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# Development of Improved Oat Varieties for Hay Production — *National Program IV* —

RIRDC Publication No. 09/147

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Development Corporation**

# **Development of Improved Oat Varieties for Hay Production: National Program IV**

by Pamela Zwer, Sue Hoppo and Peter McCormack

September 2009

RIRDC Publication No 09/147  
RIRDC Project No 002298

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ISBN 1 74151 945 4  
ISSN 1440-6845

*Development of Improved Oat Varieties for Hay Production: National Program IV*  
*Publication No. 09/147*  
*Project No. PRJ-002298*

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Electronically published by RIRDC in September 2009  
Print-on-demand by Union Offset Printing, Canberra at [www.rirdc.gov.au](http://www.rirdc.gov.au)  
or phone 1300 634 313

# Foreword

The aims of this research project were to continue the National Oat Breeding Program's component of improving oat varieties for hay production. The objective of the research was to summarise data from 2008 hay trials, select and promote advanced breeding lines into 2009 trials.

The Australian Fodder Industry has a value of \$1.5 b. Oat hay is a significant proportion of both export and domestic markets with growth particularly in the export sector. Exports reached more than 700,000 t in 2005-06, but successive droughts have reduced exports to about 500,000 t in the past two years. Potential new markets are China and the Middle East. The export hay industry is worth more than \$150 m annually and is the primary source of industry funds for this research.

With the expansion of the export oat hay industry and a more discerning domestic market there is an increased demand for oat hay varieties with adaptation across a wide range of environments and high quality. In order to provide growers, exporters, and consumers with the desired hay quality and quantity, oat variety development for hay end use is essential to maintain Australia's competitive advantage.

This project was funded from industry revenue, which is matched by funds provided by the Australian Government.

This report, an addition to RIRDC's diverse range of over 1900 research publications, forms part of our Fodder Crops R&D program, which aims to facilitate the development of a sustainable and profitable Australian fodder industry.

Most of RIRDC's publications are available for viewing, downloading or purchasing online at [www.rirdc.gov.au](http://www.rirdc.gov.au). Purchases can also be made by phoning 1300 634 313.

**Peter O'Brien**  
Managing Director  
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# Acknowledgments

The National Oat Breeding Team would like to acknowledge growers and industry from SA, WA, VIC and NSW; Australian Export Company (AEXCO) and Australian Field Crop Association (AFCA); the Research and Development Corporations, RIRDC, and GRDC; SARDI and DAFWA for the funding of this world class research program.

## Abbreviations

AFCA – Australian Field Crop Association

AEXCO – Australian Export Company

BYDV – barley yellow dwarf virus

CCN – cereal cyst nematode

CP – crude protein

DAFWA – Department of Agriculture and Food Western Australia

GRDC – Grains Research & Development Corporation

IVD – in vitro dry matter digestibility

ME – metabolisable energy

NDF – neutral detergent fibre

NSW – New South Wales

RIRDC – Rural Industries Research & Development Corporation

SA – South Australia

SARDI – South Australian Research & Development Institute

SN – stem nematode

VIC – Victoria

WA – Western Australia

WSC – water soluble carbohydrate

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# Executive Summary

## What the report is about

The report summarises the research conducted for a twelve month period from 1 July 200 to 30 June 2009 in the National Oat Breeding Program. Selections promoted to 2009 trials and new variety releases will be discussed. These advanced breeding lines represent the elite material for potential new variety release.

## Who is the report targeted at?

This report should be read by growers, industry, and researchers who are interested in the development of improved oat varieties for hay production.

## Background

With the expansion of the export oat hay industry, there is increased demand for oat hay varieties with adaptation across a wide range of environments and more discerning quality than in the past. A National Oat Breeding Program was initiated to meet the challenge of improving oat varieties for hay production in the southern region of Australia encompassing Western Australia, South Australia, Victoria, and southern New South Wales. This is the second phase of the National Oat Breeding Program based at SARDI with a selection program, technical staff, and centre for oat quality research located in the Department of Agriculture and Food Western Australia. Evaluation of advanced breeding lines for hay production is conducted at one site in Victoria.

## Aims/objectives

The release of improved oat hay varieties is essential to meet growers, exporters, and consumer's expectations. This will be achieved by coordinating a National Oat Breeding Program that develops and characterises new oat varieties for the major oat hay growing regions. Consulting growers and industry on current variety constraints has assisted with the formulation of breeding priorities resulting in the rapid uptake of newly released varieties. Customers of the export oat hay will also benefit by a consistent fodder product.

## Methods used

The National Oat Breeding Program is based on classical plant breeding methods with grower, industry, and consumer input into developing breeding priorities and selection criteria.

## Results/key findings

Advanced breeding lines were promoted to 2009 yield trials based on hay and grain productivity, hay and grain quality, disease resistance, and agronomic traits. The advanced breeding line, SV950137-6-3, was named Tungoo and SV96025-7 was named Mulgara.

## Implications for relevant stakeholders

The net benefits of developing improved hay varieties were estimated to be \$119 million with a 5% discount rate. Improved oat hay varieties return \$41 to the Australian economy for every \$1 spent on research.

In order to provide growers, processors, and customers with the desired hay quality and quantity, oat variety development for hay end use is essential to maintain Australia's competitive edge.

## Recommendations

Recommendations are targeted at the research funding community, growers, and the fodder industry.



# Introduction

Annual production of hay is 5.5 to 6.5 m tonnes worth \$1.6 b at the farm gate. About 80% of production is used domestically and 20% exported. About 4 m tonnes are used as fodder on the farm and about 1.4 m tonnes are traded domestically with 50% used in the dairy industry, 25% for the horse industry, 20% for the beef feed lot industry, and 5% for miscellaneous uses. The export hay industry has increased exports over 500,000 t in the last 10 years and is worth at least \$150 m annually. They export hay for dairy, beef, and cattle feedlots and horses.

Western Australia and South Australia lead the way for export hay production. As the industry grows it is essential that a consistent supply of high quality oat hay can be sourced for their markets. In order to achieve this, new growers enter the scene and growers currently producing oat hay increase production. The growth in hay production has spread across the entire southern region encompassing diverse environments, soil types, and production constraints. A diverse group of improved oat hay varieties is needed to meet this challenge for not only the export market, but also the domestic market.

The whole chain from grower to hay marketer to end user in export and domestic hay will benefit from the release of improved oat varieties for hay production. Growers will benefit from higher productivity and product quality due to improved disease resistance, agronomic characters, and quality traits. Benefits to processors are a reliable supply of consistent premium quality hay. End users will benefit by having a consistent supply of palatable hay. A benefit-cost evaluation conducted by the Centre for International Economics (CIE) for RIRDC was published in 2005 about the Oat Breeding Program. The Oat Breeding Program returns \$41 to the Australian economy for every \$1 invested in the research program.

# Objectives

- As part of the National Oat Breeding Program improve oat varieties for export and domestic hay production.
- Ensure oat hay varieties are adapted to the southern region of Australia.
- Set breeding priorities for hay variety development with industry interaction.

# Methodology

## Selection of Advanced Breeding Lines for S2, S3, S4, and S5 Hay Trials

### Trial Location and Entry Numbers

#### Stage 5 Hay Trials

Only one S5 trial was sown at Elmore in 2008. The entries selected for the S5 trial were evaluated in the S4 trial for two years prior to promoting them to this most advanced trial. There were 25 entries in the Elmore trial. Due to problems with the trial the lines could not be cut to determine hay yield or quality.

One S5 irrigated late hay trial with 21 entries and three replications was sown at Kerang, VIC. Hay yield was evaluated.

#### Stage 4 Hay Trials

Stage 4 trials had S5 entries as a subset in addition to breeding lines evaluated for a second year and new breeding lines promoted from S3 trials. There were 60 S4 entries in SA and WA in 2008. The S4 late hay trial had 32 entries and was sown at Kingsford and Riverton.

Hay yield for S4 entries was evaluated at four locations (Table 1). Hay quality was assessed at four sites.

**Table 1. Stage 4 trial locations in 2008 with hay yield (Hay Yld), grain yield (Grain yld), CCN assessments (CCN), and quality (Q).**

Location			
SA	Hay Yld	Grain Yld	Q
Kingsford	√	√	√
Pinery	√	√	
WA			
York	√	√	√
Wongan Hills	√	√	√

#### Stage 3 Hay Trials

Stage 3 hay trials were sown for visual observation and grain yield at three sites in SA and three sites in WA. The S3 hay trial had 36 entries harvested for grain. Table 2 shows the locations and assessments.

