



Know-how for Horticulture™

Requirements of Fresh Tomato Products and Implications for Genetic Improvement

Tony Biggs

Project Number: VX02029

VX02029

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the Fresh Tomato Industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of QFVG and Northern Victorian Fresh Tomato Industry Development Committee.

All expressions of opinion are not to be regarded as expressing the opinion of Horticulture Australia Ltd or any authority of the Australian Government.

The Company and the Australian Government accept no responsibility for any of the opinions or the accuracy of the information contained in this report and readers should rely upon their own enquiries in making decisions concerning their own interests.

ISBN 0 7341 0624 6

Published and distributed by:
Horticultural Australia Ltd
Level 1
50 Carrington Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399
E-Mail: horticulture@horticulture.com.au

© Copyright 2003



Horticulture Australia

**REQUIREMENTS OF FRESH TOMATO
PRODUCTS AND IMPLICATIONS FOR
GENETIC IMPROVEMENT**

-

A REVIEW

Project Number: VX02029
(March 2003)

Tony Biggs, Cardinal Horticultural Services Pty Ltd

and

Mike Titley, MHT Vegetable Consulting Services Pty Ltd

Horticulture Australia Project Number: VX02029

Program Leader: Tony Biggs, Cardinal Horticultural Services Pty Ltd, PO Box 124,
North Richmond, NSW 2754.

Key personnel: Mike Titley, MHT Vegetable Consulting Services Pty Ltd,
PO Box 538, Pennant Hills, NSW 2120.

Purpose of report: Independent review of the requirements for fresh tomato genetic
improvement for the Australian industry.

Acknowledgement of all funding sources:

Northern Victorian Fresh Tomato Industry Development
Committee.
Queensland Fruit & Vegetable Growers.
Horticulture Australia Ltd.

Date of report: March 2003

Any recommendations contained in this publication do not necessarily represent current Horticulture Australia policy. No person should act on the basis of the contents of this publication, whether as to matters of fact or opinion or other content, without first obtaining specific, independent professional advice in respect of the matters set out in this publication.

CONTENTS

	Page Nos
Media summary.	2
1. Introduction.	3
1.1 Project description.	3
1.2 Terms of reference.	3
2. Background.	4
2.1 Industry snapshot.	4
2.2 Plant growth characteristics.	4
2.3 Segmentation of the market.	5
2.4 Australian public breeding program.	5
3. Methodology.	7
4. Key consumer requirements for fresh tomatoes.	8
4.1 Review of previous studies.	8
4.2 The present situation.	9
5. Current trends in supply of tomato products.	11
6. Limitations and opportunities for genetic improvement based on consumer / market requirements.	12
7. Seed company involvement in supplying varieties for the Australian market.	14
8. Future involvement of public breeding program(s) with commercial seed companies.	22
9. Conclusions and recommendations for future fresh tomato genetic improvements.	23
10. Appendices.	24
10.1 Seed usage in Australia, by tomato type	24
10.2 Literature reviewed	25
10.3 People interviewed / contacted	26

MEDIA SUMMARY

Discussions with all sectors of industry and the supply chain formed an important part of this review into the requirements for Australian fresh tomatoes and implications for genetic improvement.

Reports commissioned during the 1990s identified continual improvements in the quality of fresh tomatoes in retail outlets. This review agrees with those findings and confirms that a wide range of tomato types is now available to consumers.

A detailed survey of local commercial seed companies has demonstrated that a wide range of varieties is available with resistances / tolerances to the majority of tomato pests and diseases found in Australia. Most tomatoes are grown from seed wholly developed by commercial seed companies.

It was not possible to identify any major pests and diseases which justify a national public breeding program for the development of resistances / tolerances. No other varietal characteristics were identified as potential subjects for a national public breeding program.

Following discussions with the market place and the supply chain, opportunities may be identified for specific niche tomato varieties with particular characteristics. The existing breeding programs in Queensland or Victoria could be involved in the development of germplasm for these opportunities.

Fully transparent tendering processes should be used when genetic material from existing and future public breeding programs are to be released to commercial seed companies for further development under partnership agreements.

Production information packages should be developed to accompany varieties released from public breeding programs.

1. INTRODUCTION

1.1 Project description:

The purpose of this review is to help provide direction for any future investment by industry and Horticulture Australia Limited in fresh tomato genetic improvement.

Current literature on consumer and supply chain requirements has been reviewed to provide background against which future genetic improvement programs should be considered.

The consumer and market requirements also indicate key issues that need to be addressed by industry in order to meet those requirements.

The review also contains detailed assessment of the intentions and capabilities of commercial seed companies to provide genetic material suitable to the need of the Australian industry and, most importantly, the market and consumers.

Following detailed consideration of consumer, market and industry requirements along with commercial seed company involvement and intentions, recommendations are provided for future investment in fresh tomato genetic improvement.

1.2 Terms of reference:

- Review relevant reports from previous studies (and validate where necessary) to confirm key customer requirements for fresh tomatoes.
- Assess current trends in supply of tomato product and identify gaps / limitations in meeting consumer requirements with existing products.
- In consultation with representatives of the supply chain and research agencies, assess the limitations and opportunities for genetic improvements in assisting industry with meeting these requirements.
- Provide recommendations for relevant consumer / market focused objectives for future fresh tomato genetic improvement.
- Conduct an assessment of seed company intentions in terms of supplying varieties that will meet the needs of the Australian industry, its consumers and the supply chain.
- Assess opportunities for greater involvement with seed companies in genetic improvement to meet the needs of the Australian industry, its consumers and the supply chain.
- Provide recommendations to Horticulture Australia Limited and industry for future investment in Australian fresh tomato genetic improvement.

