

## 15. *AspireNZ* decision support system for asparagus has global demand

In the asparagus sector, science and industry have worked together to develop a decision support system (DSS) tool for growers to significantly improve crop yields – up to three fold for some growers. Known as *AspireNZ*, the programme is also in the USA and it is rapidly being adopted in the UK and Europe. For growers the ‘magic’ is that they simply enter their field readings and other data into the internet based system, the calculations are automatically processed back in New Zealand and the recommendations for harvesting, irrigation etc., are fed back to the growers via the internet.



In New Zealand, asparagus is a niche horticultural sector that began exporting fresh and processed product during the 1980s. Export returns were \$16.3 million (fob) in 2003. Crop production and market returns have both fluctuated over this period and crop yields have remained comparatively low.

- During the early 1990s Crop & Food Research scientists studied the growth and development of several arable and vegetable crops, exploring ways in which their productivity could be increased. Part of their research efforts became focused on asparagus where they found that unirrigated asparagus crops consistently out-yielded the irrigated crops. This observation needed investigation.
- Research showed that the carbohydrate reserves stored in the roots of the asparagus crop varied in a consistent pattern throughout the year. Crop health, harvest timing and intensity, and climate affected these reserves.
- Poor management decisions could result in these reserves being depleted as the grower was unable to determine the capacity of the underground root reserves that supported future crop growth.
- With the understanding of what happened in the below ground ‘engine’ of the asparagus plant, the breakthrough came when it was found that the reserves could be measured and readily monitored throughout the year.
- Practical application of this knowledge came when Science and Industry (New Zealand Asparagus Council) formed a partnership that set out to develop a decision support system (DSS) that growers could use by. The system, now called *AspireNZ*, was to be based on monitoring and interpreting the levels of carbohydrate reserves stored in the roots.
- The third step was to place *AspireNZ* on the internet where it could be accessed by New Zealand and overseas growers - for a fee. An American version, *AspireUS* was developed for Washington and Californian asparagus growers in conjunction with a USA scientist.
- European growers are facing a decline in the productivity of their asparagus crops and are adopting *AspireNZ* as a management tool for use in both the UK and Europe.

The New Zealand asparagus industry has a goal of doubling the average crop yield by 2010. Failure to do so will place the industry at a competitive disadvantage. *AspireNZ* is an innovative management tool that can assist the industry to meet this goal.

*AspireNZ* tells growers the level of ‘fuel’ in the carbohydrate reserves ‘tank’, and from that to determine the optimum length of the late season asparagus harvest period when prices are usually high. *AspireNZ* also enables growers to make informed management decisions to extend the productive life of the crop by 3 years or more. The next challenge for science is to give growers a tool to measure the size and capacity of the tank.

The internal rate of return (IRR) on the R&D investment in *AspireNZ* is estimated to be 53%, with a net present value (NPV) of \$2.1 million, 2004. The equivalent 2009 values are projected to be 61% IRR and an NPV of \$5.4 million.

## 1. Background

Some 2000 ha of asparagus is grown in New Zealand mainly in the Waikato, Hawke's Bay and Manawatu-Wanganui regions with smaller areas in Bay of Plenty, Taranaki and Canterbury. There are approximately 200 growers. Average yields are about 3.0 tonnes per ha, although top growers report yields up to 9 tonnes per ha. Asparagus yields in New Zealand are low compared with many other countries.



New Zealand exports 25% of the crop as fresh asparagus, with 55% canned and frozen, and 20% sold on the domestic fresh market. In 2003 the exports of fresh asparagus were valued at \$9.1 million (fob) and processed asparagus at \$7.2 million (fob). Over 90% fresh asparagus was exported to Japan and 90% of the processed asparagus went to Australia. Domestic consumption is estimated to be about \$4.0 million. New Zealand produces about 5000 tonnes of asparagus. China produces about 450,000 tonnes which is 36% of the world's asparagus.

Asparagus is a cyclical industry with respect to both yield and market returns. Asparagus behaves as a commodity crop where growers sell on the spot price market. The Japanese market has been depressed during 2003/04. The industry is seeking to improve the coordination of crop harvesting and marketing so that optimum benefit can be gained by supplying product for either processing or fresh exports.