Stage 3 late hay trials had 48 entries and were sown at the same locations as the S3 hay trials except Mt. Barker replaced Wongan Hills in WA (Table 2).

**Table 2. Stage 3 trial locations in 2008 with hay yield (Yld), CCN assessments (CCN), quality (Q), and grain yield/visual observation only (O).**

Location	2008			
SA	Yld	CCN	Q	O
Kingsford			√	√
Pinery				√
Riverton				
WA				
Katanning			√	√
Williams				√
Wongan Hills				√

### Stage 2 Hay Trials

Hay and grain breeding lines are promoted for the first time in the program into either hay or grain trials for comparison and promotion in S2 trials. Stage 2 hay trials had 42 entries and S2 late hay trials had 101 entries in 2008. The trials were sown at three sites in SA. Observations and grain yield were collected for S2 hay and late hay trials. No S2 trial was cut for hay yield and no quality evaluation was done.

**Table 3. Stage 2 trial locations in 2008 with hay yield (Yld), CCN assessments (CCN), quality (Q), and grain yield/visual observation only (O).**

Location	2008			
SA	Yld	CCN	Q	O
Kingsford				√
Pinery				√
Riverton				√

### Trial Design

Stage 3, 4, and 5 trials had three replications. The plots were 5 m long and 1.3 m wide. The trials had 12 ranges and varying numbers of plots per range dependent on the number of entries that were evaluated. Reference varieties were included as entries in each trial for comparison.

## Hay Cutting Methods

Hay yield was measured by two sampling methods. The forage harvester was used in the first method and quadrants were cut in the second method. Both methods require plants are cut at ground level for consistency in cutting height for hay yield and quality. The trials consisted of 5 m by 1.3 m plots with entries replicated three times. In method one the entire plot was cut, weighed, and a sub-sample taken whereas for the second method, two 0.5 m<sup>2</sup> quadrants were cut in the plot, weighed, and a sub-sample taken. Sub-samples were oven dried at 60° C for both methods. Hay yield was calculated, dry weight (grams)/wet weight (grams) = percent moisture. Total wet weight (grams) was multiplied by percent moisture and converted to kilograms per hectare by conversion factors calculated for a 0.5 m<sup>2</sup> quadrant and a 5 m x 1.3m plot. All S4 and S5 trials were sampled using quadrants except Kingsford, which were harvested with the forage harvester.

## Hay Quality Assessment

With the creation of the National Oat Breeding Program, the Department of Agriculture and Food Western Australia (DAFWA) became the centre for both hay and grain quality. Calibrations were developed at DAFWA for IVD, WSC, ADF, NDF, and CP, so NIR predictions were assessed within the breeding program in 2007 at both DAFWA and SARDI.

In addition to the NIR predictions, stem thickness was also evaluated for all entries in the hay experiments. The stem was flattened 3 cm above the first node and the width measured. A percentage was calculated using a reference variety.

## Disease Resistance and Tolerance Assessment

There are a number of foliar and soil borne diseases that are production constraints for oat hay production.

The SARDI Field Crop Pathology Nematode Group only assessed breeding lines in stage 1 trials for cereal cyst nematode (CCN) resistance. They evaluated about 5,384 entries in 2008.

Stem rust, leaf rust, septoria, red leather leaf, and bacterial blight were assessed in 2008. Disease nurseries with artificial inoculation to ensure uniform infection were conducted for stem rust, leaf rust, and septoria. Two septoria nurseries are located at Mt. Barker and Manjimup, WA. A stem and leaf rust nursery was developed at Carnarvon, WA and Kingsford, SA. Natural infection of bacterial blight occurred at Riverton. Notes are collected for all breeding lines from stage 1 to stage 5.

The Australian Cereal Rust Control Program, the University of Sydney, evaluated seedling and adult plant resistance to stem and leaf rust for breeding lines from stage 1 to stage 5.

## Agronomic Trait Assessment

Data were collected for hay yield, early vigour, stem diameter, plant colour, plant maturities, lodging, shattering, and general comments about the breeding lines in stage 1 to stage 5 hay trials in 2008.

## Grain Yield Potential

Grain yield was collected for all entries in trials listed in Tables 1, 2, and 3. Stage 5, S4, and S3 trials have three replications and S2 and S1 trials are unreplicated with reference check varieties for statistical analysis. Grain trials are harvested using either a Wintersteiger or Kingaroy small plot harvester.

## **Grain Quality Assessment**

Grain quality characters were assessed for all entries in the hay trials. Data for hectolitre weight, screenings, 1000 kernel weight, and husk lignin content were collected in 2008. NIR predictions for oil, protein, and groat percent were also collected.

## **Trial Design and Data Analysis**

The hay trials were designed using the program, Agrobase™. Data were analysed by Biometrics SA. Data were analysed for each site and year using spatial techniques. The variety by trial means produced from the spatial analysis was combined with tables from previous years to form the data for an overall mixed model analysis to predict long term hay yield.



# Results and Discussion

## Advanced Breeding Lines

Breeding lines were advanced to the next level of evaluation when they met the selection criteria. The selection criteria were based on breeding priorities developed in conjunction with growers and industry. The broad breeding priorities include improved productivity, agronomics, disease resistance, hay quality, and grain quality. Breeding lines were promoted on the following selection criteria:

- Agronomics -early vigour, lodging and shattering resistance, maturity, hay yield, and grain yield
- Disease resistance and tolerance - CCN, stem and leaf rust, septoria, BYDV, bacterial blight, red leather leaf, and stem nematode
- Hay quality – IVD, CP, NDF, ADF, WSC, stem diameter, and colour
- Grain quality – protein, oil, and groat content, husk lignin content, hectolitre weight, screenings, and 1000 kernel weight

Stage 5 and S4 lines have the potential to be released as new varieties. The advanced breeding lines not promoted had deficiencies that were identified in the evaluation process. The lines were put into the crossing block to improve the deficiency.

## Selections for 2009 Hay Trials

### Stage 4 Hay Trials

There were 24 advanced breeding lines maintained in the 2009 S4 hay trial. One of the lines was selected from the WA node of the breeding program. The cross SV01171 has two sister lines in the S4 trial. These lines have excellent hay quality with good combinations of disease resistance. There were 13 advanced breeding lines promoted from the S3 hay trial to the S4 hay trial. Four lines were selected from the WA node. The lines were promoted based on their performance for the selection criteria that could be evaluated. Unfortunately the S3 trial was not cut for dry matter or quality assessment due to budget constraints. The total number of entries in the 2009 S4 hay trial is 56.

Table 4. Characteristics for entries in 2008 Hay Oat Variety Evaluation trials in SA, WA & Vic