2. BACKGROUND

2.1 Industry snapshot:

Currently, a total of approximately 17 million carton equivalents (170,000 tonnes) of fresh tomatoes are produced for the Australian market.

The major production areas are in Queensland (Bowen – around 7.5 million cartons; Bundaberg – 3.0 to 3.5 million cartons) and in Victoria's Goulburn Valley (4.0 – 4.5 million cartons).

In addition there is outdoor production at Carnarvon and Geraldton in Western Australia, around some metropolitan cities and an increasing volume of greenhouse production mainly in South Australia, Victoria, New South Wales and Queensland.

Today's production requires the use of around 85 million seeds (85,000 MX) with approximately 76% of high value, hybrid, indeterminate varieties. This percentage relates to the combined usage of field indeterminate and miscellaneous indeterminate sectors in the Appendix I table. This compares with 10 years ago when the amount of seed used was approximately 75,000 MX comprising predominantly determinate varieties, with a mixture of moderately priced hybrids and relatively inexpensive open pollinated material.

Per capita consumption of fresh tomatoes has remained static for a number of years at 8.0 – 8.5 kg per annum.

2.2 Plant growth characteristics:

Outdoor production for the fresh market has been characterised over the last 5 years by the move from determinate to indeterminate varieties.

Determinate varieties, after a certain period of vegetative growth, produce clusters (trusses) of flower buds at shoot terminals so that most vegetative growth stops. Determinate tomatoes are usually grown either on the ground as bushes or with multiple stems on low trellises.

Indeterminate plants produce trusses laterally along the stem so that the apical shoot continues to grow until it is stopped. Traditionally, indeterminate varieties were used primarily for greenhouse production. In some parts of the world greenhouse tomato plants are trained up strings and layered, producing up to 40 flower trusses and 12 metres of stem growth over a 10 – 11 month period.

More recently, most commercial seed companies have introduced indeterminate tomato varieties for growing outdoors where support is provided by canes, stakes or tall trellises.

Indeterminate varieties typically produce uniformly sized, high quality fruit with good shelf life. However, crop management is more demanding with the need for regular training, pruning and tying.

Until the end of the 1980s, fresh tomato production in Australia was dominated by open-pollinated varieties. Since then a wide selection of hybrid material has been used increasingly.

2.3 Segmentation of the market:

An increasing range of types of fresh market tomatoes is available to Australian consumers. Terms used to describe the types, and their various characteristics, are given below.

- **'gourmet'**: field grown, indeterminate, greenhouse-style fruit, predominately flattened globe shape, 135g – 160g fruits, uniformly ripening, jointed but harvested without the calyx, packed in bulk, long shelf life.
- **round**: field grown, predominantly determinate, globular/round fruit, 120g – 150g. fruits, jointless, harvested without the calyx, uniformly ripening, packed in bulk, often long shelf life.
- **Roma**: predominately field grown, mainly indeterminate but can be determinate, egg-shaped fruit with high solids, jointless, harvested without calyx, packed in bulk, long shelf life
- **cherry**: predominately field grown, determinate, globular fruit, 15g – 20g, uniformly ripening, sold loose (usually prepacked) or as clusters.
- **cocktail**: as above but fruit size 35g – 50g.
- **greenhouse**: indeterminate, often grown in soil-less systems (hydroponics), jointed fruit sold with the calyx on, uniformly ripening, sold loose/ prepacked (trays) or as clusters, long shelf life.

Grape and plum tomatoes are also available along with a few yellow fruited varieties.

Seed sales by percentage of the different tomato types is presently:

- field indeterminate - 62.4%
- rounds - 11.8%
- Roma types - 11.8%
- Miscellaneous indeterminate - 14.0%
(cherries, cocktails, greenhouse).

More detailed information on seed usage is provided in Appendix I.

2.4 Australian public breeding programs:

Fruit quality, disease resistance and high yield are major objectives with all fresh tomato breeding programs. The Australian industry, in conjunction with Horticulture Australia Limited (previously the Horticultural Research & Development Corporation), has supported separate publicly-funded breeding programs in Queensland (sub-tropical production) and Victoria (temperate production) for more than 10 years.

Each program has been directed at producing improved germplasm in terms of disease resistance and fruit quality.

Work in Queensland was previously located at two centres – Bowen and Bundaberg – although the latter program terminated with the retirement of the researcher.

The Bundaberg program developed a number of inbred lines with tolerance to bacterial wilt, an occasional but reducing problem in that growing area. Better hygiene and improved growing practices, including better rotations based on regular leasing of new land, reduced the need for wilt tolerant varieties.

Open-pollinated round varieties with resistance to Fusarium wilt race 3 (F3) were released from the Bowen program in the late 1980s. During the mid-1990s, several hybrid round-fruited varieties with F3 resistance were also developed. More recently, material is being developed for the round and gourmet markets with multigenetic resistance to F3.

A bioassay for resistance to potato tuber moth was also developed at Bowen.

Victorian work with determinate material led to the introduction in the early 1990s of Arcadia, a field ripened, firm fruited variety with extended shelf life. Subsequent work has centred on fruit quality, flavour improvement and fruit size of determinate round and gourmet types.

Commercial producers in Queensland and Victoria acknowledge the significant contributions made by public breeding programs to the industry, especially from the mid-1980s to the late 1990s. This applies particularly to the introduction of F3 resistance in Queensland and the development of superior quality ground grown varieties for Victoria.