During the early 1990s Crop & Food Research scientists were studying the growth and development of several arable and vegetable crops, exploring ways in which their productivity could be increased. Part of their research efforts became focused on asparagus and they found that unirrigated asparagus crops consistently out-yielded the irrigated crops. This observation needed an explanation.

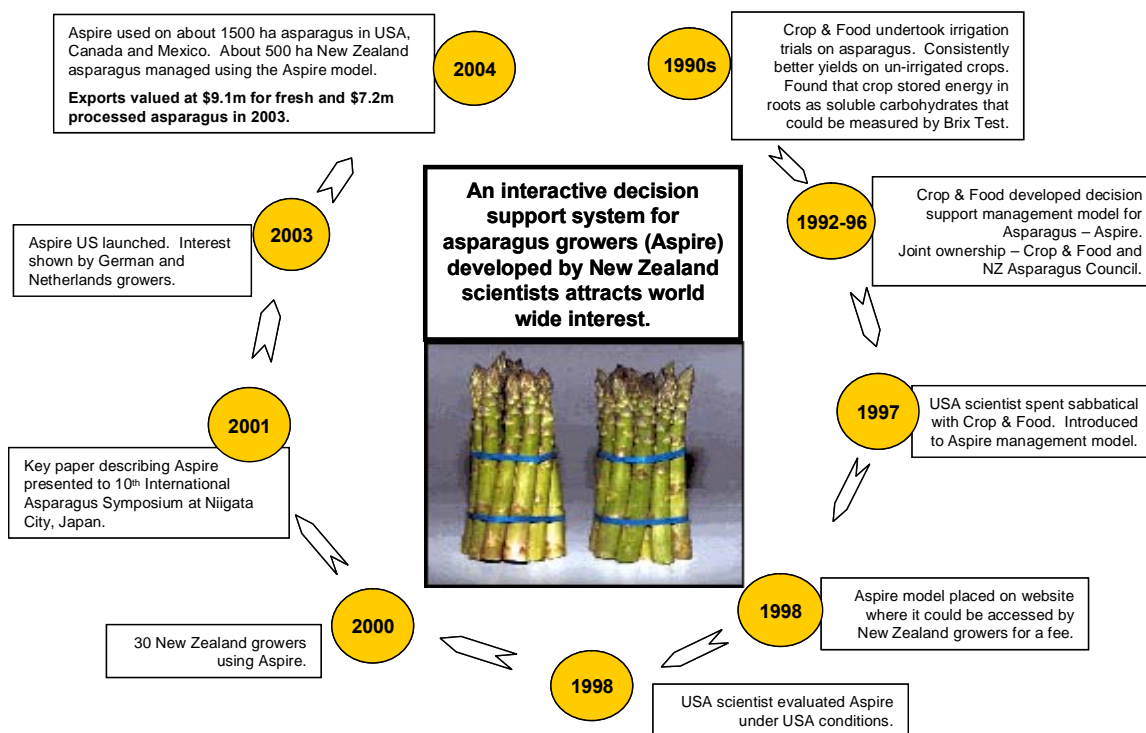
They observed that extra water and fertiliser increased the above ground ferns, but this reduced the accumulation of energy reserves needed for asparagus growth over the following spring and summer period. These reserves are stored as soluble carbohydrates in the roots. Consequently, the stimulation of fern growth during autumn actually reduces the carbohydrate levels. They found that the level of soluble carbohydrates reserves within the roots could be determined using a simple Brix test which could be readily undertaken by the growers. This finding encouraged the scientists to consider developing a decision support system (DSS) that could be used by the growers. The DSS was based on the asparagus grower monitoring the level of carbohydrates within the roots of the crop, at several key times during the year, and using that information as a guide to subsequent management decisions. In effect the root carbohydrate reserves represent the 'engine' that drives the crop performance, and identifying deviations from the optimum pattern can help to diagnose and resolve management problems.

