide is less effective in the dusty tyre tracks or on the plants, which are stressed due to being squashed under the tyre. The use of two spray nozzles in the tramline and system layouts, which allow boom sprays to be driven down alternating tyre tracks, has been found to improve tramline weed control.

Don Yule from the Queensland Department of Natural Resources points out another important issue — precision. CTF helps farmers to be more precise with their operations, and they can do each operation in exact relation to a previous or future operation.

The introduction of better guidance and automatic steering systems will enhance the benefits already being demonstrated by farmers adopting CTF.

• *Emma Leonard is a research writer with Jon Lamb Communications who has prepared this material for the Grains Research and Development Corporation.*

Improving seed emergence

BY CAROLINE PETERS

Getting seed off to a good start can be the difference between a disappointing harvest or reaping the rewards.

New semi-dwarf wheats with long coleoptiles and wider but thinner leaves are offering Australian farmers improved emergence, early vigour and higher yields.

The wheats, developed by the CSIRO Plant Industry, also provide the basis for a new approach to crop emergence problems associated with direct drill and conservation farming, particularly when combined with recent seed bed and seed emergence research.

Background. Most modern semi-dwarf wheats have a dwarfing gene, either Rht1 or Rht2 which reduces plant height, increases resistance to lodging and increases the harvest index (ratio of grain weight to plant dry matter weight). However these particular dwarfing genes also produce short, weak coleoptiles, which according to one disgruntled farmer "couldn't push through the skin on a rice pudding".

Long Coleoptiles. The coleoptile is essential for successful emergence and early plant vigour. Once the root has emerged the coleoptile, which is a sheath that encases the first leaf, pushes through the soil to the surface.

If the coleoptile is shorter than the sowing depth, the first leaf must try to push through the soil and emerge in a dark environment. The longer this takes the more vulnerable the seedling is to soil crusting and diseases in the soil.

Coleoptile lengths differ between wheat varieties and many of the older wheats had long coleoptiles, so could be sown at more variable and greater depths.

The new CSIRO wheats are using a different dwarfing gene (Rht8), which does not reduce the length of the coleoptile. Trials at the Birchip Cropping Group site in Victoria used wheat lines developed from Mara (which has the dwarfing gene Rht8) and long coleoptile lines Halberd and Insignia.

In these trials, the new lines were sown at 5, 10 and 12cm. The deeper sowing depths did reduce yields marginally (*See figure 1*), but only to equal the yield of Frame (2.4 t/ha) sown in adjacent plots at 5cm.

Reliable emergence from depth will allow better use of moisture at sowing and counteract the effects of uneven sowing depths.

In simulated stubble trials, the long coleoptile wheats showed even greater versatility by emerging 30% faster than short coleoptile wheats under 6t/ha of stubble. In these same trials the long coleoptile seedlings also produced 40% more dry matter in the first three weeks after sowing.

Early Vigour. In addition to long coleoptiles, researchers are also increasing the leaf size by selecting for broader but thinner leaves. As researcher Dr Greg Rebetzke suggested we are making wheat look more like barley; with broader leaves and a vigorous early growth habit.

Plants with early vigour shade the soil more quickly decreasing evaporation and improving the ability of the plant to compete with weeds.



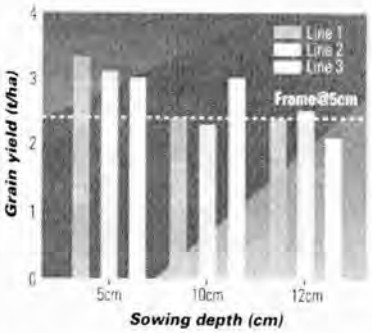


Figure 1: Change in grain yield with increasing sowing depth of three long coleoptile lines. (Trials sown at Birchip, after fallow.)

Vigorous early growth has also been associated with increased water use and greater nitrogen uptake to reduce the risk of nutrient flows into groundwater.

The long coleoptile, early vigour lines are being targeted to meet the demands of Australia's southern graingrowers. Coupled with other recent CSIRO work on reduced tillering lines, future wheats, which will be available in 2001/2002, should be more suited to the southern environment and rainfall patterns.

Other new wheats bred for transpiration efficiency will be released into the northern wheatbelt, where crops are largely grown on stored soil moisture.

Seedbed from the root's eye view. Before these new wheats become available, CSIRO soil scientist, Dr John Passioura suggests farmers dig up some plants a few weeks after emergence to check if there is any obstruction to root growth.

Roots can sense adverse conditions in the soil such as compaction, temperature, disease, dryness and salinity and send signals to the leaves to close down stomata and slow growth.

These responses occur from the development of the first leaf, even before moisture is actually limiting.

Dr Passioura suggests farmers have a few tools at their disposal to make the seedbed as hospitable to roots as possible:

• Fertiliser bands

Sowing fertiliser in a band below and to one side of the seed will cause the roots to proliferate around the band and eventually work their way to the centre. This allows a much larger proportion of fertiliser to be taken up by the crop than if the fertiliser is uniformly spread.

• Soil amelioration

If the soil is hardsetting or prone to crusting, use gypsum every few years and take steps to improve the level of organic matter, by retaining stubbles and reducing the amount of tillage. For acidic soils apply a fine grade of lime to increase the level of pH and reduce aluminium and manganese toxicity.

• Raised beds

Some farmers in the high rainfall areas of Australia are installing raised beds to prevent waterlogging and along the way have picked up the benefits of controlled traffic, reduction in compaction, precise application of fertilisers and pesticides, and increased trafficability to improve the timeliness of operations.

• Retain stubbles and use minimum tillage

Compromises are often necessary, and retaining stubbles can cause machinery blockages, disease, pest and residual herbicide problems. However, conservation farming practices will help to maintain soil structure, and organic matter levels.

In the future. Root growth is restricted in hard soils but roots can still find ways of moving through dense soil using macropores. Macropores are the channels and holes left behind by previous roots and soil organisms. Roots grow easily down them to access subsoil moisture and nutrients. However, if there are few macropores, the roots will access only some of the moisture and nutrients.

Dr Mac Kirby from CSIRO Land and Water is using novel X-ray techniques to study root distributions and the soil environment in which roots grow.

Dr Kirby has found the soil near macropores contains more roots. It also contains more nutrients and microorganisms than the bulk of the soil between the macropores (see Table).

Tap rooted plants, and perennials such as lucerne, are good at creating macropores and might be used in a conservation farming strategy designed to build up organic matter and maintain soil structure. Annual plants, which have a fibrous root system, are not as good at creating macropores.

Research undertaken by Dr Pauline Mele at Agriculture Victoria - Rutherglen, is identifying beneficial bacteria in the soil surrounding the roots and inoculating these microorganisms onto wheat roots. Some of the useful bacteria isolated help make phosphorus more available to the plant, and others stimulate nitrogen fixation. Initial laboratory inoculation results have shown an increase in root branching of up to 132%.