Recently, a proposal for a 5 year national fresh tomato breeding project (VX02012) has been submitted to Horticulture Australia Limited, with involvement of Queensland and Victorian researchers. The main objective of the project is the development of tomato spotted wilt virus (TSWV) resistant hybrids and breeding lines that are locally adapted and which meet market requirements. Commercially available TSWV resistant varieties will also be evaluated.

3. METHODOLOGY

This review was undertaken during the period January to March 2003.

A number of previous reports have been reviewed which relate to consumer expectations / reactions with fresh tomatoes and also to publicly funded breeding in Australia. The literature reviewed is listed in Appendix II.

Interviews have been conducted with members of the fresh tomato supply chain, including market wholesalers and a number of retailers.

Research scientists involved with the Queensland and Victorian fresh tomato breeding programs have also been interviewed, along with Departmental managers of research and commercialisation activities.

A detailed survey was undertaken with representatives of local seed companies and with overseas parent organisations. The results are include in **Section 8** (page 21) of the report.

Follow-up interviews were conducted with local seed company representatives in order to determine the present situation with supply of genetic material to the Australian fresh tomato industry and intentions for the future.

The draft report was circulated to interested parties and then fully discussed by grower, seed company, research and government representatives at a facilitated meeting in Sydney.

People interviewed / contacted during the review are listed in Appendix III.

4. KEY CONSUMER REQUIREMENTS FOR FRESH TOMATOES

4.1 Review of previous studies:

Fresh tomatoes are an important component of produce purchases for most Australian consumers. While annual per capita consumption has remained more or less static for a number of years at 8.0 – 8.5 kg, fresh tomatoes are used widely in salads and in an increasing range of Asian and other ethnic dishes.

A number of studies were undertaken throughout the 1990s to determine consumer reactions to fresh tomatoes and factors which influence purchase.

During that time, consumer satisfaction with tomato quality has improved significantly so that regular public outcries to voice dissatisfaction are no longer heard.

A consumer study of the fruit and vegetable market published in 1990¹ reported that “1 in 3 of consumers (surveyed) claimed dissatisfaction with the quality of tomatoes”. More than half the dissatisfied consumers claimed tomatoes were “bland, tasteless and flavourless”. Nearly a third said they were “over-ripe, soggy, mushy and watery”, while 25% claimed tomatoes were “too hard, green and picked too early”. The key attributes desired by tomato buyers were firmness, lack of blemishes, bruises or imperfection, red colour, and flavour/taste.

A marked improvement in consumer attitudes and reactions had occurred by the end of the 1990s, as indicated in a report prepared by Margaret Olsen for the Horticultural Research & Development Corporation (HRDC) and Queensland Fruit & Vegetable Gowers (QFVG)². It was reported that purchasers had negligible complaints about any aspects of quality, a significantly more positive response than that recorded in a similar survey 5 years earlier.

The HRDC/QFVG study detected no consumer criticism of ripeness nor of colour. Poor flavour was occasionally mentioned, but the wider range of tomato types available (gourmet, Roma, cherry, greenhouse, etc. as well as the traditional rounds) allowed consumers to choose fruit which suited their particular palate. In this research, the commonest criticism of tomatoes centred on the variation in internal firmness of the fruit.

In direct contrast to the Olsen report findings and to those of the consultants during this review, an incomplete study by Pinnacle Management³ reported that “since 1992 numerous studies have identified that consumer expectations in response to quality, flavour, colour and consistency of fresh tomatoes have not been satisfied”. Consequently, the Olsen report and present evidence based on supply chain interviews strongly indicates that consumer requirements and expectations for fresh tomatoes are being met and supported by the continually increasing range of types and varieties available.

¹ Consumer Study of the Fruit and Vegetable Market, (1990) – Horticultural Research & Development Corporation.

² Tomatoes – Review of Consumer Behaviour and Attitudes (1999) – Margaret Olsen

³ Tomato – Product Development Strategy (2001) – Pinnacle Management (incomplete)

While there was considerable consumer dissatisfaction with the quality of fresh tomatoes throughout the 1980s and into the early 1990s, the situation is quite different today. This is largely due to the range and type of tomato varieties being grown and marketed in Australia. Production methods, crop management and postharvest treatments have also improved which, along with more controlled supply chain management, have resulted in tomatoes of much better quality being available to consumers.

4.2 The present situation:

Over the last 5 years in particular, the introduction of a wide range of superior quality indeterminate varieties and a continually increasing selection of other tomato types (Roma, cocktail cherry, grape, plum, yellow, etc.) has meant that Australian consumers now have a great deal of choice in fresh tomato purchases.

While overall consumption remains static, the wider choice - with consumers favouring full coloured, vine-ripened, gourmet-style fruit - has resulted in decreased sales of traditional round fruit from determinate, ground grown varieties.

Most of the more recent introductions from commercial companies have long shelf life characteristics and, with the move towards vine-ripening, tomato fruit is usually much more flavoursome at point of sale. Breeding programs are paying attention to soluble solids content and sugar : acid ratios. Meanwhile the widening ethnic mix in Australia means that consumers from different backgrounds are better able to choose tomatoes with flavour specific to their requirements. Nevertheless, flavour is a subjective quality and opportunities probably exist for the marketing of specific lines of tomatoes with guaranteed flavour characteristics.

As indicated, long shelf life is an essential characteristic of today's fresh tomato varieties, thus allowing fruit to be marketed fully red. Post-purchase storage of fruit, while less of an issue than 10 – 12 years ago, could still be improved with consumer education, especially with the new long shelf life varieties. At the same time, changes in shopping frequency, with a proportion of consumers purchasing more often, have brought an increasing demand for 'ready to eat' tomatoes.