TRIAL ENT	Variety/Line pedigree	Agronomics			Grain yield %	Grain yield % var	No. obs Gr	Agronomics				Disease										Grain quality												
		PI type	heading date	Matur- ity				lodg	shatter	Eryl vig	Flk	CCN	SR	LR	BYDV	Bac bl	SN	Sep	RED	HLW	Scr %	1000 GW	Pro- tein	Oil	Groat/ nak %	lig- nin	Min L							
1	BRUSHER	DUMONT/WALLAROO/BANDICOOT	T	E	E	96	% Wintaroo	90	MS	S	3.0	0	R	MI	MS	MR	S	S	R	MS	MS	MS	I	MS	S	MS	M	M	MH	MH	M	MH	L	M
2	Carrolup		MT	EM	E	108	% Wintaroo	90	-	R	3.9	-	S	I	S		R	S	S	MS	MS	-	VI	MR-MS	VS	S	H	M	MH	H	M	MH	H	M
3	EURABBIE	NSWMA5064	D	ML	ML	101	% Wintaroo	90	R	R	6.1	0	S	I	S	MR	S	S	S	MR-MS	MS-R	S	MI	MR-MS	S	MS	M	MH	ML	M	M	M	L	M
4	KANGAROO		MT	ML	ML	84	% Wintaroo	90	R	MS	2.6	0	R	MT	MS-S	R	R-S	S	MS-S	MR-S	MR-MS	MS	MI	MR-MS	MR-S	MR	L	M	MH	M	M	M	H	M
5	MANNUS		T	ML	ML	86	% Euro	70	R	MS	8.0	-	R	M	MR	-	R	MS	-	MS	R	-	-	MS-R	-	-	ML	M	M	MH	M	M	L	MH
6	MARLOO		MT	M	EM	83	% Wintaroo	90	S	MS	3.6	0	R	MT	S	MS	R	S	S	MR-MS	VS	MS	MI	S	S	MS	M	MH	MH	H	M	M	L	M
7	TUNGOO	GLIDER/OX89:019-137	T	ML	ML	74	% Wintaroo	90	S	MS-S	5.7	0	R	MT	MS	MR	MR-S	MR-MS	MR	MR-MS	MR	R	MT	MR	MS	R	L	H	L	MH	M	ML	L	MH
8	Yallara		MT	EM	EM	104	% Wintaroo	62	R	MR	2.0	0	R	I	MS	MS	R	S	R	MS	MR	S	I	MS	S	VS	H	ML	MH	M	L	H	H	MH
9	SV96025-7	OX89:030-26/QUAKER-93-112	T	M	EM	98	% Wintaroo	90	MS	MS	3.4	3	R	MT	MS	MS	S	S	MR	MS	MR	R	T	MS	S	MR-MS	M	M	MH	MH	M	MH	H	M
10	SV96098-24	ZLATAK /EURO/OX89:153-122	MT	ML	ML	91	% Wintaroo	90	R	MR	4.6	3	MR	MT	MR	R	R	S	R	MS	MR	R	MT	MR	MS	R	ML	MH	M	MH	M	M	H	M
11	99Q070-H40		D	SEG?	EM	118	% Wintaroo	6	MR	R	3.9	-	-	M	MS	R	S	S	VS	MS-S	MR	-	-	MR-S	MS-S	-	M	MH	M	H	M	M	H	MH
12	SV00081-21	99009/95018-98	D	ML	ML	91	% Wintaroo	90	R	MR	6.4	5	R	MI-MT	MS	R	SEG	SEG	S	MS	MR-MS	R	MT	MR-MS	MS-S	MR	M	MH	M	MH	M	M	H	M
13	SV00164-24	Q-94-49/95138-23	MT	E	E	88	% Wintaroo	90	MR	S	2.9	2	MR	I	MS	MR	R	MS	S	S	MR	MR	I	T	S	S	M	M	MH	H	M	MH	H	M
14	SV00167-14	Q-95-67/95059-10	T	ML	ML	83	% Wintaroo	77	S	MR	5.3	-	MR	MT?	MR	MR	R	MR	R	MS	MR	-	-	S	S	MR-R	M	M	MH	H	M	M	H	MH
15	SV01035-16	95042-9/99192	MT	E	E	98	% Wintaroo	90	MS	MS	3.3	0	R	I	S	S	R	S	R	MR	MR	MS	I	MR-MS	MR-S	S	H	L	H	M	M	MH	H	M
16	SV01083-7	95076-3/95015-53	MT	E	E	100	% Wintaroo	77	R	MS	4.7	-	R	M	MS	R	R	MS	R	MR	MR	-	-	MS	S	MS	M	M	MH	ML	H	M	L	M
17	SV01145-10	5ZOP95/OLR-62	T	M	ML	80	% Wintaroo	77	S	MR	3.9	-	R	M	MS	MR	R	MR	R	MS	MR	-	-	MS	MS	R	M	M	MH	M	M	ML	H	MH
18	SV01164-35	96025-14/96180	MT	EM	EM	90	% Wintaroo	77	S	MR	5.1	-	R	MT	MS	R	S	MS	MR	MR	R	-	-	MS	S	VS	M	MH	MH	M	M	H	M	
19	SV01166-47	95154-25/95115-3	T	M	ML	109	% Kangaroo	3	MR	MS	2.7	-	R	M	MS	R	MS	MS	R	MS	MS	-	-	S	MS	MR	ML	MH	M	M	H	SEG	M	
20	SV01166-6	95154-25/95115-3	T	M	ML	85	% Wintaroo	77	R	R	3.5	-	MS	MT?	MR	R	S	MS	R	MS	MR	-	-	S	MS-S	R	M	MH	M	MH	M	MH	H	MH
21	SV01171-16	95137-5/OLR-62	ST	M	EM	73	% Wintaroo	77	MS	MR	5.3	-	MR	M	R	R	R	MR	R	MS	MR	-	-	S	MS-VS	MS	L	MH	M	MH	MH	MH	L	M
22	SV01171-55	95137-5/OLR-62	MT	M	EM	77	% Wintaroo	77	MS	MR	5.7	-	MS	M	MS	R	S	MR	R	MS	R	-	-	S	MS-S	MS-MR	L	M	M	H	M	M	L	M
23	SV01171-68	95137-5/OLR-62	MT	ML	ML	80	% Wintaroo	77	R	MS	7.9	-	R	MT?	MS	R	S	MR	R	MS	R	-	-	MR	MS	R	L	MH	M	MH	M	M	L	M
24	SV01171-79	95137-5/OLR-62	MT	M	EM	77	% Wintaroo	77	R	MR	5.7	-	MR	MT	MS	R	S	MR	R	S	MR	-	-	S	MS-S	MS	L	M	M	MH	M	M	L	M
25	SV01210-2	Q-97-286/97181-43	T	M	EM	84	% Wintaroo	90	MS	MR	2.4	0	R	M	MS	MR	R	MS	MR	MS	MR	R	T	MS	S	MS	M	M	MH	M	M	M	H	M
26	WAOAT2281		MT	EM	EM	105	% Wintaroo	90	-	MR	2.7	-	MR	M	MS	MR	R	S	S	-	S	-	-	MS	S	-	MH	M	H	M	M	M	H	MH
27	WAOAT2288		MT	EM	E	100	% Wintaroo	90	-	R	4.1	-	MS	M	MS	MR	S	S	MS	-	S	-	-	MR	S	S	H	M	MH	MH	M	MH	H	M
28	WAOAT2298		D	M	M	98	% Wintaroo	90	-	R	3.1	-	MR	MT?	MS	MR	S	MR	VS	MS	R	-	-	MR-R	MR-S	-	M	M	MH	H	M	M	H	MH
29	WAOAT2314		T	M	EM	107	% Wintaroo	6	-	R	3.0	-	R	M	MS	S	R	MR	R	MS	S	-	-	S-MR	MR-S	-	MH	MH	L	MH	M	M	H	MH
30	WAOAT2328		TD/ST	L	L	88	% Wintaroo	6	-	R	3.1	-	VS	I	MS	MS	R	S	R	MS	S	-	-	MS	MS-S	-	ML	MH	ML	MH	M	M	H	M
31	SWAN		T	M	EM	90	% Wintaroo	90	MS	S	2.6	0	MR	I	S	R	S	S	VS	MS	S	S	I	MS	S	S	MH	M	MH	M	M	MH	L	M
32	WALLAROO	SA check	MT	E	E	94	% Wintaroo	90	MR	S	3.9	0	R	MT	S	MS	R	S	VS	MR-MS	S	MS	MI	S	S-VS	S	L	M	MH	MH	MH	H	L	M
33	Wandering		TD	EM	EM	116	% Wintaroo	90	MS	MS	2.7	0	VS	I	S	S	S	S	VS	MR	MR-MS		I	MS	S-VS	-	MH	M	MH	MH	M	M	H	MH
34	WINTAROO	SA and WA check	T	M	M	100	% Wintaroo	90	MR	MR	4.1	0	R	MT	S	MR	S	S	VS	MR-MS	MR-MS	MR	MT	MR-MS	MR-MS	MR-MS	M	MH	MH	MH	MH	M	L	M
35	Winjardie	WA check	MT	EM	EM	101	% Wintaroo	90	R	R	2.8	-	S	I	S	MR	R	S	R	S	-	S	-	-	S-VS	-	L	MH	ML	MH	M	M	L	M
36	Outback (SA)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	VASSE (WA)		TD	L	L	77	% Wintaroo	90	R	R	3.0	-	VS	I	S	MR	R	S	R	-	S		MI	R	MS	-	ML	M	ML	MH	M	M	H	M