• Caroline Peters is a research writer with Jon Lamb Communications who has prepared this material for the Grains Research and Development Corporation.

Biological and chemical differences between soil around macropores and the remaining soil.

Soil Property	Soil around the macropores	Remaining (bulk) soil
Total bacteria (ug/g)	10.14	3.34
Carbon (%)	0.55	0.245
Nitrogen (%)	0.056	0.034
Phosphorus (mg/kg)	17.4	8.8

The following articles are samples from Meat & Livestock Australia's Sustainable Grazing Systems Program, Prograzier magazine. This publication is a useful resource, focusing on strategies for sustainable production and pasture management in grazing enterprises. It can be obtained, free, by completing the form below.



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MEAT & LIVESTOCK
AUSTRALIA

MAINTAINING OUR BIODIVERSITY

Nature Conservation

Using **natural predators** for pest control

Researchers **Finding answers**

KEY POINTS

- Provide nectar producing trees and shrubs to feed predatory insects, habitat and food for birds and sugar gliders.

Leaf eating beetles can cause enormous damage to trees, especially when they are under stress.

The larvae of some beetles also attack pastures.

But there are complex relationships out there in the paddock that can help minimise the damage they do. These complex relationships depend on trees and shrubs – particularly those that produce nectar – to work effectively.

Two distinct forms of beetles are active in defoliating trees. Scarab beetles, of which the christmas beetle is one example, hatch from the familiar curl grub larvae (red and black-headed cockchafers) which attack pastures.

The other is the leaf beetle (*Chrysomelidae*) which cause considerable damage to Eucalypts and Acacias.

The adult scarab beetle feeds on eucalypt leaves and often swarms in large numbers in spring and summer.

Magpies, currawongs, starlings and ibis all feed on scarab beetles.

Scarab beetle larvae are also parasitised by wasps of the brilliantly metallic-coloured family *Thynnidae*.

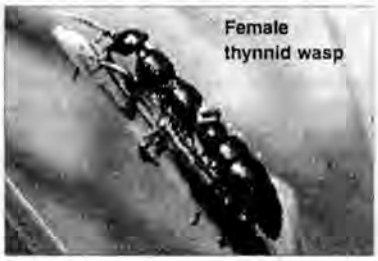
The females are often flightless and can resemble ants. They burrow into the soil to lay their eggs on curl grubs.

However, the wasp requires fertilisation after only one or two eggs have been laid. Females cannot fly to a nectar source so the male regurgitates to feed her during copulation. The male wasp must feed on nectar every day, but can fly no more than 200 metres from nectar bearing trees or shrubs.

The adult beetles also have their own parasites – tachinid flies that lay their eggs on the head and thorax of the beetle. The fly larvae burrow into the tissue of the scarab beetle, rapidly killing it. Tachinid flies also feed on nectar.

Other predators on scarab beetles include Boobook Owls and Sugar Gliders. Both require dense cover in which to hide during the day. This is best provided by acacia scrub. The gum from acacia is an important part of the Sugar Glider winter diet.

They are unable to survive long without it.



Female thynnid wasp

SAWFLY

The 'spitfire' grubs of the Eucalyptus sawfly (either *Perga affinis* or *P. dorsalis*) and other related species, are a familiar sight on eucalyptus trees.

Sawfly are pests of open woodland and ornamental trees, rather than dense forest. Individual trees often suffer complete defoliation, but severe infestations over large areas are uncommon.

The repulsive looking larvae spend the day clustered in groups. If disturbed, they raise their heads in unison and regurgitate a strongly eucalypt - scented yellow fluid. At night the grubs disperse and feed on foliage.

In the related genus *Pseudoperga*, females will stand guard over their eggs and young larvae for several weeks. This is to protect them from predatory wasps and tachinid flies, which remove them or lay eggs of their own parasitic larvae to feed on them.

During the feeding phase of the sawfly colonies, larval survival is associated with the number of individuals present. At normal population densities larval survival is nearly complete. In less than half normal populations few survive to pupation.

Few birds will eat sawfly larvae. Crimson rosellas and gang gang cockatoos will. Both these species are restricted to forests or dense woodland habitats – further indication that sawfly can be controlled by a greater density of trees and integrated ecosystem.

The key to control of sawfly is to build numbers of predatory wasps and tachinid (Bristle) flies, both of which are dependent on nectar supplies.

MOTH LARVAE

One of the most common eucalypt defoliating caterpillars is the gum leaf skeletoniser, *Uraba lugens*. Attacks on larger trees do not usually cause significant damage other than unsightly brown leaf skeletons during late summer/autumn. Attacks on saplings may result in total defoliation and death.

The larvae of the gum leaf skeletoniser is parasitised by small flies and wasps, whose own larvae develop inside the moth lava and kill it.

Similar damage can be caused by caterpillars of the autumn gum moth (*Mnesampela privata*) feeding in groups. Older caterpillars of the species consume all leaf tissue, sometimes leaving only the mid-rib.

Both the eggs and larvae of the autumn gum moth are parasitised by other insects. The eggs are attacked by minute black wasps which lay their own eggs inside the moth eggs. The young wasps develop inside the moth eggs before emerging as adults, preventing the moth eggs from hatching. The larvae of the autumn gum moth are parasitised by several larger wasps which lay their eggs in the body of the moth larvae. The developing wasp larva eventually kills the host grub.

The third group of caterpillars that damages Australian native trees are those of the Geometrid moths or 'looper' caterpillars. One of these is *Stathmorrhopa aphotista*, which is often associated with dry schlerophyll woodland. Young caterpillars feed only on the leaf surface but older caterpillars consume all the leaf. As an area of woodland is defoliated if takes on a brown appearance, almost as though trees have been scorched by fire.

The eggs of 'looper' caterpillars are often destroyed by a predatory bug that sucks out the contents of the egg. Eggs are also a parasitised by a minute black wasp, while grubs are destroyed by several species of wasps which lay their eggs in the body of the caterpillar. Other grubs may be eaten by birds or infected with a fungus.

- Information supplied by Richard Weatherly, Connewarran, Mortlake, Vic.

My favourite place

Tom Dunbabin, Dunally, Tas

A grassy cliff top, the Tasman Sea to the north, with a backdrop of hills covered in Eucalypt forest to the south.

To the east is a long white sandy beach, with a barrier dune system of native vegetation and a lagoon behind, and to the west a sheltered bay, lined with forest.

This place is natural; quiet yet dynamic; warm yet fresh; sheltered yet exposed. In it I can feel free and isolated, save for the forest robins searching for grubs, and the gannets diving for fish. The scene is just as it would have been for Aborigines a thousand years ago.