This may be caused by on-farm management practices and / or post-farm supply chain management as well as by varietal characteristics.

Variability in internal firmness may still be a problem on occasions but this can be attributed at least as much to post-farm supply chain management as to varietal characteristics. Nevertheless, commercial breeding programs are addressing the situation by introducing thicker walled fruit and multi-locular characteristics. Agronomic practices have also changed in order to address the issue of inferior internal fruit quality experienced in the early days of the introduction of gourmet-style fruit.

Food safety, while clearly identified as an issue for purchasers of all fresh produce, is not a specific problem with tomatoes and quality management systems throughout the supply chain have been introduced to ensure that potential problems are identified and eliminated.

Other general issues also relate to the whole range of horticultural crops – and not just tomatoes, including the development of genetically modified organisms (GMO's), the use of genetic markers, the requirements by international retailers for environmentally friendly production facilities and the development of resource-efficient varieties. While these, and other, issues may ultimately influence tomato varietal improvement, there are other broader compounding political and social factors which currently override specific crops requirements.

Fresh tomatoes are available year round and, with the exception of crop damage due to climatic factors and the possibility of light supplies in August / September, consumers are able to purchase all types throughout the year. Commercial seed companies provide varieties with extended cropping seasons so that there are few gaps in the transition from Queensland to Victorian production. In addition, greenhouse production helps to ensure continuity of supply.

While average retail prices for fresh tomatoes are now higher than 10 years ago, the improved quality and greater range of types means that post-purchase losses are much less and, hence, consumers rarely complain about value for money.

5. CURRENT TRENDS IN SUPPLY OF TOMATO PRODUCTS

As indicated in **Section 4 – Consumer Requirements for Fresh Tomatoes**, a much wider range of tomato types is available to Australian consumers than was the situation even 5 years ago. This reflects that fresh tomatoes are one of the major target species for improvement and evaluation by commercial seed companies world wide. New, different and improved genetic material is continually being released and, while the Australian market is not large by overall world standards, this material is evaluated in this country and made available to local producers and, hence, consumers.

Specialist growing systems, such as hydroponic production in greenhouses, are used to provide continuous supplies of fruit with consistent size, quality and appearance. Experience and data from these systems have been modified and adapted for use in open field, indeterminate crop production in Australia.

As also indicated previously, quality factors such as flavour are no longer the consumer concern that they were in the past. Flavoursome, uniformly red, vine-ripened, long shelf life tomatoes are available to consumers.

Depending on market forces, there may be supply chain opportunities for extending options for the sale of fresh tomatoes. Presently, there is only limited group marketing of fruit with designated specifications for particular outlets, although grape and some large-fruited tomatoes are already handled this way. It may be possible to develop further whole-of-chain partnerships with growers, a marketer and retailers in which specifications are agreed and monitored at each stage. Similar marketing arrangements exist with other horticultural crops in this country, sometimes based on privately owned varieties, and are most successful when easily identifiable points of difference can be demonstrated.

While there are no specific food safety issues with fresh tomatoes at present, any heightened concerns could require fruit to be pre-packed in order to reduce the risk of post-packhouse contamination. Pre-packaging is widely used overseas, such as in the United Kingdom, where loose or trusses of fruit are displayed on shallow plastic trays over-wrapped with polythene film. Such pre-packs provide additional advantages such as identification, coding and ease of handling.

As the range of varieties and tomato types continues to increase, there will be more opportunities for marketing the fruit ‘on the truss’ rather than loose. Red and yellow fruited cocktail, Roma, plum and cherry tomatoes are retailed this way overseas where the integrity is maintained and the appearance enhanced by pre-packing.

6. LIMITATIONS AND OPPORTUNITIES FOR GENETIC IMPROVEMENT BASED ON CONSUMER / MARKET REQUIREMENTS

In some sectors of industry there is apparent concern that supplies of fresh tomato material from overseas seed companies could no longer be available to the Australian industry at some unspecified time in the future.

No evidence can be detected for this concern. In fact, the availability of material and involvement of commercial companies is continually increasing and the market is becoming even more competitive. From detailed discussions and analysis with representatives along the tomato supply chain it is clear that the diverse range of tomato types and varieties available in Australia is meeting both agronomic and customer / consumer requirements. Australian seed companies supplying fresh tomato seed, and their international linkages, are shown in Table 1.

Within the Australian publicly funded fresh tomato breeding sector Queensland Horticulture Institute staff have indicated that niche markets have been developed for varieties from the Bowen breeding lines and other opportunities may exist. For example; for the use of multi-ocular, 'beefsteak' varieties which are suitable for slicing, especially with the food service sector.

There may also be opportunities to promote the health benefits of tomatoes especially the lycopene content and its' anti-oxidant properties.

Other opportunities for genetic improvement may occur but need to be carefully considered and costed in the light of consumer and market requirements. No major gaps have been identified in the supply of fresh market tomatoes to Australian consumers nor in the availability of suitable genetic material for local producers. There is nothing to indicate that the situation will change.

Table 1. Australian seed companies supplying fresh tomato seed, along with their international linkages.