Disease key: CCN = Cereal Cyst Nematode, SN = Stem Nematode, SR = Stem Rust, LR = Leaf (crown) Rust, BYDV = Barley Yellow Dwarf Virus, Bac = bacterial blight, Sep = septoria, RLL = Red leather leaf (previously spermospora)

Disease ratings: I = intolerant, MI = moderately intolerant, T = tolerant, MT = moderately tolerant, R = resistant, S = susceptible, seg = segregating. End use: M = milling, M? = potential milling, F = feed

Grain quality: HLW=Hectolitre weight, Scrings=Screenings %, 1000 GW=1000 grain weight; ratings L = low, M = moderate, H = high

**Table 5. Hay quality for entries in 2008 Hay Oat Variety Evaluation trials in SA, WA & Vic**

TRIAL ENT	Variety/Line	Hay yield %	Hay yield % var	No. obs Hay	Hay quality							
					Dig	Crud prot	NDF	WSC	ME	ADF	Stem Diam	Hay Col
1	BRUSHER	92	% Wintaroo	6	MH	M	M	MH	9.3	31.1	M	5
2	Carrolup	81	% Wintaroo	5	M	MH	M	M	9.1	30.4	F	-
3	EURABBIE	88	% Wintaroo	5	H	MH	L	MH	9.8	27.2	M	4
4	KANGAROO	83	% Wintaroo	5	M	MH	MH	ML	9.2	31.3	F	3
5	MANNUS	-	-	-	-	-	-	-	-	-	-	-
6	MARLOO	87	% Wintaroo	5	M	MH	M	M	9.3	30.5	M	5
7	TUNGOO	88	% Wintaroo	5	M	M	M	M	9.4	31.5	M	3
8	Yallara	85	% Wintaroo	6	MH	M	ML	MH	9.3	29.8	MF	-
9	SV96025-7	86	% Wintaroo	5	M	M	M	M	9.0	31.8	M	4
10	SV96098-24	89	% Wintaroo	5	M	MH	M	M	9.4	30.4	MF	4
11	99Q070-H40	85	% Wintaroo	5	MH	MH	ML	M	9.6	28.4	MF	-
12	SV00081-21	86	% Wintaroo	5	H	MH	ML	MH	9.7	28.5	F	3
13	SV00164-24	82	% Wintaroo	5	MH	MH	ML	MH	9.4	29.4	M	5
14	SV00167-14	87	% Wintaroo	3	MH	MH	M	M	9.3	30.6	M-T	7
15	SV01035-16	90	% Wintaroo	6	M	M	M	MH	9.1	31.2	M	7
16	SV01083-7	81	% Wintaroo	3	MH	MH	M	M	9.3	30.8	M	-
17	SV01145-10	88	% Wintaroo	3	MH	M	M	MH	9.3	29.7	M-T	4
18	SV01164-35	87	% Wintaroo	3	MH	M	ML	MH	9.3	29.4	MF	-
19	SV01166-47	95	% Kangaroo	4	MH	MH	ML	MH	9.7	26.5	M	4
20	SV01166-6	84	% Wintaroo	3	MH	M	M	M	9.3	30.7	F	4
21	SV01171-16	86	% Wintaroo	3	MH	MH	ML	MH	9.5	29.1	MF	4
22	SV01171-55	82	% Wintaroo	3	MH	M	L	MH	9.5	28.7	F	4
23	SV01171-68	90	% Wintaroo	3	MH	M	M	M	9.3	30.7	MF	1
24	SV01171-79	84	% Wintaroo	3	MH	MH	ML	MH	9.5	29.6	M	4
25	SV01210-2	91	% Wintaroo	5	MH	M	M	M	9.2	31.2	MF	4
26	WAOAT2281	91	% Wintaroo	5	M	M	M	M	9.1	31.4	MF	-
27	WAOAT2288	90	% Wintaroo	5	M	M	M	MH	9.1	30.4	M	-
28	WAOAT2298	84	% Wintaroo	5	H	MH	ML	M	9.7	28.7	F-T	-
29	WAOAT2314	87	% Wintaroo	5	M	M	M	M	9.1	31.8	M-T	-
30	WAOAT2328	89	% Wintaroo	5	MH	MH	M	MH	9.5	29.2	M	-
31	SWAN	90	% Wintaroo	5	M	M	M	MH	9.3	30.3	M	6
32	WALLAROO	86	% Wintaroo	5	M	M	M	M	9.1	32.2	MF	4
33	Wandering	86	% Wintaroo	5	MH	MH	M	ML	9.5	29.4	M	-
34	WINTAROO	100	% Wintaroo	6	M	M	M	M	8.9	32.6	M	3
35	Winjardie	84	% Wintaroo	3	M	M	M	M	9.1	31.2	M	-
36	Outback (SA)	-	-	-	-	-	-	-	-	-	-	-
36	VASSE (WA)	93	% Wintaroo	3	MH	MH	ML	MH	9.5	29.0	M-T	7

Dig=digestibility, Crude prot=crude protein, NDF=neutral detergent fibre  
ADF=acid detergent fibre, WSC=water soluble carbohydrates  
ME=metabolisable energy, stem dia=stem diameter, Hay col=hay colour

### Stage 5/4 Late Hay Trials

There were 13 advanced breeding lines maintained in the S5/4 late hay trial for 2009. SV95137-6-3, recently named Tungoo, and another line being increased for release, SV96098-24, were also included in this trial. One breeding line, SV99163-29, had similar maturities to Glider, which is considered a late variety. Five lines were medium late maturity, Tungoo and SV98086-8, SV01145-23, SV01145-47, and SV01171-8 were similar to Kangaroo. One line was very late, SV97200-3, similar to Targa and is being increased for release as a new variety. All of the breeding lines have resistance or moderate resistance to CCN with improved early vigour. Tables 6 and 7 show the entries and their characteristics for the 2008 S5/S4 late hay trial.

There were 24 lines promoted from the S3 late hay trial to the S5/S4 late hay trial for 2009. All advanced breeding lines represent enhanced hay quality combined with improved disease resistance. The total number of entries in the 2009 S5/S4 late hay trial is 44.

### **Stage 3 Hay Trials**

There were 28 breeding lines selected from the S2 hay trial promoted to the 2009 S3 hay trial. The lines were promoted based on hay yield, hay quality, and disease resistance. The 2009 S3 hay trial has 72 entries.

### **Stage 3 Late Hay Trial**

There were 73 advanced breeding lines from S2 trials promoted to the 2009 S3 late hay trial. The 2009 S3 late hay trial has 84 entries.

### **Stage 2 Hay Trial**

There were 197 lines promoted from S1 trials to the 2009 S2 hay trial. The number of entries reflects the importance of the late maturity trait in the program. There were a total of 205 entries in the S2 hay trial for 2009.

### **Stage 2 Late Hay Trial**

There were 82 breeding lines promoted from S1 trials to the 2009 S2 late hay trial. The total number of entries for the 2009 S2 late hay trial is 89.

## **New Variety Releases**

### **Mulgara**

Approximately 16 t of seed was produced in 2008 for the new tall, midseason variety, Mulgara. It is similar in hay yield to Wintaroo, but has improved disease resistance. Mulgara is resistant and moderately tolerant to cereal cyst nematode and resistant and tolerant to stem nematode. It is moderately resistant to bacterial blight, and moderately susceptible to stem rust, leaf rust, and barley yellow dwarf virus. Hay quality is similar or slightly better than Wintaroo.

### **Tungoo**

Approximately 2.5 t of seed was produced for the medium to late maturing Tungoo. Seed multiplication was affected by dry conditions, reducing grain yield significantly. Commercial amounts of seed should be available after the 2009 harvest.