MAINTAINING OUR BIODIVERSITY

Soil Health

Soil microbes - the underground **powerhouse of pastures**

Researchers **Finding answers**

THE old cliché 'out of sight, out of mind' certainly applies to soil microbes. We are rarely aware of these microscopic organisms, diligently working away in our soils.

The occasional field mushroom popping out of the soil might attract our attention, gastronomically speaking; or some of those brightly coloured toadstools.

However, it should also remind us of the mass of microscopic filaments of soil fungi that are decomposing organic matter and recycling vital nutrients back to plants.

Because soil microbes cannot be seen by the naked eye, it is hard to monitor their activity. Measurement methods can be complicated.

Researchers in northern NSW have found a positive link between earthworm numbers and soil microbial biomass.

"Conditions that favour earthworm activity also favour soil microbes," says Greg Lodge, principal scientist with NSW Agriculture in Tamworth.

"So one way to get a handle on microbes is to monitor earthworm numbers. It is far easier to count earthworms in soil than it is to measure soil microbial mass."

He said one way to get an indicator of soil health was to dig for earthworms in late winter or early spring, when soils are moist.

"Aim to find more than three earthworms per spade width – 20 x 20cm square and 10 cm deep)."

Another easy way to monitor the health of your soil microbes could be to look at the litter levels on the soil surface, says Kath King, of the University of New England Armidale NSW.

"High litter, of good quality, means healthy microbes," she says.

Pasture litter is dead plant material that covers the soil surface.

It protects the soil surface and provides an important ground cover, helping to reduce water, sediment and nutrients lost by surface runoff.

Most of the water used or lost by a pasture is by evapotranspiration; water used by the plants is transpired and water that evaporates from plant and soil surfaces is lost.

These losses can be as high as 200-400mm a year, depending on the amount of litter and bare soil.

High amounts of litter (>1500kg/ha or three handfuls per square foot) can slow water losses, particularly in summer. This makes more water available for plant growth.

Kath says litter also protects the soil by reducing soil surface temperatures. Lower temperatures and higher soil moisture make conditions more conducive for soil microbial activity.

Litter is one of the major sources of forage for invertebrate animal 'decomposers' and soil microbes.



Soil microbe hypogastrura

The rate at which litter is broken down to particles of organic matter and incorporated into the soil depends on litter quality.

Clover provides the highest quality litter, followed by green leaves of grass, dead leaf material and finally dead stem material.

Clover can be physically broken down in a matter of days through the activities of soil invertebrate animals into particulate organic matter that washes into soil in the next rain shower. Dead stems, made of tougher material, can take many months to be incorporated.

Once in the soil, these organic particles are in a kinder environment for microbial action. Temperature and moisture conditions are more favourable for microbes than in the surface litter layer.

"Because clover litter is such a high quality source of 'microbial fodder', when managing litter it is a good idea to try to use clover litter in spring when the nutrients released by microbes will be sopped up by plants in their spring growth, and not lost through leaching. This helps prevent acid soil problems encountered in southern Australian pastures through legume use."

Native pastures with moderate levels of litter in northern NSW have 5-10 fold greater rates of water infiltration compared to bare soil surfaces.

"Increased water infiltration into the soil makes more water available for plant growth and reduces the likelyhood of excessive runoff."

But chemicals leaching from the litter of some plants, such as phalaris, can

My favourite place

Warren King

One of the first places I think of as a favourite place is a paddock! Not just any paddock though, this one is part of the SGS National Experimental site at Carcoar and it is a real 'slice of landscape'.

In a hectare and a half there is ridge, slope and gully; south and north-facing aspects; weeds, native perennial grasses and lilies, as well as magnificent yellow box and ribbon gum.

Here is an ecosystem writ small — biodiversity and landscape hand-in-glove. I nearly stepped on a brown snake here. I identified Early Nancy for the first time here. Funny thing is, the worms seem to like it too — we found more here than anywhere else.



MAINTAINING OUR BIODIVERSITY

Soil Health

reduce the germination of subterranean clover in autumn.

"In these situations, litter levels may need to be managed to ensure adequate levels of clover in the pasture," Greg says.

In summer rainfall environments, excessive litter levels in native pastures can also reduce clover emergence by physical restriction of the germinating seedling or through shading.

So grazing in late summer-early autumn may be required.

Litter can have an overall beneficial effect on clover germination with large, healthy seedlings and more rapid establishment occurring in areas with litter compared to bare soil surfaces.

"Our main message here is that pastures with a low level of litter overlying the soil surface have low soil microbial activity," Kath says.

Kath King, University of New England Armidale NSW kking@une.metz.edu.au
Greg Lodge, NSW Agriculture Tamworth greg.lodge@agric.nsw.gov.au.







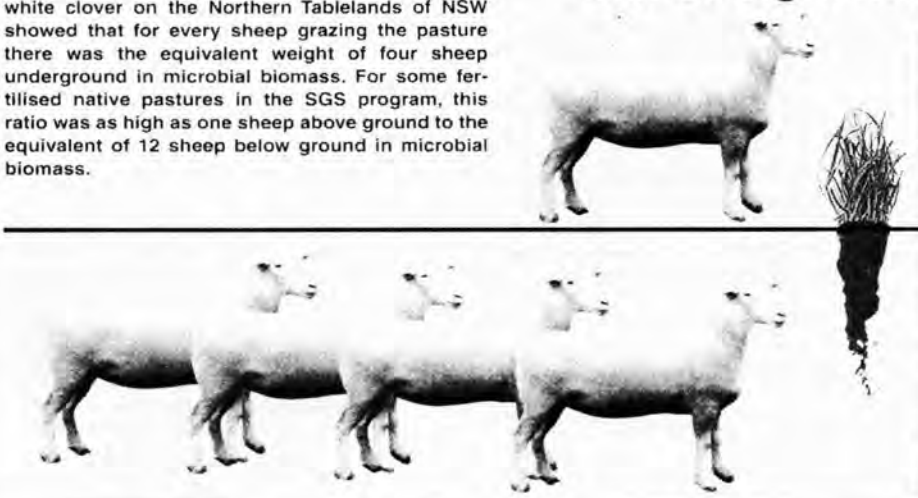
Mushrooms and toadstools (above) should also remind us of the mass of microscopic filaments of soil fungi (right) that are decomposing organic matter and recycling nutrients back to plants; and the microarthropods (far right) hypogastrura (facing page) and earthworms that are in our soils.

KEY POINTS

- Most soil microbes - bacteria and fungi - are in the top five centimetres of the soil;
- For optimal activity, most soil microbes need temperatures in the range of 15 to 35^{o}C and adequate soil moisture;
- Bare, exposed soil surfaces are hostile environments for soil microbes. They are too hot and dry;
- Soil microbes are an essential part of the chain of breakdown of litter, dung and plant root residues, and the recycling of soil nutrients from soil organic matter;
- High levels of organic matter also improve soil structure and water infiltration and increase the ability of the soil to hold water in the plant root zone;
- As well as their nutrient cycling role in soil, microbes enhance soil structure with fungal filaments physically binding soil particles together while microbial exudates glue soil particles into water-stable soil aggregates;
- Like grazing livestock, the pasture soil microbes need to be well fed for a healthy system to be operating; and
- As with your livestock - the higher the nutrient content (or quality) of feed for the microbes, the better they perform.