The next step was for Crop & Food Research to form a partnership with the NZ Asparagus Council and to set up a programme to develop a DSS tool for growers. The research was supported by a Technology for Business Growth Grant from Technology NZ. This partnership produced **AspireNZ**, a DSS tool which is jointly owned by both parties. It has been put on the internet where it can be accessed by New Zealand and overseas growers, for a fee. About 500 ha of New Zealand asparagus is managed using **AspireNZ**.

Several events have conspired to assist the offshore development of Aspire. A USA scientist with New Zealand connections, Dr Dan Drost of Utah State University, has adapted **AspireNZ** for US asparagus growers in association with the Washington Asparagus Commission and the Californian Asparagus Commission. He found that the DSS tool was robust and valued by these growers. **AspireUS** was launched in February 2003, and is now used on almost 2000 ha of asparagus in Canada, USA and Mexico. About 50,000 ha asparagus is grown in North America.

Within the European Union, the decline in asparagus productivity has led to a decreased crop profitability which is a common constraint for European growers and a significant concern to the technologists who support that sector. There is a keen interest in **AspireNZ** shown by growers in Germany, Netherlands, UK and France. Recently the European Community has set up a working group led by ADAS, United Kingdom to carry out a European validation of **Aspire** in the expectation of using this DSS tool to make informed decisions on disease management and to investigate and manage the causes of the long term yield decline.

## 2. Timeline



## 3. Science and innovation features

The primary innovation has been the provision of a DSS tool that provides the crop manager with quantitative information about the state of the asparagus crop, enabling management decisions to be made which will raise the productivity of the crop.

- **AspireNZ** is an interactive decision support system that helps asparagus growers to achieve higher yields and better long-term crop performance. This requires that root carbohydrate levels are monitored and managed during the crop’s annual growth cycle. Growers are able to measure the level of soluble carbohydrates in their asparagus crops at the end of the harvest season, during the period of fern growth, and before harvest begins in the spring, using a refractometer.

- **AspireNZ** contains an information database which provides feedback over the internet to growers about their crops enabling informed management decisions to be made. Growers register and pay a fee for the service and provide information about their crops. The website for the model was launched in 1998. **AspireUS** was launched in 2003.
- **AspireNZ** provides information to the grower who can then decide when to stop harvesting and how to manage crop inputs in order to produce a high yield the following year.
- **AspireNZ** is owned jointly by Crop & Food Research and the NZ Asparagus Council which represents the New Zealand asparagus industry.

#### 4. Benefits

- Extends life of crop. Management decisions based on the state of the carbohydrate tank are likely to extend the productive life of the crop from 10 to 12 years up to 15 years or more. Crop establishment may take up to 4 years and the use of **AspireNZ** can reduce the risk of over-harvesting during this period.
- Extends harvest season. On the New Zealand domestic market, typically mid season prices may be around \$2/kg whereas post-Christmas prices may reach \$10/kg. **AspireNZ** can guide growers as to how long they can continue to harvest at the end of the season, without reducing the following year's production
- Assess impact of adverse events. **AspireNZ** can be used to determine the likely impact of events such as floods, hailstorms, and disease infection. Diseases may stop the carbohydrate tank being filled. However, if the tank is already full when the diseases such as Stemphyllium attack, sprays may be unnecessary.
- **AspireUS** has changed some irrigation practices. e.g. Some growers in Washington State have implemented tactical irrigation systems such as the use of water tapes which save water and improve the accumulation of carbohydrate in the storage roots, leading to higher yields.
- Although **AspireNZ** cannot overcome the effects of a cool spring on crop production the grower is able to use the decision support system to avoid over-harvesting the crop when carbohydrate reserves are low.
- The **AspireNZ** decision support system has a potential application with other crops such as peonies and carrots.

#### 5. Return on R&D investment

The return on R&D investment was assessed by comparing the industry performance with the innovation in place with that of a counterfactual<sup>1</sup> situation which identifies a possible industry performance had the innovation not happened.