**Table 6. Characteristics for entries in 2008 Late Hay Oat Variety Evaluation trials in SA & Vic**

TRIAL ENT	Variety/Line	pedigree	Agronomics			Grain yield %	Grain yield % var	No. obs Gr	Agronomics				Disease												Grain quality										
			PI type	heading date	Matur- ity				lodg	shatter	Eryl vig	Flk	CCN		SR		LR			BYDV	Bac bl		SN		Sep		RED	HLW	Scr %	1000 GW	Pro- tein	Oil	Groat/ nak %	lig- nin	Min L
													Res	Tol	SA	WA	SU GH	SU FLD	WA		SA	Res	Tol	SA	WA	LVS									
1	EURABBIE	NSWMA5064	D	ML	ML	101	% Wintaroo	90	R	R	6.1	0	S	I	S	MR	S	S	S	MR-MS	MS-R	S	MI	MR-MS	S	MS	M	MH	ML	M	M	M	M	L	M
2	GLIDER		MT	L	L	84	% Kangaroo	84	MS	MS	7.6	0	MS	I	MR	R	R	MR	R	MR-S	R	R	T	R	MS-S	R	L	ML	MH	MH	M	ML	L	M	
3	KANGAROO		MT	ML	ML	84	% Wintaroo	90	R	MS	2.6	0	R	MT	MS-S	R	R-S	S	MS-S	MR-S	MR-MS	MS	MI	MR-MS	MR-S	MR	L	M	MH	M	M	M	H	M	
4	RIEL		T	L	VL	69	% Kangaroo	84	R	MS	1.9	0	R	I	MS	R	MR	MR	R	R-MS	S	S	I	R-S	MR-MS	MR?	ML	MH	ML	MH	M	ML	SEG	M	
5	TUNGOO	GLIDER/OX89:019-137	T	ML	ML	74	% Wintaroo	90	S	MS-S	5.7	0	R	MT	MS-S	MR	MR-S	MR-MS	R	MR-MS	MR	R	MT	MR	MS	R	L	H	L	MH	M	ML	L	MH	
6	SV96098-24	ZLATAK/EURO//OX89:153-122	MT	ML	ML	91	% Wintaroo	90	R	MR	4.6	3	MR	MT	MR	R	R	S	R	MS	MR	R	MT	MR	MS	R	ML	MH	M	MH	M	M	H	M	
7	SV97200-3	8ZOP95/OX92:056-4	T	VL	VVL	49	% Kangaroo	5	MR	S	1.9	0	MR	MI	R	R	MS	MS	R	MR-S	MR-S	S	I	MR	MS	MS	L	ML	MH	M	M	VL	H	MH	
8	SV98086-8	AK-5/90078-27	D	ML	ML	109	% Kangaroo	84	R	R	3.8	4	R	MT	S	R	S	S	MR	MS-S	MR-S	S	MI	MR-MS	MR-S	S-MS	L	M	MH	MH	M	M	H	MH	
9	SV99163-29	GLIDER/AK-1	T	ML	L	94	% Kangaroo	5	MS	MR	3.4	2	MS	I	MR	R	MS	MS	R	MS	MS	R	MI	MR	MS-S	MR	ML	MH	M	MH	M	MH	SEG	M	
10	SV00222-8	99069/93103-5	MT	L	L	76	% Kangaroo	5	R	R	5.9	-	R	I	S	R	MS	MS	MR	MS	R-MS	-	-	MR	MS	MR-R	L	M	M	MH	M	ML	H	M	
11	SV01145-23	5ZOP95/OLR-62	T	ML	ML	77	% Kangaroo	3	S	R	2.7	-	R	I	S	R	MS	MS	R	MS	MR	-	-	MR	MS	MR	ML	ML	H	M	M	ML	L	M	
12	SV01145-38	5ZOP95/OLR-62	T	ML	L	75	% Kangaroo	3	MS	MR	3.5	-	R	I	S	MS	R	MR	R	S	MR	-	-	MR	MS	R	ML	ML	MH	MH	M	M	L	MH	
13	SV01145-47	5ZOP95/OLR-62	T/SEG	L	L	73	% Kangaroo	3	VS	MR	2.9	-	MR	MI	R	R	R	MR	R	MR	MR	-	-	S	MR-MS	MR	ML	ML	MH	MH	M	M	H	MH	
14	SV01171-8	95137-5/OLR-62	MT	ML	ML	79	% Kangaroo	3	R	MR	6.0	-	MS	MI	MS	R	R	MR	R	MS	MR	-	-	MR	MR-MS	R	L	M	M	MH	M	MH	L	M	
15	TARGA		T	VL	VL	71	% Kangaroo	5	MS	MS	5.0	0	S	MI	S	R	MS	MS	S	MS-S	S	S	MI	R	MS	MR	ML	ML	MH	MH	M	L	H	M	
16	VASSE	CHECK	TD	L	L	77	% Wintaroo	90	R	R	3.0	-	VS	I	S	MR	R	S	R	-	S	-	-	MI	R	MS	-	ML	M	ML	MH	M	M	H	M

Disease key: CCN = Cereal Cyst Nematode, SN = Stem Nematode, SR = Stem Rust, LR = Leaf (crown) Rust, BYDV = Barley Yellow Dwarf Virus, Bac = bacterial blight, Sep = septoria, RLL = Red leather leaf (previously spermospora)

Disease ratings: I = intolerant, MI = moderately intolerant, T = tolerant, MT = moderately tolerant, R = resistant, S = susceptible, seg = segregating. End use: M = milling, M? = potential milling, F = feed

Grain quality: HLW=Hectolitre weight, Scrings=Screenings %, 1000 GW=1000 grain weight; ratings L = low, M = moderate, H = high

# Implications

## Benefit Cost Analysis

The net benefits of developing improved hay varieties were estimated to be \$119 million with a 5% discount rate. Improved oat hay varieties return \$41 to the Australian economy for every \$1 spent on research (RIRDC Publication No 05/169).

## National Program

The National Oat Breeding Program has gained national recognition for producing improved oat hay varieties for hay production offering growers of export and domestic hay varietal choices and increased profits. The program will continue striving to develop improved varieties in the future.

The National Breeding Program has generated income streams for the equity partners, SARDI and RIRDC through royalty payments.

A unique arrangement of information sharing was developed between the National Oat Breeding Program and industry representing growers, exporters, customers/markets by the creation of Australian Export Company (AEXCO). This association has assisted with rapid uptake of new improved varieties.

## Growers

The new varieties offer growers a broad spectrum of root and leaf disease resistances, a range of maturities to reduce of the risk of weather damage, resistance to brown leaf, higher grain yield potential compared to traditional hay varieties, higher quality feed grain, and an increased opportunity to achieve premium grade export hay. The result is increased economic returns to growers. Seed producers in the Australian Field Crop Association (AFCA) have also benefited economically by the production of quality assured seed of the new varieties for AEXCO.

## Exporters

The new varieties provide opportunities to meet customer's expectations for the consistent supply of high quality hay for dairy and beef cattle. This will result in a greater market share for Australian exporters compared to the USA and Canada.

The commercialisation arrangement with AEXCO and the National Oat Breeding Program has provided a unique opportunity to give feed back to the breeding program from growers and consumers about breeding priorities. Moreover with the creation of AEXCO exporters have a feeling of ownership for the new varieties. The fast uptake of new varieties is the result of this relationship.

## Customers

The new varieties provide a consistent supply of quality oat hay with characters that improve animal performance for milk production and meat quality.

# Recommendations

The RIRDC funding of SAR-8A, SAR-31A, SAR-50A, and PRJ-002298 has assisted in the development of a vibrant National Oat Breeding Program for improved varieties for hay production. In the last 10 years new germplasm was introduced to increase genetic variability for characters important to improved oat hay varieties, crosses were made with adapted lines to the introduced germplasm, and populations derived from the crosses. The breeding program has now matured to include all stages of early generation population development and advanced breeding line evaluation. With the development of the breeding program, the size of the program has almost doubled with funding remaining at a levels less than or similar to five years ago. In order to bring the program to the next stage, funding levels will need to increase.