Out of sight-out of mind

Research on a fertilised, sown pasture of phalaris-white clover on the Northern Tablelands of NSW showed that for every sheep grazing the pasture there was the equivalent weight of four sheep underground in microbial biomass. For some fertilised native pastures in the SGS program, this ratio was as high as one sheep above ground to the equivalent of 12 sheep below ground in microbial biomass.





• Our main message here is that pastures with a low level of litter overlying the soil surface have low soil microbial activity.•

MAINTAINING OUR BIODIVERSITY

On-Farm Integration

Focus beyond the paddock and onto off-farm management impact

Researchers **Finding answers**

FARMS are usually a mixture of mini-landscapes within a larger landscape. Yet most decisions are made at a paddock level and may not reflect what happens across the landscape.

The challenge for producers, according to Warren King of NSW Agriculture, is to better understand how all the components in the landscape interact so they achieve their aims for the whole property, rather than trying to optimise the management of each paddock separately.

Warren says there are patterns of biodiversity within paddocks, between paddocks, between farms and within regions.

"We need to think beyond the paddock because each paddock does not exist in isolation," Warren says. "Water, nutrients, soil, seeds and animals all move across paddock boundaries."

He says biodiversity across the landscape is more important than within a paddock because the maintenance of some species may depend upon what happens in nearby paddocks.

KEY POINTS

- Think beyond the paddock.
- New areas of biological control.
- Environmentally friendly products strike chord with consumers.

"It is obviously impractical to maintain similar levels of biodiversity in every paddock, but it is important to consider the different ecological niches across the landscape and, where possible, maintain examples of each – whether these be dry and wet grasslands, wood and shrub lands, wetlands, riparian zones and waterways."

SURROUNDING LANDSCAPE

He says when thinking about the management of a landscape it is important to consider how on-site management may affect not only the diversity of species within a farm, but also the diversity of species across the surrounding landscape.

He says there are many questions that need to be asked including:

- Do you harbour weeds, pests and diseases that could spread into neighbouring areas?
- Are there beneficial insects, birds and reptiles that can help control pests?
- What contribution could be made by your property to wider landscape goals?
- Is your water management influencing the hydrology of surrounding areas, streams and rivers?
- Is your chemical use having an impact on the food supply of native insects, birds and reptiles? Spray drift may not be a problem, but if all the predatory insects and other animals are affected, they can't do a useful job for you in helping to manage some of your pests.

Warren says biological control of weeds and pests is a preferred practice for many farmers.

"A new area of biological control is to maintain areas of diversity so that predatory insects, birds and bats, for example, are available to help reduce crop pests."

He says managers should resist the temptation to 'clear up' those last areas of native plants, as these may be the refuge for useful predators.

WEEDS

Weeds are always of concern to farmers. The focus is usually on those weeds that affect production.

However, from a native biodiversity perspective, Warren says it is also important to consider the environmental weeds – those weeds that may only have a small impact on production, but can take over in native areas.

"Weeds such as bridal creeper and blackberries are very competitive and many rare and vulnerable species are threatened by them. Weed management needs to take into account all the likely impacts of the weeds present when deciding upon control measures."



He says with the marketing of 'environmentally friendly' products becoming more important and a way of obtaining a premium from concerned consumers, an important part of any environmental management system is to clearly demonstrate that the whole landscape is being managed appropriately.

He says many farmers remain concerned about the off-site impacts of unthinking chemical use. The endosulphan affair clearly demonstrated that unwise use of chemicals severely damaged the cattle market because consumers and authorities do not want chemical residues in meat.

"Similar concerns exist with biodiversity and we need to think about how best to manage the many ecosystems that sustain our farms," Warren says.

"Farms no longer operate in isolation from neighbours and the more we can do to understand the interrelationships among parts of the landscape, the more effective our management will be.

"Total quality management and continuous improvement are key aspects in developing a quality assurance-environmental management system that can be used to market farm products."

Our favourite place

Erin Gorter, WA

Until ten minutes ago, I was not consciously aware that I had a special place that I gravitated to when the need arose!



When asked to identify and write about a 'favourite place', I made myself a cup of tea, found a chocolate biscuit and sat on the side step of our verandah in the sunshine to think about the question at hand.

I sat there for at least ten minutes - gazing at the trees that border the paddock; counting the day-old lambs frolicking with their mothers; watching the blue wrens hopping among the plants; listening to the magpies singing in the trees.

I thought of many places I enjoy, but none of them fitted the 'favourite' description. It was only then that I realised that I had been sitting at my favourite place all along!"

SGS reports on 5 years of R&D investment

Practice Change

Assessing profitability and sustainability

Researchers Finding answers

SGS national research sites had a strong focus on both productivity and sustainability.

There are currently well established methods for presenting the productivity and profitability of research results (kg/ha and $/ha), but no recognised way to present sustainability information. Moreover, the research often does not continue long enough to 'prove' some of the resource impacts.

To overcome this limitation, a practical economic framework was developed in SGS to enable a 'triple bottom line' report on the results of treatments from the national experiment sites.

This framework took account of both the production and natural resource results, combined both measured results and the subjective assessments of the scientists, and could be applied consistently across all SGS research sites and themes.

The focus was on presenting within one simple table, the gross margin, the key production implications, the off-farm and on-farm impacts on the resource base, and an overall assessment of the treatment.

Using the framework

The key elements for making decisions about adopting SGS messages, and for comparing the national experiment treatments, were considered to be:

- **Profitability** as indicated by Gross Margin, but tempered with an indication of the key considerations involved in deriving the GM.
- **On-farm resource impacts** given as a subjective rating, between -5 (major negative impact) and +5 (major positive impact), together with a list of the major upsides or downsides.
- **Off-farm resource impacts** given as a subjective rating, between -5 (major negative impact) and +5 (major positive impact), together with a list of the major upsides or downsides.
- All elements combined into an **Overall Assessment** – the pros and cons for each treatment. This needs to include information on risks, likely variability, ease of implementation and other considerations.

The purpose was to provide producers with not only the traditional information on how a treatment changed wool production, or profit per hectare, but to also provide a range of other information to tell 'the whole story' on the likely effects of that treatment.

As an example of how the framework can be applied, two contrasting treatments from the National Experiment site at Albany, WA, appear above. These were a traditional, annual pasture, and a kikuyu based pasture.