COMPANY	CONTACTS (S)	INTERNATIONAL LINKAGES
LeFroy Valley Seeds Pty Ltd	Oliver Draganovic David Vernon	Hazera Clause
Rijk Zwaan Australia Pty Ltd	Arie Baelde Stephen Roberts Mark Stevens	Rijk Zwaan De Ruiter Zeraim
South Pacific Seeds Pty Ltd	Shaun Jackson Owen Rhodes David McDonald	Seminis Vegetable Seeds (Petoseed / Royal Sluis and others (undisclosed))
Yates Vegetable Seeds Pty Ltd	Garth Campbell Paul Connolly	Seminis Vegetable Seeds (Asgrow / Bruinsma and others (undisclosed))
Syngenta Seeds Pty Ltd	Richard Tuttleby	Syngenta
Fairbanks Selected Seeds Pty Ltd	Jeff Billing	Undisclosed
Henderson Seed Group Pty Ltd	Andrew Henderson Geoff Lowman	Sunseeds, Limagain and others (undisclosed)
Daehnfeldt	Lou Spijker	Daehnfeldt
<u>Other international companies contacted</u>		
Seminis AustralAsia	Paul Lloyd	Combined genetics
Sakata Seeds	Peter Scott	Mayford Seeds (RSA)
BHN	Undisclosed	Florida and South America
Western Seeds	Undisclosed	Dutch and Canary Islands
United Genetics	Undisclosed	United States-based

7. SEED COMPANY INVOLVEMENT IN SUPPLYING VARIETIES FOR THE AUSTRALIAN MARKET

The majority of Australian vegetable seed companies have formal, exclusive distribution agreements with international seed companies who specialise in fresh market tomato breeding.

Several companies (Syngenta, Rijk Zwaan and Limagrain) have subsidiaries in Australia while others distribute a range of overseas company varieties and are not always willing to disclose their sources due to commercial sensitivity in the Australian market.

The overwhelming majority of fresh market tomato varieties supplied to the Australian industry have been developed in overseas breeding programs although it is acknowledged that material developed in public breeding programs in this country has been incorporated into some varieties. This incorporation of Australian genetic material peaked during the mid-1990s when the local industry was dominated by round varieties.

The following Tables 2.1 – 2.6 summarise the availability of major fresh market tomato varieties and trial material available from commercial seed companies for use in the main Australian growing regions. Data is provided from LeFroy Valley Pty Ltd, Rijk Zwaan Pty Ltd, Yates Vegetable Seeds Pty Ltd, Syngenta Seeds Pty Ltd, Fairbanks Selected Seeds Pty Ltd and South Pacific Seeds Pty Ltd. Also included is a list of abbreviations used to indicate resistances / partial resistances / tolerances in tomatoes (Table 3).

Bacterial canker occurs sporadically in Australia where it can be contagious and destructive, especially when plants are growing under stressed conditions. However, feedback from growers in Queensland and Victoria indicates that cultural practices, based on crop and seed hygiene, usually enable the disease to be adequately managed.

It can be seen that, in total, a wide range of varieties of each tomato type is available for use in the different Australian growing regions. Disease resistances / tolerances are also incorporated, including tomato spotted wilt virus (TSWV/Sw) and Fusarium wilt race 3 (FFF/F3) in many instances. In addition, more disease resistant / tolerant material will become available from commercial companies over the next 2 – 3 years.

Table 2.1 - LeFroy Valley Fresh Market Tomato Varieties 2003

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet	Angie/Belinda/Pacifica	11 lines-F3etc	TMVF3NTSWV
	Det./Semi Det. Round	Torro	Roma's	VF3NBspTSWV
	Egg/Roma	Colibri/Malawi	37146/372212210/2211	TMVF2VNSFr/ F3/TSWV
	Truss			TMVF2C5, TSWV, TYLCV, PTO
	Cherry/Cocktail	Naomi/Josephina	9 new varieties	VF3/TMVF2
Bundaberg	Indet./Gourmet	As above+593/144/852/	11 new lines	TMVF2N, TSWV
	Det./Semi Det. Round			
	Egg/Roma	As above	As above	As above
	Truss	Yonnina	2309/2349/3484/3485	TMVF2C5N
	Cherry/Cocktail	as above+gold drops (grape)	as above	
S.E. Qld./Granite Belt	Indet./Gourmet			
	Det./Semi Det. Round	as above	as above	as above
	Egg/Roma			
	Truss	FA 612	FA 655	TMVF2
	Cherry/Cocktail			
Goulburn Valley & Melb. Metro	Indet./Gourmet	593/144/1444	11 new lines	TMVF2NTSWV
	Det./Semi Det. Round			
	Egg/Roma	Colibri/Malawi/Salita	0166/37146	
	Truss			
	Cherry/Cocktail			
Virginia & Murray Bridge	Indet./Gourmet	Rosmarie	Puntero+11 new varieties	TMVF2NTSWV
	Det./Semi Det. Round			
	Egg/Roma	Colibri/Malawi/Salita	0166T	TMVF2NTSWV
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Rosmarie	Puntero+11 new varieties	TMVF2NTSWV
	Det./Semi Det. Round			
	Egg/Roma	Colibri/Malawi/Salita	0166T	TMVF2NTSWV