## Appendix 1 & 2: 2008 Stage 5/4 hay trial entries

ENTRY08	NAME	PEDIGREE
1	BRUSHER	DUMONT/WALLAROO//BANDICOOT
2	CARROLUP	
3	EURABBIE	NSWMA5064
4	KANGAROO	SA and WA check
5	MANNUS	MA5488
6	MARLOO	
7	TUNGOO	GLIDER/OX89;019-137
8	YALLARA	Euro*2/ND931075 or ND9308572
9	SV96025-7	OX89;030-26/QUAKER-93-112
10	SV96098-24	ZLATAK /EURO//OX89;153-122
11	99Q070-H40	
12	SV00081-21	99009/95018-98
13	SV00164-24	Q-94-49/95138-23
14	SV00167-14	Q-95-67/95059-10
15	SV01035-16	95042-9/99192
16	SV01083-7	95076-3/95015-53
17	SV01145-10	5ZOP95/OLR-62
18	SV01164-35	96025-14/96180
19	SV01166-47	95154-25/95115-3
20	SV01166-6	95154-25/95115-3
21	SV01171-16	95137-5/OLR-62
22	SV01171-55	95137-5/OLR-62
23	SV01171-68	95137-5/OLR-62
24	SV01171-79	95137-5/OLR-62



25	SV01210-2	Q-97-286/97181-43
26	WAOAT2281	
27	WAOAT2288	
28	WAOAT2298	
29	WAOAT2314	
30	WAOAT2328	
31	SWAN	WA check
32	WALLAROO	SA check
33	Wandering	WA check
34	WINTAROO	SA and WA check
35	Winjardie	WA check
36	Outback	
37	SV01058-55	96171-18/SD93055
38	SV01059-12	99192/95060-29
39	SV01084-21	95076-3/96167-16
40	SV01101-7	95060-39/99139
41	SV01154-42	96025-14/97004-12
42	SV02030-37	SYDUNIBC-51/QUAKER-99-25
43	SV02056-12	01051/ACASSINIBOIA
44	SV02074-5	QUAKER-98-34/95077-4
45	SV02101-11	01091/96204-9
46	SV02101-6	01091/96204-9
47	SV02121-1	01095/97192-10
48	SV02147-12	12836CN/96208-92
49	SV02155-21	01122/95138-28-6
50	SV02159-13	01169/96200-5
51	SV02170-16	01125/96208-92
52	SV02191-16	97004-12/97168-33
53	SV02233-18	WINTAROO/QUAKER-97-62

54	SV02233-23	WINTAROO/QUAKER-97-62
55	SV02233-5	WINTAROO/QUAKER-97-62
56	SV02021-26	97213-11/01019

## Appendix 2: 2008 Stage 5/4 late hay trial entry list

ENTRY	NAME	PEDIGREE
1	EURABBIE	NSWMA5064
2	GLIDER	
3	KANGAROO	SA and WA check
4	RIEL	
5	TUNGOO	GLIDER/OX89;019-137
6	SV96098-24	ZLATAK /EURO//OX89;153-122
7	SV97200-3	8ZOP95/OX92;056-4
8	SV98086-8	AK-5/90078-27
9	SV99163-29	GLIDER/AK-1
10	SV00222-8	99069/93103-5
11	SV01145-23	5ZOP95/OLR-62
12	SV01145-38	5ZOP95/OLR-62
13	SV01145-47	5ZOP95/OLR-62
14	SV01171-8	95137-5/OLR-62
15	Targa	
16	Vasse	
17	SV02016-30	97037-1/01019
18	SV02017-26	97037-1/01026
19	SV02017-9	97037-1/01026
20	SV02020-25	95060-56/01027
21	SV02024-9	QUAKER-98-36/QUAKER-99-46
22	SV02029-26	98216-2/QUAKER-98-34
23	SV02041-5	MN94207/95113-17
24	SV02048-34	01054/97216-1

25	SV02049-7	QUAKER-98-52/01040
26	SV02050-2	01028/QUAKER-98-37
27	SV02050-5	01028/QUAKER-98-37
28	SV02053-22	01033/ACASSINIBOIA
29	SV02054-22	01068/96204-11
30	SV02103-10	01057/96096-10
31	SV02137-29	01106/96204-9
32	SV02141-40	01204/97004-12
33	SV02143-27	01082/97181-8
34	SV02160-13	96200-5/01135
35	SV02172-5	01134/96204-5
36	SV02222-18	RUSTNURSERYNZ- 2101/ACASSINIBOIA

## Appendix 4: 2008 Stage 3 hay trial entry list

name	pedigree
01Q275-2KG	SV93075-28/93Q516-40-27
02096-22KG	97031-6/96025-7
02120-4KG	01186/96200-2
02123-7KG	01121/95073-44
02129-9KG	QUAKER-97-284/97013-7
02161-15KG	01216/96204-5
02182-1KG	97020-5/95052-23
02Q320-10KG	WAOAT2143/SV95046-13
02Q320-13KG	WAOAT2143/SV95046-13
02Q334-5KG	WAOAT2182/SV95046-13
02Q344-37KG	WAOAT2134/SV95045-4
03003-1WT	97011-4/UFRGS988012-2
03049-6WT	02216/99094-10
03103-8WT	96030-23/02225
03108-17WT	97176-3/97192-9
03108-28WT	97176-3/97192-9
03108-29WT	97176-3/97192-9
03108-30WT	97176-3/97192-9
03108-32WT	97176-3/97192-9
03108-36WT	97176-3/97192-9
03108-40WT	97176-3/97192-9
03108-58WT	97176-3/97192-9
03134-3WT	95138-28-23/99107-10
03148-6WT	99075-13/UFRGS998005-1

03163-2WT	98095-13/99112-8
03227-12WT	WAOAT2132/SP99-201
03227-9WT	WAOAT2132/SP99-201
03233-45WT	QUAKER-97-284/96098-24
BRUSHER	DUMONT/WALLAROO//BANDICOOT
EURABBIE	NSWMA5064
KANGAROO	SA and WA check
MARLOO	
WALLAROO	SA check
WANDERING	
WINJARDIE	
WINTAROO	SA and WA check

## Appendix 5: 2008 Stage 3 late hay trial entry list

name	pedigree
01Q244-2KG	93Q510-2-32/95Q660-R3
KANGAROO	
02004-22KG	95018-98/RIEL
02004-27KG	95018-98/RIEL
02006-8KG	95018-98/GRAZA50
02107-15KG	01064/96096-10
02123-27KG	01121/95073-44
02123-34KG	01121/95073-44
02161-20KG	01216/96204-5
02169-4KG	01215/95111-48
02182-6KG	97020-5/95052-23
02193-2KG	95073-44/96047-8
02204-12KG	96053-6/95073-53
02204-8KG	96053-6/95073-53
02209-14KG	01220/QUAKER-99-50
02219-1KG	98116-12/QUAKER-99-66
02226-11KG	QUAKER-99-38/96012-25
03005-10WT	97016-3/UFRGS91906
03005-15WT	97016-3/UFRGS91906
03020-11WT	99094-16/QUAKER-99-26
03020-2WT	99094-16/QUAKER-99-26
03026-10WT	QUAKER-98-39/98159-7
03029-11WT	QUAKER-98-40/97197-5
03029-14WT	QUAKER-98-40/97197-5
03030-1WT	QUAKER-98-40/99133-10

03099-10WT	96098-24/97016-2
03099-15WT	96098-24/97016-2
03103-37WT	96030-23/02225
03103-4WT	96030-23/02225
03113-17WT	95138-33-32/02212
03113-22WT	95138-33-32/02212
03113-7WT	95138-33-32/02212
03133-1WT	95138-28-23/98127-42
03134-10WT	95138-28-23/99107-10
03134-20WT	95138-28-23/99107-10
03141-12WT	97176-3/98127-37
03148-13WT	99075-13/UFRGS998005-1
03148-16WT	99075-13/UFRGS998005-1
03153-24WT	95138-28-42/96098-24
03153-37WT	95138-28-42/96098-24
03163-1WT	98095-13/99112-8
03192-32WT	98159-7/98213-2
03212-14WT	KANGAROO/97016-1
03221-49WT	95138-28-45/QUAKER-97-284
03221-8WT	95138-28-45/QUAKER-97-284
03227-3WT	WAOAT2132/SP99-201
03227-4WT	WAOAT2132/SP99-201
03233-23WT	QUAKER-97-284/96098-24
03238-2WT	96191-7/HENDON
03239-4WT	CDCPACER/96191-7
03240-17WT	SA98511/96025-7
03259-6WT	95137-6-3/97200-3
EURABBIE	NSWMA5064
GLIDER	



GRAZA51	CHECK
KANGAROO	SA and WA check
MANNUS	NSWMA5488
RIEL	
SV96098-24	ZLATAK /EURO//OX89;153-122
TARGA	
TUNGOO	GLIDER/OX89;019-137
VASSE	CHECK
WANDERING	
WINTAROO	SA and WA check