Producers are enthusiastic about its relative simplicity while providing key information for an assessment of the financial and environmental pros and cons of a particular research treatment.

Evaluation of Kikuyu pasture treatment at Albany, WA

On-farm Resource Impacts

Rating -5 –4 –3 –2 –1 0 1 2 3 (4) 5

Key Impacts
- Low groundwater recharge
- Low nutrient losses
- Low or nil soil acidification
- Low soil erosion risk
- Reduction in broadleaf weeds
- Low plant diversity

Off-farm Resource Impacts

Rating -5 –4 –3 –2 –1 0 1 2 (3) 4 5

Key Impacts
- Reduced salinity risk
- Reduced eutrophication of waterways
- Reduced erosion of river and creek banks
- Reduced sediment in waterways
- Increased potential invasion of waterways and native bush by kikuyu

Profitability

Gross Margin - $279 per hectare

Other Key Considerations
- More fertiliser required
- Improves wool characteristics
- Maintains live-weight over summer/autumn
- Increased costs associated with kikuyu establishment and higher stocking rates
- Additional management skills needed compared to traditional, annual pastures.

Overall assessment

Pros
- Provides green feed all year
- Allows high stocking rate without supplementary feeding
- Reduces salinity risk and soil erosion
- Increases returns per ha

Cons
- Poor winter performance when legume content low
- Increase sheep worm burden due to green leaf in summer/autumn
- Kikuyu is susceptible to frost

Evaluation of annual pasture treatment at Albany, WA

On-farm Resource Impacts

Rating -5 –4 –3 (–2) –1 0 1 2 3 4 5

Key Impacts
- High groundwater recharge and nutrient loss
- Rapid soil acidification
- High soil erosion risk
- Increased weeds
- Increased soil nitrogen fertility
- Increased soil non-wetting

Off-farm Resource Impacts

Rating -5 –4 (–3) –2 –1 0 1 2 3 4 5

Key Impacts
- High salinity risk
- High eutrophication risk for waterways
- Erosion of river and creek banks
- Increased sediment in waterways
- Loss of Flora and fauna

Profitability

Gross Margin - $100 per ha

Other key considerations:
- Changing feed supply can weaken wool
- A lot of supplementary feeding required
- This is the traditional system, so its well known and easy to manage
- Fits easier into a cropping rotation than perennial pastures

Overall assessment

Pros
- Productive pasture within growing season
- Legume provides N input
- Suitable for set stocking
- Can produce good hay or silage

Cons
- No production in summer/autumn
- Poor dry residue in autumn
- Significant amounts of groundwater recharge
- High risk of acidification, erosion and non-wetting soils
- Subject to weed invasion

SGS reports on 5 years of R&D investment

Decisions, Decisions: the path to on-farm practice change

Changes are continually going on in everyone's life. While some are forced on us, most change occurs when a person wants a different outcome.

If graziers want to improve their productivity of their farm, their profit or sustainability, they have to make changes to the way they operate.

Some changes, such as a brand of drench are simple; while others, such as changing from set stocking to rotational grazing, can be complex.

In both cases, people go through a series of steps to make the change.

Practice change is a three stage process;

a. **Motivation** - the reasons or desires for wanting to change practice.
b. **Exploration** and **Trialing** - planning what changes to make and how to make them.
c. **Doing it** - taking the new practice and adopting it across the farm.

UNDERLYING PRINCIPLES

During the SGS Program, a Practice Change model was developed from a combination of extension theory and practical experience from producers, researchers and extension practitioners in the program.

The diagram outlines not only the elements of the process of change but also highlights the transitional decisions made between each element.

SGS PRACTICE CHANGE MODEL

The transition between each of the three phases is important as it involves significant decision making steps.

Unless decisions are made and there is follow up action, there will never be any change.

This implies a continuous planning, trialing, adoption and evaluation cycle. The model also suggests an increasing level of commitment as a person moves through the phases of the practice change model.

MOTIVATION PHASE:

Creating a reason or desire for wanting to change practices ...

Motivation is created by the anticipation of either a possible gain or a potential loss, and is an essential ingredient of every change process.

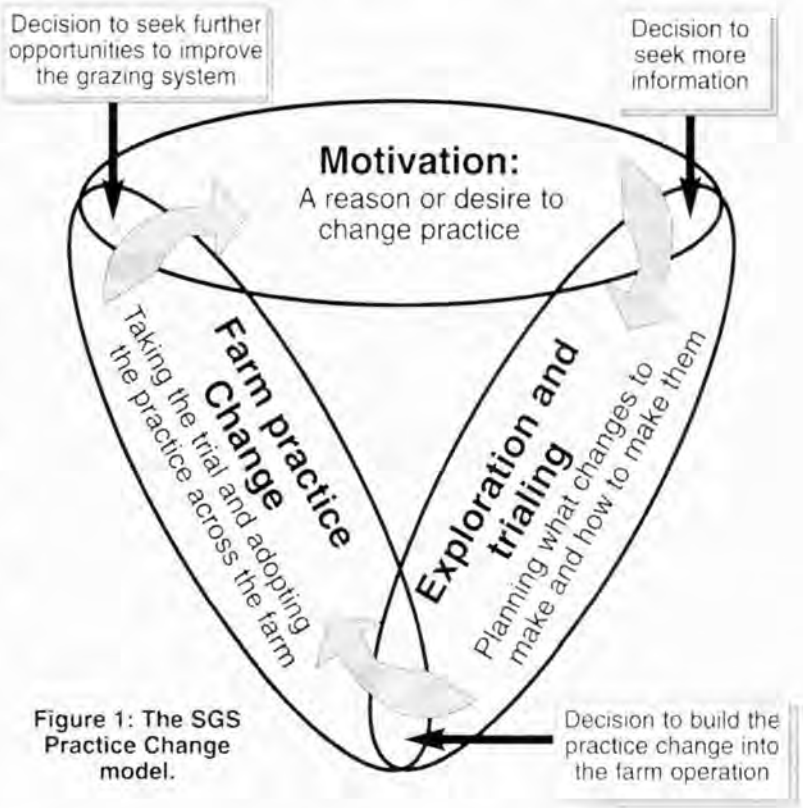


Figure 1: The SGS Practice Change model.

Possible gain: The strongest desire to change is usually created by exposure to an opportunity, where it is possible to envisage a possible gain.

Irrespective of which perspective is taken, the realisation of a potential 'bettering' of a current position is a strong motivator.

The effectiveness in demonstrating a possible gain to a person is partly determined by the goals and aspirations that the individual has.

Potential loss: At the other end of the spectrum, the desire to change may be created by appreciating the potential for a future loss.

In summary:

Motivation is created by recognising a potential gain or by anticipating a loss. Recognising a gain is a stronger motivation to change than a threatened loss.

New information, simple monitoring/benchmarking tools and industry recognised assessment procedures that allow for market discrimination can assist in creating the motivation to change.

