What is the next new crop? 
Review of the Australian New Crops Info 2014 Website

July 2015
RIRDC Publication No. 15/072
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http://www.newcrops.info/

by Dr Rob Fletcher

July 2015

RIRDC Publication No 15/072
RIRDC Project No 006338
Foreword

New agricultural industries contribute to the resilience of our rural sector through diversification of the economic base. They provide benefits to primary producers, their supply chain commercial partners and our regional economies.

Commonly, these industries are first commercialised overseas are then introduced and adapted for production in Australia. Examples of new crops produced in Australia over the past fifty years include chick peas, rapeseed, kiwi fruit, triticale, persimmon, capsicum, lentils, coriander and fennel (FAOSTAT, 2010).

Crops that have been produced in new locations within Australia are also considered new crops. Examples include olives, macadamia nuts, sweet potato, mango, avocado, strawberry, broad bean, rockmelons, lupin, mung and adzuki beans, some forms of berry crops, lettuce, mandarin, sorghum, spinach, seed cotton, several forms of exotic tropical fruit, as well as mushrooms and truffles (FAOSTAT, 2010).

The plant species responsible for the ever-expanding product range within the Australian native food industry are a special form of new crop: almost all of them have not previously been commercialised anywhere else in the world.

To initiate a new crop, entrepreneurs start by finding what is already known about the plant species to be commercialised. The Australian New Crops Website was established in 1996 in order to target this fundamental step. It has provided new crop developers with information and new ideas as well as reference lists of publications on all plants.

The current project provides a further update, along with an expansion of the available information and it is located at the Australian New Crops Info 2014 Website (http://www.newcrops.info/).

The website also investigates whether publicly available information such as this can be used to answer a common enquiry received by RIRDC: “What is the next new crop?” The bulk of this report addresses this issue.

This project was funded from RIRDC Core Funds which are provided by the Australian Government.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation
About the Author

Dr Rob Fletcher has been responsible for the Australian New Crops Website since its inception at the University of Queensland Gatton Campus in 1996; the initial content was prepared by Mr Gerry Kregor. Dr Fletcher was a member of the Advisory Committee for the New Plant Products Program of RIRDC for nine years from its inception in 1999, was an invited speaker on the process of new crop commercialisation at more than 100 conferences and workshops throughout Australia between 1994 and 2006 and was a keynote speaker at the Fifth National New Crops Symposium held in 1999 at Atlanta, Georgia, USA. Up until his retirement from the University of Queensland in February 2007, he had supervised eight PhD projects, five other postgraduate degree projects and more than 25 Final Year/Honours Study projects, mostly on some aspect of new crop development. He completed 28 research projects (1993-2006), valued at more than $3 million.

## Contents

Foreword ............................................................................................................................................... iii  
About the Author .................................................................................................................................. iv  
Executive Summary ........................................................................................................................... viii  
Introduction ........................................................................................................................................... 1  
Objectives ............................................................................................................................................... 2  
Methodology .......................................................................................................................................... 3  
  Species list ........................................................................................................................................ 3  
  Searching .......................................................................................................................................... 3  
  Trends, Keywords and Crop Use/products ....................................................................................... 3  
Results .................................................................................................................................................. 10  
  Trends ................................................................................................................................................ 10  
  Demonstration of trends showing a recent focus in attention ........................................................ 11  
  Demonstration of trends showing a previous focus in attention..................................................... 12  
  Demonstration of trends showing both a previous and a recent focus in attention ......................... 14  
  Demonstration of trends following a name change ........................................................................ 16  
  Demonstration of trends where there may be confusion about a name .......................................... 17  
Implications .......................................................................................................................................... 19  
Recommendations ................................................................................................................................ 19  
Appendix .............................................................................................................................................. 20  
  Appendix Figures demonstrating trends showing a recent focus in attention .............................. 20
Tables

Table 1 The terms used to screen abstracts for the most likely scope for 68 crop uses/products........7