## Appendix 6: 2008 Stage 2 hay trial entry list

entry08	trial08	name	pedigree
1	08S2TH	03001-46KG	98075-26/UFRGS950152
2	08S2TH	03004-17KG	98075-35/UFRGS988012-1
3	08S2TH	03021-40KG	99074-32/UFRGS14
4	08S2TH	03021-41KG	99074-32/UFRGS14
5	08S2TH	03021-42KG	99074-32/UFRGS14
6	08S2TH	03032-34KG	02223/99074-12
7	08S2TH	03041-1KG	01030/97192-26
8	08S2TH	03041-34KG	01030/97192-26
9	08S2TH	03041-46KG	01030/97192-26
10	08S2TH	03050-18KG	02213/00117-14
11	08S2TH	03052-55KG	96098-24/95137-6-3
12	08S2TH	03052-58KG	96098-24/95137-6-3
13	08S2TH	03052-77KG	96098-24/95137-6-3
14	08S2TH	03052-90KG	96098-24/95137-6-3
15	08S2TH	03052-92KG	96098-24/95137-6-3
16	08S2TH	03052-97KG	96098-24/95137-6-3
17	08S2TH	03054-2KG	97082-33/96025-7
18	08S2TH	03067-27KG	98095-10/UFRGS19
19	08S2TH	03079-15KG	96171-18-1/02232
20	08S2TH	03085-10KG	97016-8/98159-7
21	08S2TH	03085-9KG	97016-8/98159-7
22	08S2TH	03088-104KG	99113-31/UFRGS950152
23	08S2TH	03088-125KG	99113-31/UFRGS950152
24	08S2TH	03088-127KG	99113-31/UFRGS950152

25	08S2TH	03088-136KG	99113-31/UFRGS950152
26	08S2TH	03088-57KG	99113-31/UFRGS950152
27	08S2TH	03088-77KG	99113-31/UFRGS950152
28	08S2TH	03088-78KG	99113-31/UFRGS950152
29	08S2TH	03088-86KG	99113-31/UFRGS950152
30	08S2TH	03088-96KG	99113-31/UFRGS950152
31	08S2TH	03094-2KG	95137-6-3/02210
32	08S2TH	03095-1KG	02224/95137-6-3
33	08S2TH	03122-3KG	97002-2/97186-3
34	08S2TH	03128-12KG	99074-32/99084-4
35	08S2TH	03141-4KG	97176-3/98127-37
36	08S2TH	03141-8KG	97176-3/98127-37
37	08S2TH	03175-5KG	97016-8/95138-28-49
38	08S2TH	03182-10KG	02129/KANGAROO
39	08S2TH	03182-22KG	02129/KANGAROO
40	08S2TH	03182-23KG	02129/KANGAROO
41	08S2TH	03182-4KG	02129/KANGAROO
42	08S2TH	03185-2	WAOAT2099/QUAKER-98-77
43	08S2TH	03189-10KG	96171-18/BRUSHER
44	08S2TH	03189-5KG	96171-18/BRUSHER
45	08S2TH	03189-9KG	96171-18/BRUSHER
46	08S2TH	03193-34KG	02214/97002-11-8
47	08S2TH	03193-35KG	02214/97002-11-8
48	08S2TH	03196-31KG	97214-10/98240-15-31KG
49	08S2TH	03197-53KG	97181-5/98227-25
50	08S2TH	03210-11KG	96025-7/95138-33-22
51	08S2TH	03210-5KG	96025-7/95138-33-22
52	08S2TH	03213-11KG	96171-18-1/KANGAROO

53	08S2TH	03213-6KG	96171-18-1/KANGAROO
54	08S2TH	03215-3KG	02076/98240-15
55	08S2TH	03219-31KG	96171-18-1/BRUSHER
56	08S2TH	03219-32KG	96171-18-1/BRUSHER
57	08S2TH	03219-33KG	96171-18-1/BRUSHER
58	08S2TH	03219-5KG	96171-18-1/BRUSHER
59	08S2TH	03224-2KG	95137-6-3/ND880107
60	08S2TH	03225-1KG	97082-33/WINTAROO
61	08S2TH	03225-2KG	97082-33/WINTAROO
62	08S2TH	03228-14KG	95138-33-32/97082-33
63	08S2TH	03228-2KG	95138-33-32/97082-33
64	08S2TH	03228-3KG	95138-33-32/97082-33
65	08S2TH	03228-7KG	95138-33-32/97082-33
66	08S2TH	03231-2KG	BRUSHER/CDCORRIN
67	08S2TH	03232-13KG	QUAKER-97-284/KANGAROO
68	08S2TH	03232-24KG	QUAKER-97-284/KANGAROO
69	08S2TH	03232-31KG	QUAKER-97-284/KANGAROO
70	08S2TH	03234-1KG	QUAKER-97-284/CDCBELL
71	08S2TH	03245-12KG	02128/KANGAROO
72	08S2TH	03245-19KG	02128/KANGAROO
73	08S2TH	03245-27KG	02128/KANGAROO
74	08S2TH	03252-39KG	97212-8/WAOAT2132
75	08S2TH	03258-10KG	95137-6-3/96191-1
76	08S2TH	03258-18KG	95137-6-3/96191-1
77	08S2TH	03273-11KG	97016-3/95137-6-3
78	08S2TH	03273-12KG	97016-3/95137-6-3
79	08S2TH	03273-23KG	97016-3/95137-6-3
80	08S2TH	03273-7KG	97016-3/95137-6-3
81	08S2TH	03273-8KG	97016-3/95137-6-3

82	08S2TH	03273-9KG	97016-3/95137-6-3
83	08S2TH	03274-29KG	95138-33-20/97037-1
84	08S2TH	03274-35KG	95138-33-20/97037-1
85	08S2TH	03276-14KG	KINGFISHER/96171-18-1
86	08S2TH	03276-15KG	KINGFISHER/96171-18-1
87	08S2TH	03276-16KG	KINGFISHER/96171-18-1
88	08S2TH	03278-5KG	BRUSHER/95073-13
89	08S2TH	03278-6KG	BRUSHER/95073-13
90	08S2TH	03280-87KG	97181-20/97192-9
91	08S2TH	03281-36KG	97181-20/96177-22
92	08S2TH	03281-38KG	97181-20/96177-22
93	08S2TH	03282-49KG	97205-29/97181-4
94	08S2TH	03282-59KG	97205-29/97181-4
95	08S2TH	CARROLUP	WA CHECK
96	08S2TH	EURO	SA CHECK
97	08S2TH	KANGAROO	SA/WA CHECK
98	08S2TH	WALLAROO	SA CHECK
99	08S2TH	WANDERING	
100	08S2TH	WINJARDIE	WA CHECK
101	08S2TH	WINTAROO	SA/WA CHECK

## Appendix 7: 2008 Stage 2 late hay trial entry list

entry08	trial08	name	pedigree
1	08S2LH	03014-9KG	00084-13/UFRGS14
2	08S2LH	03019-14KG	QUAKER-98-34/99074-15
3	08S2LH	03019-6KG	QUAKER-98-34/99074-15
4	08S2LH	03021-51KG	99074-32/UFRGS14
5	08S2LH	03024-7KG	QUAKER-98-39/98217-5
6	08S2LH	03028-17KG	QUAKER-99-26/97051-3
7	08S2LH	03032-2KG	02223/99074-12
8	08S2LH	03035-12KG	WAOAT2099/95137-6-3
9	08S2LH	03035-21KG	WAOAT2099/95137-6-3
10	08S2LH	03035-23KG	WAOAT2099/95137-6-3
11	08S2LH	03035-3KG	WAOAT2099/95137-6-3
12	08S2LH	03035-5KG	WAOAT2099/95137-6-3
13	08S2LH	03052-100KG	96098-24/95137-6-3
14	08S2LH	03052-103KG	96098-24/95137-6-3
15	08S2LH	03052-16KG	96098-24/95137-6-3
16	08S2LH	03052-1KG	96098-24/95137-6-3
17	08S2LH	03052-24KG	96098-24/95137-6-3
18	08S2LH	03052-28KG	96098-24/95137-6-3
19	08S2LH	03052-29KG	96098-24/95137-6-3
20	08S2LH	03052-2KG	96098-24/95137-6-3
21	08S2LH	03052-31KG	96098-24/95137-6-3
22	08S2LH	03052-33KG	96098-24/95137-6-3
23	08S2LH	03052-44KG	96098-24/95137-6-3