Delivery of these tools and products through a non-threatening process is essential.

EXPLORATION AND TRIALING PHASE:

Planning what changes to make and how to make them ...

The Exploration & Trialing phase involves working through a series of logical steps. These include:

- Seeking a range of possible solutions to the problem.
- Deciding on an appropriate practice that fits the goals/vision.
- Weighing up the options and dealing with conflicting messages.
- Developing the appropriate skills to

SGS reports on 5 years of R&D investment

Practice change on-farm

successfully adopt the practice change.

- Gaining support from the 'inner circle' involved in decision making.

At this stage it is not necessarily a single solution, rather a range of possible solutions or options.

Financial implications are significant (but not the only) impacts sought. Considerations on lifestyle, future aspirations and goals further influence the evaluation of options.

VISION: A picture will begin to develop an 'in the mind' of what is seen to be different.

Failure to have this picture can often lead to frustration through wanting to change but not being able to describe the change.

This often leads to unwise investments of time, money and emotional resources.

'COMFORT ZONE' AND RISK: During this phase alternatives are quickly evaluated and the unpalatable responses dropped out.

Usually it is those practice changes that fit the current 'comfort zone' that are retained for further examination. Additional 'filtering' also occurs and generally it is the practices that can be incorporated without dramatic disruption to the current farming situation that are pursued.

AVERSION TO RISK is critical during this phase of adoption. Up to a certain stage in the exploration and trialing phase, 'participation' can occur without having to make any significant intellectual, emotional or financial commitment.

This occurs without a significant cost (except for time) at farm walks, field days, workshops, seminars and conferences supported by brochures and hand out material.

Progressing past the 'tyre kicking' stage usually involves a larger commitment.

SKILL DEVELOPMENT: Increasing the technical capacity to understand and then apply the principles of the messages is critical. Confidence, level of knowledge and skill can reduce the anticipated risk.

SOCIAL SUPPORT FOR DECISION MAKING: Before large-scale practice change is contemplated on an individual farm, it is common to gain support from an 'inner circle' or closer group.

The major support providers are family members, other farmers (farmers talking to farmers) and trusted friends, advisers and/or business partners.

TRIALING becomes a critical tool to assist decision-making.

Trialing has the advantage of minimising the risk with individual practice change, highlights the benefits and the difficulties and allows testing of parts of a more complex system.

The more there are locally based trials that demonstrate an outcome and where producers are aware of the results, the more the perceived risk is reduced.

A key aspect of trialing is the need to show short-term results, say within a one to three year period. Financial benefits are commonly sought.

Importantly, if the practice change trialed on a small scale does not provide the response anticipated, it is easy to revert back to previous practices with minimal disruption.

In summary:

The exploration and trialing phase involves working through a series of logical steps to build confidence in the proposed practice change and to reduce the risks.

This includes developing the skills and to gathering the necessary 'social support' to make the change.

Tools that assist in demonstrating (and measuring) the impacts of practice change, both at demonstrations and on an individual's property, are vital.

Appropriate support activities, whether they are group based or one-to-one opportunities are essential.

FARM PRACTICE CHANGE PHASE:

Supporting the implementation of change ...

SOCIAL SUPPORT: Many traditional extension programs cease to provide support during this phase of the practice change process.

In some cases, whole farm practice change does occur, especially if the result of the changed practice is above expectations.

If the response is below expectations, slower than expected, or the impact takes a long time to manifest, then practice change will probably be slowed or abandoned altogether with reversion to previous practices.

Peer expectation, personal support and encouragement helps maintain commitment. This support may be in a group environment but may be equally provided by one-to-one support.

Public recognition of achievements in practice change, via farm walks, farm field days, presentations at seminars and through the mass media, provide a powerful means of reinforcing practice change.

SCALING-UP: The rate of adoption from a trial to the whole farm will vary depending on whether the practice meets expectations and the capacity to implement the change.

At this stage the wide spread adoption primarily relates to the degree of confidence in 'scaling up' the trial.

In summary:

The farm scale phase hinges on the degree of confidence in the practice change. This will be harder to maintain if the results are below expectations or are slow to be realised.

Tools that allow the impacts of the practice change to be measured at a 'higher order' (farm-scale) are critical, and support structures need to:

- Facilitate the discussion and exploration of unexpected issues and consequences that occur during practice change, either through group or one to one activities.
- Provide opportunities for positive public recognition and acknowledgment of the practice change.

Maintaining confidence and commitment to the practice change are the keys to farm-scale adoption.

Source: Final report of the SGS Social & Adoption Harvest Team

My favourite place

Rod Dowe

My favourite place is an odd shaped patch, fenced seven years ago to enclose a streamfed soak , three remnant areas of trees, and allow controlled grazing.

A pond has been excavated, the Red Gum, Peppermint, and Box have been joined by regeneration plus plantings of "exotics".

It's wonderful to see the reversal of the biodiversity loss signs — declining species complexity, dying soils and inevitable soil loss. If allowed, Nature can create.

Through ongoing regeneration, it's now a valuable source of clean, clear water for downstream flow and pumping for stock watering.



There is visible biodiversity above ground, trees, birds, insects, waterlife, plants; animals and, more importantly, through the laying down of organic matter we are creating new, active living soil, with abundant biodiversity underground.

MORE PROFITABLE ANIMAL PRODUCTION

Managing the Grazing System

Managing native pastures for **better livestock production**

On-farm research **Results**

NATIVE pastures are the most widespread pasture type in the temperate high rainfall zone. Yet little is known about their productivity.

Generally regarded as a low input option, where production and pasture quality is likely to be low, they are more likely to be used in wether and store cattle production systems.

Most native pastures are dominated by perennial grasses. Some of these (those known as the C3 grasses – Wallaby grass, *Austrodanthonia* spp. and weeping grass, *Microlaena stipoides*) are tolerant of grazing, have good feed 'quality' and respond to fertiliser.

Others are frost-sensitive and summer growing – the C4 grasses that are mainly productive in late spring or summer, depending on rainfall.

According to Greg Lodge, principal research scientist at the Centre for Crop Improvement, Tamworth, NSW, livestock production from native pastures can be improved in two ways.

"The first involves management to reduce undesirable species such as wiregrass (*Aristida* spp.) and/or increase the abundance of more desirable species," Greg said.

This involves the matching of grazing and management times to key periods in the plant's life cycle (flowering, seeding and seedling recruitment) to manipulate species composition.

Greg said large increases in livestock production can be achieved by removing low quality plants that cause seed contamination of wool and meat.

"Secondly, livestock production can be improved by increasing the quality and quantity of green feed on offer.

"This can be achieved by using superphosphate and subterranean clover, or some form of rotational grazing that gives the plant a rest from defoliation and allows it to regenerate."