Table 2.2 - Rijk Zwaan Aust. Fresh Market Tomato Varieties 2003

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet	Trigger Roland Cinea	73-541 RZ 73-540 RZ Tributes	TmVF3 TmVF3 TmC5VF2FrSwSt TmC5VF3Fr
	Truss			
	Cherry/Cocktail	Cherilino		TmC5VF2N
Bundaberg	Indet./Gourmet	Petula, Lady Rosa Trigger Cinea Mercedes	Allora 73-541 RZ Clarence	TmVF2N TmVF3 TmC5VF2FrSwSt TmVF2 TmC5VF2FrWi
	Truss	Tradiro (greenhouse)		
	Cherry/Cocktail			
S.E. Qld./Granite Belt	Indet./Gourmet	Petula Mercedes	Cinea Allora Clarence	TmVF2 TmC5VF2FrSwSt TmVF2N TmVF2 TmC5VF2FrWi
	Truss	Tradiro (greenhouse)		
	Cherry/Cocktail			
Goulburn Valley & Melb. Metro	Indet./Gourmet	Cinea Petula Lady Rosa	Allora	TmC5VF2FrSwSt TmVF2 TmVF2N TmVF2N
	Truss	Various		all
	Cherry/Cocktail			
Virginia & Murray Bridge	Indet./Gourmet	Cinea Izabella Beatrice	Allora	TmC5VF2FrSwSt TmVF2N TmVF2N TmVF2N TmC5VF2Sw TmC5VF2Fr
	Egg/Roma Truss	Gaudi Myriade as for other states		
	Cherry/Cocktail	Cherilino		TmC5VF2N
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Cinea Lady Rosa Petula Allora		TmC5VF2FrSwSt

Table 2.3 - Yates Vegetable Seed Pty Ltd

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet	Ember Redcoat (new ground only)	Status II 21 items YTO 6092	F3 F2 F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	F3 TSWV TSWV, N, BW F3
	Egg/Roma	Aztec	Status II 5 items	
Bundaberg	Indet./Gourmet	Redcoat	Ember Avanti Status II 21 items YTO 6092	F3 F2 TSWV F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	TSWV TSWV, N, BW TSWV
	Egg/Roma	Aztec	YTE 6149	
S.E. Qld./Granite Belt	Indet./Gourmet	Redcoat	Ember Avanti Status II 21 items YTO 6092	F3 F2 TSWV F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	TSWV TSWV, N, BW TSWV
	Egg/Roma	Aztec	YTE 6149	
Goulburn Valley & Melb. Metro	Indet./Gourmet	Redcoat	Ember Avanti Status II 21 items YTO 6092	F3 F2 TSWV F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	TSWV TSWV, N, BW TSWV TSWV
	Egg/Roma	Aztec	YTE 6149 Status II 1 item	
Virginia & Murray Bridge	Indet./Gourmet	Redcoat	Ember Avanti Status II 21 items YTO 6092	F3 F2 TSWV F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	TSWV TSWV, N, BW TSWV TSWV
	Egg/Roma	Aztec	YTE 6149 Status II 1 item	
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Redcoat	Ember Avanti Status II 21 items YTO 6092	F3 F2 TSWV F3 TSWV F3 F3
	Det./Semi Det. Round	Tracer	Status II 7 items	TSWV TSWV, N, BW TSWV TSWV
	Egg/Roma	Aztec	YTE 6149 Status II 1 item	

Table 2.4 - Syngenta Seeds Pty Ltd Fresh Market Tomato Varieties 2003

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet	Blade	1	V,FFF, TMV, Fcr
	Det./Semi Det. Round	TA 1301 (Intro)	1	V,FFF, N, Fcr
	Egg/Roma	Arnie	1	V,FFF, P
Bundaberg	Indet./Gourmet	Blade	1	V,FFF, TMV, Fcr
	Det./Semi Det. Round	TA 1301 (Intro)	1	V,FFF, N, Fcr
	Egg/Roma	Arnie	1	V,FFF, P
	Cherry/Cocktail	Bantom Cherish	1	TMV, V, FF, C5, N
S.E. Qld./Granite Belt	Indet./Gourmet	Revolution	1	V,FF, TMV, CS, Fcr
	Egg/Roma	Arnie	1	V,FFF, P
Goulburn Valley & Melb. Metro	Indet./Gourmet	Revolution Red Ruby	1 1	V,FF, TMV, C5, Fcr V,FF, TMV, St
	Egg/Roma	Arnie	1	V,FFF, P
Virginia & Murray Bridge	Indet./Gourmet	Red Bluff	1	TMV,N,V,F,St
	Det./Semi Det. Round	n/a	n/a	n/a
	Egg/Roma	Rosina Napoli	1 1	TSWV,V,FF,N TSWV,V,FF
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Rachel	1	TMV,V,FF,C5,Fcr
		Providence	1	TMV,V,FF,N
		Mexico	1	TMV,FF,C5
	Egg/Roma	Rosina Napoli	1 1	TSWV,V,FF,N TSWV,V,FF

Table 2.5 - Fairbanks Selected Seeds Fresh Market Tomato Varieties 2003

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet		Force	F3 N TM V TYLC
	Det./Semi Det. Round		Coach	F3 N TM V TYLC
	Egg/Roma	Grenade		VFFF
Bundaberg	Indet./Gourmet	Telix		VFFN
	Det./Semi Det. Round	Intrigue		VFF
	Egg/Roma	Grenade		VFFF
S.E. Qld./Granite Belt	Indet./Gourmet		Various	Bs, BW, Co, F2, LT, N, TMV, V
	Det./Semi Det. Round			
	Egg/Roma			
	Truss Cherry/Cocktail			
Goulburn Valley & Melb. Metro	Indet./Gourmet	Telix	Various	VFFN TSWV
	Det./Semi Det. Round		Various	VFFN TSWV
	Egg/Roma		Various	VFFN TSWV
	Truss	Durinta Faraon		TMV,F12,N,LT TM,V,F2,FR
Virginia & Murray Bridge	Indet./Gourmet	Telix	Various	VFFN TSWV
	Det./Semi Det. Round			
	Egg/Roma	Orello Romana Durinta		TMV,F12,N,LT TMV,F12,N,LT TMV,F12,N,LT
	Cherry/Cocktail		Various	TMV,F12,N,LT
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Telix	Various	VFFN TSWV
	Det./Semi Det. Round	Intrigue		
	Egg/Roma	Grenade ROMANA		
				TMV,F12,N,LT