##### Key information used in the analysis:

1. The area of asparagus was 2015 ha in 2002 and produced about 5,600 tonnes of asparagus. The area was assumed to have declined to 1500 ha in 2004 with a proportional decline in production.
2. In 2004 about 33% of the New Zealand asparagus crop is being managed using **AspireNZ**, which was first used in 2000. Assumed that fees received increased by 20% over 2004 levels by 2009.
3. The crop volume was assumed to be marketed as follows: 25% fresh export, 20% fresh domestic and 55% processed.

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<sup>1</sup> Refer Appendix

4. **AspireUS** was first used by North American growers in 2003. Assumed that overseas fees received for **AspireUS**, and any European equivalents, increased by 100% over 2004 levels by 2009.
5. Assume **AspireNZ** management enables New Zealand growers to extend harvest beyond 24 December each year and increase the marketable yields by 500 kg/ha. Assumed that this extra harvest was distributed to 50% fresh export and 50% fresh domestic markets at the average price for the year.
6. Assume **AspireNZ** management extends crop life by 20%. This advantage applied to 33% of the national crop in 2003.

**Counterfactual:** (What would have happened if this innovation had not occurred?)

1. Assume that without **AspireNZ** management the life of New Zealand asparagus crops is reduced by 20%. Reduced crop life is a cost to the grower and assumed to reduce gross margins by \$200/ha/year. Crop establishment costs were assumed to be \$12,000/ha.
2. Assume that without **AspireNZ** management New Zealand growers do not to extend harvest beyond 24 December. The reduced annual sales represent an income loss to growers.
3. No sales of **AspireNZ** to New Zealand growers.
4. No offshore sales of **AspireNZ**.

**Assessment results:**

	as at 2004	as at 2009
Internal Rate of Return <sup>2</sup>	53%	61%
Net Present Value <sup>3</sup>	\$2.1 million	\$5.4 million

The 2009 assessments are based on the assumptions that:

- Crop area declines from 1900 ha in 2004 to 1800 ha in 2009.
- Average yields will increase from 3 tonnes/ha in 2004 to 4 tonnes/ha in 2009. This result is expected as a result of industry rationalisation and Vegfed’s concerted drive to double yields by 2010.
- The profile of asparagus use and prices will not change after 2004.
- Overseas fees for **AspireUS** and others will double between 2004 and 2009, while the portion of New Zealand crop under **AspireNZ** management will increase from 33% to 50% over the same period.

**6. Quotes**

- Traditional New Zealand practice is to cease harvest on 24 December, but crops may provide up to 100 kg/ha/day of spears after that date. One grower claimed that *“every week’s harvest beyond Christmas day is worth \$100,000”*.
- *“Asparagus decline results in decreased crop productivity and profitability and is a common constraint for European growers. The problem is being addressed by ASPIRE, a European Community concerted action project led by ADAS, which aims to reduce the effects of asparagus decline across Europe..... It is hoped that future research will involve European validation of a decision support system developed in New Zealand (**AspireNZ**), which measures and interprets root*

<sup>2</sup> Refer Appendix

<sup>3</sup> Refer Appendix

carbohydrate status in order to diagnose and resolve problems of asparagus crop performance.” Dr Kim Green, ADAS Research Review, UK.

- “A challenging observation to conventional wisdom is that the two more successful cases (of decision support systems), **AspireNZ** and **FARMSCAPE**, were both conceived from a science push while the less successful **Maize Calculator** was designed in response to industry pull.” Peter J. Stone and Zvi Hochman
- “The success of **AspireNZ** in New Zealand – and its international renown amongst asparagus growers - has led its developers to pursue and be pursued for international deployment. Regionally specific versions of **AspireNZ** can now be found in a range of countries, and are being trialled in several more, where it is used in ways that the developers had not originally intended. In the USA, where it has been applied to ca 4% of the crop area in the first year of release, **AspireUS** has been used mainly to inform changes in irrigation practice. Farmers using **AspireUS** have drastically reduced the water applied to their crops. In Europe it is being used to inform decisions on disease management and to investigate and manage causes of long-term yield decline (D. Wilson pers. comm.).” Peter J. Stone and Zvi Hochman
- “It remains to be seen whether the currently high rates of ongoing use of **AspireNZ** continue, once farmers ‘get a feel’ for the implications of varying root carbohydrate levels. The developers of **AspireNZ** are seeking to avoid this persistent ‘problem’ of DSS by continually adding functionality to the system in response to marketing-derived intelligence (D Wilson pers. comm.).” Peter J. Stone and Zvi Hochman
- “**AspireNZ** again appears to go against the trend. It has been designed for remote use and is deployed solely via the internet. It certainly relies on a relationship between farmers and scientists in order to garner credibility but once this phase has passed it is used by farmers individually and unassisted. This is probably not surprising given that it is exceptionally easy to use, addresses simple and individual operational issues and relies on only one measured input. Relationships between farmers and scientists add little to its utility.” Peter J. Stone and Zvi Hochman