Superphosphate and sub clover provides high quality feed for livestock in winter-spring. This native grass/sub clover pasture was grazed at 8 sheep/ha, compared with nearby unimproved native pasture grazed at 6 sheep/ha. Litter from sub clover is rapidly incorporated into the soil increasing organic matter, microbial activity and labile carbon. This gives a well-structured soil surface with lower runoff and improved water infiltration.

'Sub and super' increases the quantity and quality of green forage in winter and spring, allowing producers to change to breeding and finishing enterprises in more favourable areas.

However, these systems require careful management to ensure the clover does not out-compete the native grasses and that excess nitrogen produced by the clover does not lead to weedy pastures or acid soil.



• Livestock production can be improved by increasing the quality and quantity of green feed on offer. •

In summer rainfall environments, native grasses may also need increased grazing pressure in summer to allow for adequate legume germination in autumn.

"For wool producers, such systems can increase stocking rate and wool production. But they can increase fibre diameter, reducing profitability."

Sub clover may also increase ground cover levels in native pasture and, compared with continuous grazing, large increases in soil microbial activity recorded. This improves the health of the system.

Many native pastures continuously grazed at low to moderate stocking rates. Compared with continuous grazing, changing to a simple two or four paddock rotation (4 weeks grazing-4 weeks rest; or 4 weeks grazing-12 weeks rest) could have major benefits for livestock as well as for the pasture.

Livestock benefits occur mainly by increasing the amount of green forage available to the stock or, with longer rest periods, by providing a feed buffer.

"Increased green feed is the main driver of animal production," Greg said.

A feed buffer ('standing haystack') has distinct advantages in drier environments, since producers know how much feed is in front of them and they have time to plan for alternative management strategies (supplementary feeding, agistment, selling of surplus stock) in unfavourable seasons.

"While rotations can be flexible and increased or slowed, depending on the season, their main aim is to conserve or ration the feed supply. The pastures will not dramatically change species composition, unless the periods of grazing and rest coincide with those key times in the plant's life cycle."

Excessive periods of rest may lead to increased standing dead grass, reduced amount of green and less flowering.

However, resting of native pasture can have several benefits, particularly if the rest periods are around 45-90 days.

"It allows for the build up of litter, which is trampled when stock graze at increased rates. This litter protects the soil surface, adding to ground cover and is an important source of forage for soil microbes."

About 1500-3000kg/ha of litter (more than three handfuls per square foot) are needed to minimise the effects of raindrop impact, slow water runoff and reduce soil surface temperatures.

With litter levels and ground cover above 70%, more rainfall infiltrates the soil and more water is available for plant growth. With high levels of litter and a moister, cooler soil surface, a better environment is provided for soil micro-organisms and earthworms.

"Compared with areas that are continuously grazed at the same stocking rate, rotational grazing of native pastures in northern NSW has led to a three-fold increase in soil microbial activity and a four-fold increase in earthworm numbers," Greg said. "This improvement in soil health can directly benefit plants and livestock production because pastures grow more green leaf for longer periods."

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SGS MORE PROFITABLE ANIMAL PRODUCTION

Integrating the Production System

Stress-free handling & nutrition the **keys to quality beef**

SGS On-farm research Results

ALMOST 10% of Australian beef falls into the category of 'dark cutters'. That's a potential loss to the industry of about $36 million a year!

However, by following simple guidelines in cattle management and handling, much of this loss can be avoided. And there are flow-on benefits, such as reduced bruising, improved animal welfare and reduced weight loss.

According to the MSA Tips and Tools 08 called 'The effect of pH on beef eating quality', at the heart of the dark cutting problem is the relationship between pH (the acidity-alkalinity scale) and muscle glycogen levels.

Every animal has energy contained in its muscles in the form of glycogen. Once the animal is dead, the muscle glycogen is converted to lactic acid which causes pH to fall.

"The more glycogen there is, the more lactic acid will be produced," the MSA Tips and Tools says. "This is good because lactic acid enables the pH to fall to within the acceptable 5.30 to 5.70 range."

But animals short on glycogen, produce insufficient lactic acid after slaughter and the pH will stay high. This is bad and results in dark meat.

If the cattle are being sold through an MSA underpinned market, the maximum pH allowed is 5.70. Carcases with a pH above this will not grade MSA and are excluded from many meat brands, food service operations and markets such as the Japanese trade.

Transport stress, handling stress and weather stress all reduce muscle glycogen levels.

KEY POINTS IN BEEF QUALITY

- The acceptable pH range is 5.30 to 5.70 for guaranteed eating quality.
- Eating quality is reduced and more variable above 5.70.
- A high pH (>5.70) will generally result in "dark cutting" meat.
- Energy (glycogen) levels in the animal at slaughter are important in obtaining a pH within the acceptable range.
- Stress or exertion will result in cattle losing energy.
- Guidelines for minimising the dark cutting risk in your operation are available from Meat and Livestock Australia at www.mla.com.au.

Glycogen levels are influenced by the amount and value of the feed that the animal has been eating in the month before slaughter.

Cattle receiving high levels of nutrition from feedlot rations or first class pasture will have high glycogen levels. Restricted intake or low quality feed will significantly reduce glycogen, often below critical levels.

When an animal is exposed to a new environment, unfamiliar sounds or new animals in the social group, they can become stressed.

When that happens the glycogen stored in the muscles is rapidly mobilised to enable the animal to run or attack.

In the case of severe stress or exertion, it takes at least five days of good nutrition before energy stores start to build.

Poor mustering or handling during yarding and transport loading increases glycogen loss.

To minimise the amount of stress when mustering, avoid using electric prodders or dogs. Rattles or flappers cause less stress. Any excessive noise will also increase stress.

As energy continues to be lost while animals are transported and yarded, it is important to minimise the loss by making the time from transport to slaughter as short as possible and paying attention to transport and pre-slaughter conditions and practice.

Weather extremes also create stress and increase glycogen use.

Cattle use energy in cold weather maintaining body temperature. Likewise, when cattle are hot, they pant and sweat in an attempt to cool through evaporation, again using energy.



• Glycogen levels are influenced by the amount and value of the feed the animal has eaten in the month before slaughter. •

To minimise cold weather stress, cattle should be sold and trucked in good condition. In cold weather pre-transport feeding is particularly important.

Wind chill from rain, sleet and wind is often more detrimental than cold temperature alone. If there is a grazier's alert forecast, it might be an option to postpone trucking cattle until the weather has improved.

In hot weather, cattle should be trucked at night to minimise heat exhaustion.

Cattle are most at risk of dark cutting during autumn or winter, when the amount of available pasture is limited. Cattle at this time often have minimal energy reserves so cold snaps or frost can have a critical effect.