Figures

Figure 1 The components of a typical page in Australian New Crops Info 2014: title and trends ........4
Figure 2 The components of a typical page in Australian New Crops Info 2014: keywords, most likely scope for crop uses/products and references (and links to abstracts)..............................5
Figure 3 The components of a typical page in Australian New Crops Info 2014: links to RIRDC and acknowledgements.............................................................................................................6
Figure 4 A typical chart, showing the popularity of Trifolium pratense over time.........................10
Figure 5 Trends derived for Azadirachta indica (Neem, Nimtree, Indian Lilac) for the years 1901-2013, showing high levels of recent attention in the literature..........................................................11
Figure 6 Trends derived for Dianthus caryophyllus (Carnation, Clove Pink, Rainbow Pink)........12
Figure 7 Trends derived for Digitalis lanata (Grecian Foxglove, Woolly Foxglove).....................12
Figure 8 Trends derived for Festuca arundinacea (Tall Fescue)......................................................13
Figure 9 Trends derived for Veratrum viride (Indian Poke, Indian Hellebore, False Hellebore, Green False Hellebore, American False Hellebore, American White Hellebore, Bear Corn, Big Hellebore, Corn Lily, Devils Bite, Duck Retten, Itch-weed, Itchweed, Poor Annie, Blue Hellebore, Tickleweed)......................................................................................13
Figure 10 Trends derived for Digitalis glomerata (Ascherson's Orchardgrass, Cock's-Foot, Orchard Grass, Orchardgrass). ..................................................................................................................14
Figure 11 Trends derived for Lolium multiflorum (Italian Ryegrass, Annual Ryegrass, Australian Ryegrass, Short Rotation Ryegrass, Westerwolds Ryegrass).........................................................14
Figure 12 Trends derived for Poa pratensis (Kentucky Bluegrass, Smooth Meadow-Grass, Common Meadow-Grass, Spreading Bluegrass)......................................................................................15
Figure 13 Trends derived for Ricinus communis (Castorbean, Castor Oil Plant)............................15
Figure 14 Trends derived for Triticum vulgare (top) and Triticum aestivum (bottom) .................16
Figure 15 Trends derived for Wollemia nobilis (Wollemi Pine), first discovered in 1994, north-west of Sydney ........................................................................................................................................16
Figure 16 Trends derived for Ginkgo biloba (Maidenhair Tree).....................................................17
Figure 17 Trends derived for Gingko biloba (Maidenhair Tree).....................................................17
Figure 18 Trends derived for Ginko biloba (Maidenhair Tree).....................................................18
<table>
<thead>
<tr>
<th>Appendix Figure</th>
<th>Trends derived for Plant (Genus, Species)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trends derived for <em>Betula pendula</em> (European White Birch, Silver Birch)</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Trends derived for <em>Betula papyrifera</em> (Kenai Birch, Paper Birch, White Birch, Canoe Birch)</td>
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</tr>
<tr>
<td>3</td>
<td>Trends derived for <em>Brachypodium distachyon</em> (Purple False Brome)</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>Trends derived for <em>Curcuma longa</em> (Common Turmeric)</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>Trends derived for <em>Eucalyptus globulus</em> (Eurabbie, Southern Blue Gum, Blue Gum, Tasmanian Bluegum)</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>Trends derived for <em>Hypericum perforatum</em> (Perforate St John's-wort, Common Saint John's wort, St John's wort)</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>Trends derived for <em>Jatropha curcas</em> (Barbados Nut, Purging Nut, Physic Nut, JCL)</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>Trends derived for <em>Panax ginseng</em> (Chinese Ginseng, Ginseng)</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>Trends derived for <em>Phragmites australis</em> (Common Reed)</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>Trends derived for <em>Physcomitrella patens</em> (Physcomitrella Moss)</td>
<td>24</td>
</tr>
<tr>
<td>11</td>
<td>Trends derived for <em>Pinus pinaster</em> (Maritime Pine, Cluster Pine)</td>
<td>24</td>
</tr>
<tr>
<td>12</td>
<td>Trends derived for <em>Populus tremula</em> (European Aspen, Aspen, Common Aspen, Eurasian Aspen, Quaking Aspen)</td>
<td>25</td>
</tr>
<tr>
<td>13</td>
<td>Trends derived for <em>Punica granatum</em> (Pomegranate, Granada, Granatapfel, Grenadine, Grenade, Granatäpple, Gránátalma, Pomogranà)</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>Trends derived for <em>Quercus ilex</em> (Holly Oak, Evergreen Oak, Holm Oak)</td>
<td>26</td>
</tr>
<tr>
<td>15</td>
<td>Trends derived for <em>Quercus robur</em> (English Oak, Pedunculate Oak, French Oak)</td>
<td>26</td>
</tr>
<tr>
<td>16</td>
<td>Trends derived for <em>Rosmarinus officinalis</em> (Rosemary, Anthos)</td>
<td>27</td>
</tr>
<tr>
<td>17</td>
<td>Trends derived for <em>Zingiber officinale</em> (Garden Ginger)</td>
<td>27</td>
</tr>
</tbody>
</table>
Executive Summary