24	08S2LH	03052-46KG	96098-24/95137-6-3
25	08S2LH	03052-4KG	96098-24/95137-6-3
26	08S2LH	03074-24KG	COOMALLO/QUAKER-98-6
27	08S2LH	03080-11KG	96030-23/02083
28	08S2LH	03080-17KG	96030-23/02083
29	08S2LH	03081-11KG	97186-3/97197-1
30	08S2LH	03081-17KG	97186-3/97197-1
31	08S2LH	03081-19KG	97186-3/97197-1
32	08S2LH	03085-13KG	97016-8/98159-7
33	08S2LH	03099-1KG	96098-24/97016-2
34	08S2LH	03099-3KG	96098-24/97016-2
35	08S2LH	03100-27KG	97037-1/02209
36	08S2LH	03100-30KG	97037-1/02209
37	08S2LH	03100-37KG	97037-1/02209
38	08S2LH	03100-43KG	97037-1/02209
39	08S2LH	03100-59KG	97037-1/02209
40	08S2LH	03115-9KG	97016-2/02234
41	08S2LH	03122-39KG	97002-2/97186-3
42	08S2LH	03131-32KG	WANDERING/ZOR98-323
43	08S2LH	03137-4KG	98113-5/96180-55
44	08S2LH	03140-11KG	98217-5/97186-3
45	08S2LH	03147-1KG	98095-24/UFRGS930597-34
46	08S2LH	03147-3KG	98095-24/UFRGS930597-34
47	08S2LH	03152-17KG	02035/95138-33-22
48	08S2LH	03152-23KG	02035/95138-33-22
49	08S2LH	03152-28KG	02035/95138-33-22
50	08S2LH	03152-34KG	02035/95138-33-22
51	08S2LH	03163-12KG	98095-13/99112-8
52	08S2LH	03163-14KG	98095-13/99112-8

53	08S2LH	03163-22KG	98095-13/99112-8
54	08S2LH	03163-24KG	98095-13/99112-8
55	08S2LH	03163-26KG	98095-13/99112-8
56	08S2LH	03163-6KG	98095-13/99112-8
57	08S2LH	03175-16KG	97016-8/95138-28-45
58	08S2LH	03175-17KG	97016-8/95138-28-45
59	08S2LH	03175-2KG	97016-8/95138-28-45
60	08S2LH	03175-36KG	97016-8/95138-28-45
61	08S2LH	03175-39KG	97016-8/95138-28-46
62	08S2LH	03175-48KG	97016-8/95138-28-47
63	08S2LH	03175-57KG	97016-8/95138-28-48
64	08S2LH	03175-8KG	97016-8/95138-28-45
65	08S2LH	03187-23KG	95060-56/02214
66	08S2LH	03187-4KG	95060-56/02214
67	08S2LH	03187-5KG	95060-56/02214
68	08S2LH	03195-11KG	99074-15/97195-3
69	08S2LH	03195-13KG	99074-15/97195-3
70	08S2LH	03195-15KG	99074-15/97195-3
71	08S2LH	03195-20KG	99074-15/97195-3
72	08S2LH	03195-39KG	99074-15/97195-3
73	08S2LH	03195-44KG	99074-15/97195-3
74	08S2LH	03211-13KG	KANGAROO/97016-5
75	08S2LH	03211-27KG	KANGAROO/97016-5
76	08S2LH	03211-8KG	KANGAROO/97016-5
77	08S2LH	03211-9KG	KANGAROO/97016-5
78	08S2LH	03213-13KG	96171-18-1/KANGAROO
79	08S2LH	03213-17KG	96171-18-1/KANGAROO
80	08S2LH	03214-29KG	02086/99149-23
81	08S2LH	03217-10KG	02078/95138-28-23



82	08S2LH	03223-13KG	95137-6-3/URS20
83	08S2LH	03223-19KG	95137-6-3/URS20
84	08S2LH	03223-6KG	95137-6-3/URS20
85	08S2LH	03223-8KG	95137-6-3/URS20
86	08S2LH	03224-4KG	95137-6-3/ND880107
87	08S2LH	03224-9KG	95137-6-3/ND880107
88	08S2LH	03228-30KG	95138-33-32/97082-33
89	08S2LH	03229-20KG	95138-33-32/SA98084
90	08S2LH	03231-12KG	BRUSHER/CDCORRIN
91	08S2LH	03231-13KG	BRUSHER/CDCORRIN
92	08S2LH	03231-19KG	BRUSHER/CDCORRIN
93	08S2LH	03231-31KG	BRUSHER/CDCORRIN
94	08S2LH	03231-40KG	BRUSHER/CDCORRIN
95	08S2LH	03231-49KG	BRUSHER/CDCORRIN
96	08S2LH	03232-34KG	QUAKER-97-284/KANGAROO
97	08S2LH	03232-39KG	QUAKER-97-284/KANGAROO
98	08S2LH	03232-49KG	QUAKER-97-284/KANGAROO
99	08S2LH	03232-50KG	QUAKER-97-284/KANGAROO
100	08S2LH	03232-51KG	QUAKER-97-284/KANGAROO
101	08S2LH	03232-60KG	QUAKER-97-284/KANGAROO
102	08S2LH	03234-11KG	QUAKER-97-284/CDCBELL
103	08S2LH	03245-34KG	02128/KANGAROO
104	08S2LH	03245-35KG	02128/KANGAROO
105	08S2LH	03258-16KG	95137-6-3/96191-1
106	08S2LH	03273-16KG	97016-3/95137-6-3
107	08S2LH	03273-24KG	97016-3/95137-6-3
108	08S2LH	03273-25KG	97016-3/95137-6-3
109	08S2LH	03273-2KG	97016-3/95137-6-3
110	08S2LH	03273-4KG	97016-3/95137-6-3

111	08S2LH	03273-5KG	97016-3/95137-6-3
112	08S2LH	03274-25KG	95138-33-20/97037-1
113	08S2LH	03276-10KG	KINGFISHER/96171-18-1
114	08S2LH	03276-11KG	KINGFISHER/96171-18-1
115	08S2LH	03276-12KG	KINGFISHER/96171-18-1
116	08S2LH	03276-17KG	KINGFISHER/96171-18-1
117	08S2LH	03276-18KG	KINGFISHER/96171-18-1
118	08S2LH	03276-19KG	KINGFISHER/96171-18-1
119	08S2LH	03276-1KG	KINGFISHER/96171-18-1
120	08S2LH	03276-22KG	KINGFISHER/96171-18-1
121	08S2LH	03276-25KG	KINGFISHER/96171-18-1
122	08S2LH	03276-2KG	KINGFISHER/96171-18-1
123	08S2LH	03276-31KG	KINGFISHER/96171-18-1
124	08S2LH	03276-32KG	KINGFISHER/96171-18-1
125	08S2LH	03276-34KG	KINGFISHER/96171-18-1
126	08S2LH	03276-4KG	KINGFISHER/96171-18-1
127	08S2LH	03276-6KG	KINGFISHER/96171-18-1
128	08S2LH	03276-7KG	KINGFISHER/96171-18-1
129	08S2LH	03276-8KG	KINGFISHER/96171-18-1
130	08S2LH	03276-9KG	KINGFISHER/96171-18-1
131	08S2LH	03278-14KG	BRUSHER/95073-13
132	08S2LH	CARROLUP	WA CHECK
133	08S2LH	GLIDER	SA/WA CHECK
134	08S2LH	KANGARO O	SA/WA CHECK
135	08S2LH	RIEL	SA CHECK
136	08S2LH	VASSE	WA CHECK
137	08S2LH	WINTAROO	SA CHECK

# Development of Improved Oat Varieties for Hay Production

— *National Program IV* —

RIRDC Publication No. 09/147

By Pamela Zwer, Sue Hoppo and Peter McCormack

This project was the continuation of the National Oat Breeding Program's component of improving oat varieties for hay production. The objective of the research was to summarise data from 2008 hay trials, select and promote advanced breeding lines into 2009 trials.

With the expansion of the export oat hay industry and a more discerning domestic market, there is an increased demand for oat hay varieties with adaptation across a wide range of environments and high quality. In order to provide growers, exporters, and consumers with the desired hay quality and quantity, oat variety development for hay end use is essential to maintain Australia's competitive advantage.

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