21 Tips to give beef a chance

1 Select cattle on temperament, as well as performance.
2 Familiarise animals to handling and human contact.
3 Ensure cattle are on a rising plane of nutrition prior to marketing. Enable growth rates of at least 0.6kg/ day.
4 Provide susceptible slaughter cattle (those with a high value and potential for discounting for dark cutting) with a high energy diet prior to marketing.
5 Where possible exclude heifers in oestrus from slaughter consignments.
6 Market bulls separately.
7 Don't market for slaughter too soon after purchase.
8 Comply with manufacturer's instructions regarding the use of HGPs.
9 Avoid marketing in, or through, weather extremes.
10 Only market healthy animals for slaughter.
11 Use well designed facilities for slaughter stock preparation.
12 Consider supplementary feeding before consigning.
13 Use reputable transport companies.
14 Muster and assemble stock as quietly and efficiently as possible.
15 Avoid running cattle to assembly areas.
16 Minimise use of dogs, electric prodders and other goads.
18 Keep animals in their social groups. Don't mix mobs of unfamiliar animals.
19 Be patient and allow time and space for cattle to move through yards.
20 Use well designed loading ramps.
21 Avoid dehydrating animals.

How Shane Gregg produces organic beef

Producer I'm doing it

Organic beef. If you think it's only for fanatics and alternative lifestylers, think again.

Consumers around the world are demanding safe, clean food said Shane Gregg who has been quick to develop systems on his 1600 hectare property at Stanthorpe, on the NSW-Qld border, to produce what the customer wants.

"Many consumers believe that only organic production systems can supply safe, clean food," Shane said.

He said Australia has a big opportunity to be one of the world's providers of food produced in a way that is closer to natural systems, with a minimum of unnatural input.

"Maybe we have to remember what Australia's world marketing advantages are and not aim for the extra daily gain in a forced system.

"Consumer perception will dictate our future in agriculture," he said.

Shane said the simplest way to look at organic production was to think of EU and Cattlecare accreditation.

"Organic accreditation is the same principle, except that the requirements on what can be used to enhance the animal production are more strict.

"In simple terms the standards require the system to be sustainable and work in tune with natural systems, minimising highly processed inputs to force higher production."

Shane and Maree Gregg's property, Mossvale, comprises loam to coarse granite country on the northern tip of the Northern Tablelands of NSW.

The property retains about 40% timber. Average annual rainfall in the area is 750 millimetres. This falls mostly in summer although they can get rain throughout the year.

They run 400 black baldy and Angus breeders, crop a small area of organic soybean and finish cashmere feral-cross goats for the goat meat trade.

The cattle herd has been self replacing but they are moving to greater use of Charolais and Wagyu-cross sires.

Shane said the fundamentals of organic meat production were the same as quality conventional beef production. The main difference is that the production system cannot be "pushed" to the point where it is perceived to be unhealthy for the environment or the animals.



Organic beef producer, Shane Gregg

"You also have to be careful not to believe that if you are organic you are producing a quality product," he said.

The Greggs have developed a profit share partnership with an organic farmer from near Toowoomba, Qld.

"We grow our weaners to 300kg and he finishes them on organic forage crops, grass and supplements, including grain husks, hulls and protein meal.

"This allows us to supply our market for seven months of the year with a consistent product. We then direct market the beef to butchers and, more recently, to Australian Country Choice, which supplies Coles' organic beef.

"It's a profit share partnership that works," Shane said. "Our finisher doesn't have to outlay money for store cattle and we optimise value."

Breeding cattle on Mossvale are selected for their natural resistance to parasites and ability to perform in the environment.

Cattle that do not make the grade are sold into the "conventional" markets.

An animal supplement program using certified natural minerals is used to boost animal health and cover deficiencies in available feed.

Organic certified copra meal is used as a supplement if pasture quality falls to a point where production targets cannot be met. A flexible stocking rate and fodder budget is used to minimise supplementation.

Calves are weaned into a cell which has been spelled in late summer. They have access to a small amount of copra, depending on season.

A soybean rotation is being tested prior to sowing down to permanent pastures in paddocks that have not responded well under the current grazing management.

These are the paddocks sown to temperate pastures 20 years ago and in which the native plants have not re-established.

Fertility has been addressed in these paddocks with compost made on farm from chicken and pig manure.

"An organic beef system is not a great deal different to many other meat producers who are practicing sustainable grazing. The main difference is that we have put in place systems that are audited every year and backed by Biological Farmers Australia, the certifying organisation recognised by some consumers as having integrity and, therefore we enjoy a marketing edge when our beef is labelled with their logo."

MAINTAIN PRODUCTIVITY

Shane said the big difference to Mossvale's profitability had been the ability to maintain productivity while reducing cost, largely through the use of cell grazing and the lift in price/kg.

Paddocks on Mossvale range from seven to 30 hectares - a single hot wire is used to break large paddocks into smaller blocks.

The couple run three grazing 'cells' of breeders, mixed weaners and replacement heifers.

He said SGS had reinforced the "most powerful and economic tool" producers have to make change -- the grazing animal itself.

"It is coming up at most SGS sites that if you incorporate animals into a grazing system that includes resting the pasture, you will achieve a positive outcome."

Contact Shane Gregg 07 4686 1247



Richmond High School at Manning Valley Beef Week

Rachel Parkes (yr 12), Richmond High School, with sash and prizes for "Champion Judge, Manning Valley Beef Week, 2002", with Bruce Serivener, (president), and Mark Samson, (Head Judge).





Rachel Parkes (yr 12), Richmond High School, awarded "Champion Parader", Manning valley Beef Week 2002

Richmond High Students inspecting their prize-winning carcase.
(Left to Right: Yvette Louis, yr 9; Rachel Parkes, yr 12; Kane Royman, yr 9; Robyn Reed, teacher; Charlie Cassels, teacher.)



MANNING VALLEY BEEF WEEK (MAY 1ST-4TH 2002)
(A Teacher's Perspective)

Do you fatten steers at your school? If you're interested in a great steer show, then get yourself to Wingham Showground next year for Manning Valley Beef Week.

The show is superbly run in a relaxed social atmosphere, and places strong emphasis on student learning. Students (120 this year) compete in Judging, Parading, Led Steer and a new Beef Appreciation competition which allowed students to assess led steers and follow the process right through to Wingham Abattoirs where the same led steer carcasses were reassessed in the chiller. A truly wonderful learning experience rarely available to students these days due to health and legislative restrictions. The staff at Wingham Abattoir were extremely welcoming and informative.

The show attracts plenty of quality sponsorship and students were well rewarded with substantial prizes. Also, as this is an open competition, schools get to compete against commercial breeders in the same competition (which was very satisfying).

Wingham Showground offers excellent camping facilities, or there is a motel nearby. Come up and see a beautiful part of the country!

Special thanks to Peter and John for their excellent organisation and hospitality.

See you there in 2003.

Charles Cassels
(Agriculture Teacher
Richmond High School)

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