What the report is about

This report addresses the primary concerns of anyone planning to commercialise a new crop use or product: where to start. What is the next new crop likely to be and what is already known about it?

Who is the report targeted at

The target audience for this report is anyone planning to commercialise a new crop.

Background

The Australian New Crops Website was established in 1996 (as an offshoot of Project UQ-33A, 1993-8). The current project provides the most recent update of this website and it has been made available through the Australian New Crops Info 2014 Website (http://www.newcrops.info/).

Aims/objectives

The primary objective of this project was to review and rejuvenate the Australian New Crops Website. For each of more than 41,000 plant species, the aim was to provide lists of published references (1901-2013), along with contact information for the author(s), keywords and an indication of the most likely scope for any crop use or product.

The project has also investigated whether publicly available information such as the trends in mentions over time and the keywords and associations of plant species with specific crop uses or products can be used to answer a common enquiry: “What is the next new crop?”

Methods used

An original plant name list was created from the Plant Name Lists of the Australian National Herbarium, Royal Botanic Gardens, Kew and United States Department of Agriculture. Preliminary screening in the late 1990’s established that the best coverage of the world literature on plants was available from five specific on-line databases.

Charts of trends of mentions over time (“research intensity”) for each plant species were created with the Macro Express software, using the dates of publication extracted from the relevant publications. A proportional micro index was also charted, to take account of the increasing annual size of the world literature on plants.

Keywords were pooled and ranked for each species. The available abstracts were also screened for 270 target terms (which represented 68 crop uses/products) and analysed to provide the most likely scope for these crop uses/products from each of these species.

Results/key findings

The findings of this project are represented in the Australian New Crops Info 2014 Website (http://www.newcrops.info/). This report includes charts that demonstrate a recent focus of attention for individual plant species (Figure 5 and Appendix Figures 1-18). Charts demonstrating other responses such as a previous focus of attention or the response to a name change have also been included (Figures 6-15).
Those plant species currently the focus of attention, together with a brief summary of their most significant keyword and crop use/product information have been tabled in the website (http://www.newcropskey.info/focus_of_attention.htm).

Implications for relevant stakeholders:

The charts of research intensity (included for each species in the website) and lists of plant species commonly associated with crop uses or products (http://www.newcropskey.info/crop_uses/crop_uses_front_page.htm) can be an approach to identifying those plant species that warrant a preliminary desk-top investigation for their suitability for commercialisation as new crops.

Once a new crop use or product has been identified in this way, links on New Crops Info’s front page lead to summaries of the principles behind new crop commercialisation through individual counselling (The Ten Points http://www.newcrops.info/ten_points.htm), small group processes (The Do Our Own Marketing Research short course http://www.newcrops.info/door_marketing.htm), and new crop industry development (The Thirteen Steps http://www.newcrops.info/thirteen_steps.htm). In the past, these pages have ranked between 18 and 28 in the 30 most visited pages on the Australian New Crops Website.