Table 2.6 - South Pacific Seeds Fresh Market Tomato Varieties 2003

Region	Sector	Current Commercial varieties	Trials planned 2003 (#)	Resistances
Bowen	Indet./Gourmet	Pinnacle		VFFF ToMV ASC St
	Det./Semi Det. Round	Guardian Sequoia		VF3 TSWV VF3 N
	Egg/Roma	Commando Ricochet		VFFF N Bsk VF3 NT P
Bundaberg	Indet./Gourmet	Pinnacle		VFFF ToMV ASC St
	Det./Semi Det. Round	Guardian		VF3 TSWV
	Egg/Roma	Romeo Samba		VFF N T VFF Bsk
	Cherry/Cocktail	Sweet Grape		V FF
S.E. Qld./Granite Belt	Indet./Gourmet	Thunder		VFF ToMV
	Egg/Roma	Romeo Samba Commando		VFF N T VFF Bsk VFFF N Bsk
Goulburn Valley & Melb. Metro	Indet./Gourmet	Temptation Rajah		V F1,2 TMV N
	Det./Semi Det. Round	Pinnacle Rebel		VFFF ToMV ASC St FR 2
	Egg/Roma	Hi peel 108		
Virginia & Murray Bridge	Indet./Gourmet	Piramid Evita		VFF N TMV
	Det./Semi Det. Round Egg/Roma	Nisha (saladette type)		V F N TMV C3
	Cherry/Cocktail	Bliss Shamina Showcase		F1 N TMV ASC
Carnarvon/Geraldton & Perth Metro	Indet./Gourmet	Temptation		V F1,2 TMV N
	Egg/Roma	Romeo Nisha (saladette type)		VFF N T V F N TMV C3

Table 3. Abbreviations used to indicate resistances / partial resistances / tolerances to tomato diseases.

Common name of disease	Scientific / commercial abbreviation
Cucumber Mosaic Virus	CMV
Tomato Spotted Wilt Virus	TSWV/Sw
Tomato Yellow Leaf Curl Virus	TYLCV
Tobacco Mosaic Virus	TMV/Tm
Tomato Mosaic Virus	ToMV (numbers specify pathotype)
Bacterial Canker	Cmm
Bacterial Speck	Pst/BSK
Bacterial Wilt	Rs/BW
Bacterial Spot	Xv
Alternaria Stem Canker	Aal/ASC
Cladosporium Races/Leaf Mould	Cf5
Fusarium Race 1	F(F1)
Fusarium Race 2	FF(F2)
Fusarium Race 3	FFF(F3)
Fusarium Crown & Root Rot	Fr/Fcr
Stemphylium/Grey Leaf Spot	St
Verticillium	V
Root-knot Nematode	N*
Silvering	Si(Wi)
Powdery Mildew	Oi
Phytophthora	Ph

N* - resistance does not work above 28°C

Sources: Western Seeds, Rijk Zwaan, Petoseeds.

8. FUTURE INVOLVEMENT OF PUBLIC BREEDING PROGRAM(S) WITH COMMERCIAL SEED COMPANIES

Prior to the introduction of indeterminate varieties into the Australian fresh tomato industry at the end of the 1990s, material such as Tri-Star from the Bowen program and Arcadia from Victoria was commercialised by several seed companies.

Commercialisation of public breeding program material has reduced significantly since 1998 when the indeterminate variety, Daniela (R144) was introduced to this country. This introduction was the trigger for other commercial seed companies to develop indeterminate types and these varieties now account for around two thirds of fresh tomato seed sales in Australia. (Appendix I)

Consequently, at this time, the public breeding programs in Queensland and Victoria have produced a range of inbred lines and experimental hybrids with features which will need development into commercial varieties if the features are required by industry.

The Queensland and Victorian governments now fully recognise that partnership arrangements with commercial seed companies and / or other members of the supply chain are essential if any germplasm from public breeding programs is to be successfully utilised into the industry.

Support for germplasm development was expressed by the Victorian government with specific concentration on the development of science which underpins breeding programs. Breeding lines should be released to commercial companies which are nearer to the market, while evaluation of material should also be a near market function.

Feedback from the seed industry indicates that it is important that calls for expressions of interest in such partnerships should be completely transparent and available to all interested commercial organisations.

Whatever arrangements are made for the commercialisation and introduction of germplasm from fresh tomato public breeding programs, market forces will determine if there is a demand for the material.

9. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE FRESH TOMATO GENETIC IMPROVEMENTS

- **RECOMMENDATION 1**

Overwhelming evidence presented during this review indicates that commercial seed companies are providing the vast majority of fresh tomato varieties used by Australian growers. This material is enabling growers to produce the range of tomato types demanded by the supply chain, culminating in consumer satisfaction.

Evidence also indicates that there are virtually no important pests and disease which justify being the focus of national breeding programs. Where problems are identified, for example bacterial canker, it is agreed that cultural practices and improved seed hygiene can be used to manage the situation.

Consequently, **it is recommended** that no case exists for a national, fresh tomato, publicly-funded breeding program to address the current situation. A full and adequate range of material is available from commercial seed companies to meet the needs of industry, the supply chain and consumers.