## 7. Related activities

Field advice for **AspireNZ** is available to New Zealand growers through regional consultants attached to FruitFed and/or CropWatch.

Future development of **AspireNZ**: The methodology needs to be expanded to allow the size of the ‘tank’ (i.e. the volume of the carbohydrate reserves) to be determined. The present model only tells the manager the level of ‘fuel’ in the tank.

## 8. Information sources

Information supplied by:

- Dr Derek Wilson & Sarah Sinton, Scientists, Crop & Food Research, Lincoln. Leader of the **AspireNZ** research programme.
- Andrea Bourhill, Business Manager, Crop & Food Research, Hawkes Bay.
- Stewart Tylee, Feilding. Asparagus grower.

Other references

- **AspireNZ** and **AspireUS** see [www.apirenz.com](http://www.apirenz.com) and [www.aspireus.com](http://www.aspireus.com). These websites have two sections: the public section contains general information about the system, and the secure section is available only to registered users.
- “**AspireNZ: A Decision Support System for Managing Root Carbohydrate in Asparagus.**” 2001. D.R. Wilson, C.G. Cloughley and S.M. Sinton, New Zealand



Institute for Crop & Food Research Ltd. Presented at the 10<sup>th</sup> International Asparagus Symposium at Niigata, Japan.

- Horticulture Monitoring Reports, 2000, 2001, 2002, 2003 & 2004. Published by MAF.
- [www.adas.co.uk/hort/pdf](http://www.adas.co.uk/hort/pdf)
- “If interactive decision support systems are the answer, have we been asking the right questions?” 2004. Peter J. Stone<sup>1</sup> and Zvi Hochman.<sup>2</sup> Proceedings of the 4<sup>th</sup> International Crop Science Congress, 26 Sep – 1 Oct 2004, Brisbane, Australia.
- “ASPIRE - Asparagus: Integrating Research on Decline in Europe.” 2003. [www.europa.eu.int/comm/research/quality-of-life/ka5/en/projects/qlrt\\_1999\\_30861\\_en.htm](http://www.europa.eu.int/comm/research/quality-of-life/ka5/en/projects/qlrt_1999_30861_en.htm). Project Leader: Dr Kim Green, ADAS Consulting Ltd, UK.

## Appendix

The working definitions used in this assessment were as follows:

<sup>1</sup>**Counterfactual:** *Counterfactuals are the statement of what would have happened (or could happen) in the absence of a specific event, programme or action. Counterfactuals are the “what ifs”, “thought experiments”, “alternatives to actual history”; they imagine what would have happened to an economy, an industry or a business if, contrary to fact, some present conditions were changed, in this case, if a specific R&D advance had not occurred.*

<sup>2</sup>**Net Present Value (NPV):** *Net Present Value represents the stream of benefits, less the stream of costs, converted into equivalent values today, using an appropriate discount rate. In the case of R&D, we have summed the benefits of an identified R&D advance, taken away the stream of costs and used a 7% discount rate to calculate the NPV.*

<sup>3</sup>**Internal Rate of Return (IRR):** *The Internal Rate of Return calculates the interest rate received for an investment consisting of costs and income that occur over a specific period. By examining the costs, and when they occur, compared to the benefits over time, the IRR calculation estimates the return from the project as an interest rate calculation. It is the rate of interest at which the present value of future cash flows is exactly equal to the initial capital investment.*

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