Recommendations

Each page of the Australian New Crops Info 2014 Website carries a warning: “All information is included in good faith but this website does not warrant or guarantee the accuracy of any information on these pages, nor does the website accept responsibility for any loss arising from the use of this information”. It is therefore recommended that visitors to the website use it to identify plant species worthy of a closer investigation. Any further action will depend on the user’s evaluation of the usefulness and accuracy of this information. It is always important to test all things.
**Introduction**

This project has been designed and executed to assist RIRDC’s fundamental purpose of encouraging and supporting the development of new and emerging crop industries for Australia.

To initiate a new rural industry, entrepreneurs first need to find what is already known about the species to be commercialised. The Australian New Crops Website was established in 1996 (as an offshoot of Project UQ-33A, 1993-8), to target this fundamental step for new crops.

A new crop is a plant species that has been successfully commercialised in a new place.

The current project provides the most recent update of this information and it has been made available through the Australian New Crops Info 2014 Website (http://www.newcrops.info/).

New Crops Info provides lists of literature references for more than 41,000 plant species, with author addresses, links to abstracts, lists of ranked keywords, charts of trends in species’ mentions over time (now termed by some as a measure of research intensity) and indications of possible uses or products.

This information is an essential component of desk-top screening of the feasibility of a new crop development project. It assists the new crop entrepreneur in identifying the crop use or product upon which a commercial industry is to be based.

Links on New Crops Info’s front page outline the principles behind the major follow-up steps that occur once the initial screening of crop uses or products has been completed. These links focus upon individual counselling (The Ten Points), small group processes (The Do Our Own Marketing Research short course) and new crop industry development (The Thirteen Steps).

Such information about new crop development has proved to be popular in the past: over three years from June 2010, these pages in the previous Website were ranked between 18 and 28 in the 30 most visited pages on the Australian New Crops Website.

A major assumption behind these endeavours was that visitors to the website were seeking information about a specific plant species: “What is known about species A, especially any crop use or product?”.

However, a regular enquiry since this work began in 1993 has been: “What is the next new crop?”

This Website can now also address this enquiry through using two different approaches:

1. The growth in mentions for individual plant species over time; this research intensity has been charted and species can be compared, especially in relation to recent “research activity” trends, as expressed in proportional terms;

2. The identification of individual plant species that have been most commonly associated in the literature with particular crop uses or products.

Results from each of these approaches form the bulk of this report.
Objectives

The focus of business for RIRDC is to invest in new and emerging rural industries with a view to improving the viability of the rural sector through diversification.

The New Plant Products Program of RIRDC aims to identify opportunities for, and facilitate, the development of new crop industries that are well-placed to make a substantial contribution to rural and regional development in the future.

The mission of the Australian New Crops Website (since 1996) has been to support these endeavours through providing access to the information already known about a plant species, through the published literature.

The primary objective of this project was to review and rejuvenate the Australian New Crops Website for this purpose. The previous Website provided reference lists for more than 41,000 plant species, along with any available contact information for the relevant author(s). These lists formerly covered the period 1926-2006; the current project has extended and updated this information.

As well, the new Website (Australian New Crops Info 2014; http://www.newcrops.info/) provides keywords and indications of possible uses or products for each plant species, derived from targeted analyses of what has already been published in the refereed literature.

The secondary objective of this project has been to answer the question: “What is the next new crop?”

This question has been tackled by identifying those plant species that are currently creating interest amongst the research community worldwide and analysing what crop uses or products may be relevant.
Methodology

Species list


This list totals 82,337 species, but publications have been detected for only about 41,000 of these species.