- **RECOMMENDATION 2**

New genetic material is constantly being introduced by seed companies and evaluated by them in all appropriate growing regions in Australia. **It is recommended** that this system of varietal evaluation be continued.

- **RECOMMENDATION 3**

It is possible that niche and /or specific market opportunities exist, or may arise, for fresh tomatoes with particular characteristics. These opportunities may best be serviced by breeders in the Queensland and Victorian Departments of Agriculture. It is likely that these initiatives will be related more to quality characteristics than to specific disease packages.

It is recommended that niche and / or specific market initiatives should consider the requirements of all sectors of the supply chain in order to meet customer and consumer requirements. Regular meetings of representatives from the fresh tomato supply chain with breeders would facilitate the development of relevant objectives.

- **RECOMMENDATION 4**

It is recommended that material from existing or new local fresh tomato breeding programs should be made available to interested parties through a fully transparent tendering process. Resulting partnerships will determine how the material should be developed.

- **RECOMMENDATION 5**

It is also recommended that complete agronomic production packages be developed for all varieties resulting from public breeding programs. Availability of such information should better ensure that varieties attain their genetic potential.

10. APPENDICES

Appendix I – Seed usage in Australia, by tomato type

Estimated Tomato Seed Usage – Australia March 2003

Region	Field Indeterminate	Rounds	Roma / Eggs	Miscellaneous Indeterminate (cherry, grape, cocktail, large truss, greenhouse)
BOWEN	18,000 MX	4,000 MX	5,000 MX	1,000 MX
BUNDABERG	10,000 MX	500 MX	1,000 MX	1,000 MX
SOUTH EAST QUEENSLAND	2,000 MX	500 MX	1,000 MX	1,000 MX
SYDNEY METRO.	1,500 MX		500 MX	5,000 MX
GOULBURN VALLEY AND MELBOURNE METRO	9,000 MX	4,000 MX	1,000 MX	1,500 MX
VIRGINIA	6,000 MX Half shade/half greenhouse		500 MX	1,000 MX
WESTERN AUSTRALIA	6,000 MX	500 MX	500 MX	1,000 MX
OTHER	500 MX	500 MX	500 MX	500 MX
TOTAL- MX %	53,000 MX 62.4%	10,000 MX 11.8%	10,000 MX 11.8%	12,000 MX 14.0%

March 2003

Appendix II – Literature reviewed.

- Consumer study of the fruit and vegetable market (1990) – Horticultural Research & Development Corporation.
- Tomatoes – Review of consumer behaviour and attitudes (1999) – Margaret Olsen. (HRDC Report VG 98149)
- Tomato – Product Development Strategy (2000) – Pinnacle Management (incomplete).
- Fresh tomato breeding review (1999) – Peter Lawrence. (HRDC Report VG 618)
- Export Market research for the Queensland and Victorian fresh tomato industries (1999) – Dr W. Roso *et al* (HRDC Report VG 98146)

Appendix III – People interviewed / contacted/ visited

- Vegetable Seed Industry interviews via email and telephone

LeFroy Valley Aust. Pty Ltd
Oliver Draganovic: 03. 5977 3733
David Vernon; 0418 794 574

Rijk Zwaan Australia Pty Ltd
Arie Baedle: 03. 5348 9003
Mark Stevens: 0418 741 355
Stephen Roberts: 0408 613 534

South Pacific Seeds
Shaun Jackson: 07. 3393 3766
Val Moreno: 0418 798 728

Syngenta Seeds
Richard Tuttleby: 03. 9706 3033

Yates Vegetable Seeds
Garth Campbell: 0417 780 683
Paul Connolly: 0417 227 873

Fairbanks Selected Seeds
Jeff Billing: 0408 351 761

Henderson Seed Group P/L.
Andrew Henderson: 03. 9850 2266

Daehnfeldt Seeds
Ole Johansen: Area Manager S.E. Asia

Seminis AustralAsia
Paul Lloyd: 0417 032 507

Sakata Seed Company
Peter Scott 0418 796 599

Dr. Bob Heisey
Previously tomato breeder with Asgrow Seed Comp. San Jaun Bautista, CA

Dr. Doug Heath
Fresh market indeterminate tomato breeder Seminis Seeds, Woodlands, CA

Dr. Jay Scott
Fresh market tomato breeder University of Florida, Bradenton, FL

- Discussions / interviews during visit to Goulburn Valley, 11-13 February 2003 & attendees at Tomato Industry Workshop 20 March 2003

Indeterminate growers

Tony Mercuri
Joe Vraca
Frank Rossignoulo

Ground growers

Alby Borzillo (Gillieston Fresh)
Carlo Tartaglia (CPA Packers)

Queensland growers

Andrew Philip (SP Exports)
Jamie Jurgens (vee jay's)

Seedling grower

Barooga Nursery – Michael Florance

Industry Consultant

Mike Schultz – Serve-Ag, Shepparton

Government breeders/agronomists at Tatura

Dr. Roger Ashburner
Bill Ashcroft
Ray Holland (ex. District Horticulturist)

Government breeder QHI

Dr. Des McGrath

- Discussions with government Department managers

Victoria:

Russell Sully, Institute for Horticultural Development, Knoxfield. 03.9210 9222

Queensland:

Chris Adriaansen, Queensland Horticultural Institute. 07.3986 9401

- Discussions / visits with supply chain personnel

Felicity Robson, The Harvest Company.
Charlie Evripidou, Fruities, Miranda, Sydney.
Johnny Commisso, Simply Fresh, Woden, ACT.
John Baker, Produce Marketing Australia Pty Ltd.
Woolworths store, Baulkham Hills, Sydney.