Searching

The original searching for published literature that mentioned any individual plant species commenced in 1997, using CD-based reference materials. The lists of contents for the journals identified through this process were then located on-line. Most of this searching defaulted to a small number of on-line databases which were then used as sources of literature information:

Science Direct (http://www.sciencedirect.com);
Wiley Online Library (http://onlinelibrary.wiley.com/advanced/search);
High Wire (http://highwire.stanford.edu/cgi/search);
Oxford Journals (http://services.oxfordjournals.org/search.dtl) and

Synonyms were identified through The Plant List (http://www.theplantlist.org/) and common names through Plants Database, United States Department of Agriculture, National Resources Conservation Service http://plants.usda.gov/ and Wikipedia (http://en.wikipedia.org/wiki/Main_Page).

Trends, Keywords and Crop Use/products

Charts of trends (Figure 1) were created with the Macro Express software, using dates extracted from the revelant publications; the proportional micro index was derived as a proportion of the total number of papers available in any year (scaled by multiplying by one million).

Keywords (Figure 2) from all relevant publications were pooled and ranked according to their frequency, using the same software.

The most likely scope for crop use/product (%) (Figure 3) was derived from a screening of the relevant papers’ abstracts to find the frequencies for 270 target terms (amalgamated into 68 crop uses/products, Table 1). The tallies for each of more than 41,000 plant species were examined to derive Chi Squared tests for heterogeneity for each plant species and the proportional contribution from each crop use/product for each species was converted into a percentage and included in each species’ webpage. Macro Express was used for these tasks.
Figure 1  The components of a typical page in Australian New Crops Info 2014: title and trends
Keywords

[Total number of keywords included in the papers that mentioned this species: 26969]
Azadirachta indica (927), azadirachtin (275), neem (164), Adsorption (159), insect control (152), plant extracts (123), Medicinal plants (122), India (113), Toxicity (107), kinetics (83), neem extracts (63), neem seed extract (63), Meliaceae (79), leaves (77), Internet resource (76), mortality (74), antifeedants (68), seeds (66), Methylene blue (62), biological control (60), insecticidal properties (60), limonoids (58), Biosorption (55), Neem oil (54), Biodiesel (53), Melia azedarach (52), antifeedant (49), chemical constituents of plants (49), Antioxidant (48), insect pests (47), botanical insecticides (46), Traditional medicine (46), larvae (45), Apoptosis (44), Oxidative stress (44), essential oils (42), Malathion (42), antibacterial activity (41), Culex quinquefasciatus (41), Silver nanoparticles (41), Antioxidants (40), Plutella xylostella (40), Aedes aegypti (38), Cytotoxicity (38), antioxidant activity (36), growth (36), dose response (34), essential oil (34), transestefication (34), Haemonchus contortus (33), isothersms (33), oviposition (33), Ethnobotany (33), Thermodynamics (32), Antibacterial (31), Isotherm (31), Nigella (31), terpenoids (31), Activated carbon (30), control (30), plant pests (30), neem kernel meal (29), chemoprevention (28), insecticides (28), Neem tree (28), Plant extract (28), Anopheles stephensi (27), Larvicidal (27), biosynthesis (26), efficacy (26), Larvicidal activity (26), natural products (25), rats (25), Jatropha curcas (25), pesticidal plants (25), integrated pest management (24), Diabetes (23), phytochemicals (23), terpenes (23), antifungal activity (22), chemical composition (22), crop yield (22), Green synthesis (22), meliaceous plants (22), Onion sativa (22), antimicrobial activity (21), bark (21), Callisto bruchus maculatus (21), chemical structure (21), In vitro (21), Plasmodium falciparum (21), reproduction (21), Adsorption kinetics (20), Biopesticide (20), biopesticides (20), disease control (20), Fungi (20), Heavy metals (20), nematode control (20), …

Most likely scope for crop use/product (%):

[Please note: When there are only a few papers mentioning a species, care should be taken with the interpretation of these crop use/product results: as well as a mention may relate to the use of a species, or the context in which it grows, rather than a product]
pesticide (27.35), biofuel (20.18), dye (16.42), weed (4.16), medicinal (4.05), timber (3.99), insect repellent (3.19), hemiparasite (2.93), ornamental (2.63), poison (2.56), …

References (and links to abstracts):

[Number of papers mentioning Azadirachta indica: 44555; Any undated papers have been included at the end]

Figure 2 The components of a typical page in Australian New Crops Info 2014: keywords, most likely scope for crop uses/products and references (and links to abstracts)
Figure 3  The components of a typical page in Australian New Crops Info 2014: links to RIRDC and acknowledgements
Table 1  The terms used to screen abstracts for the most likely scope for 68 crop uses/products.

[This list of crop uses/products was derived from RIRDC project PRJ-000436 (2006). Single page descriptions were created for each of the 500 plant species showing the greatest recent increase in mentions up to that time.

In the Australian New Crops Info 2014 website, the lists of most likely scope for crop use/product on each webpage (as shown in the example in Figure 1) have the following introduction: “When there are only a few papers mentioning a species, care should be taken with the interpretation of these crop use/product results; as well, a mention may relate to the use of a species, or the context in which it grows, rather than a product”.

Examples are provided below (1-9) for those terms which were influenced in this manner.]

<table>
<thead>
<tr>
<th>Crop use/product</th>
<th>Terms used for screening abstracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  allelopathy</td>
<td>allelopathic, allelochemical</td>
</tr>
<tr>
<td>2  aquatic</td>
<td>aquatic plant, aquarium plant, hydrophyte, macrophyte, saltwater plant, freshwater plant</td>
</tr>
<tr>
<td>3  beverage</td>
<td>beverage, brewing, drink, tea, beer, wine</td>
</tr>
<tr>
<td>4  biofuel</td>
<td>biofuel, biodiesel, bioethanol, green diesel, biogas, petrol, green energy</td>
</tr>
<tr>
<td>5  bioindicator</td>
<td>bioindicator, biomonitor</td>
</tr>
<tr>
<td>6  birdseed</td>
<td>birdseed, bird seed, bird food, bird feed</td>
</tr>
<tr>
<td>7  boundary</td>
<td>boundar, barrier, hedge, fence, windbreak, wind break</td>
</tr>
<tr>
<td>8  breeding</td>
<td>breeding</td>
</tr>
<tr>
<td>9  cane/bamboo</td>
<td>cane, bamboo, wicker, basket, basketweaving, basket weaving, wickerware, wicker ware</td>
</tr>
</tbody>
</table>
| 10 cereal¹      | cereal, grain

   [Some species were identified as “cereal” but were actually species frequently associated with cereals, perhaps as weeds of cereal crops]
| 11 charcoal      | charcoal, char, biochar            |
| 12 chewing       | chewing gum, masticator, bubble gum |
| 13 clothing fibre| clothing fibre, clothing fiber, textile fibre, textile fiber, fabric fibre, fabric fiber |
| 14 companion plant| companion planting, polyculture, intercrop, nurse crop, multiple crop |
| 15 cosmetics     | cosmetics, beauty, skin care, toiletries, body care, skincare, bodycare |
| 16 cut flower    | cut flower, floricultur            |
| 17 dietary fibre | dietary fibre, dietary fiber, roughage, ruffage |
| 18 dye           | dye                               |
| 19 erosion control| erosion control, soil stabilisation, soil stabilization, sediment control, slope stabilisation, slope stabilization |
| 20 essential oil | essential oil, fragrance, perfume, aromatic compound, volatile oil, ethereal oil, aetherolea, essence, smell |
| 21 flavouring/spice| flavouring, flavoring, culinary herb, spice |
| 22 fodder        | fodder, animal feed, animal food  |
| 23 food dye      | food colouring, food dye, food pigment, lake pigment, food colourant, food colorant, food coloring |
| 24 food for humans| human food                        |
| 25 forage        | forage                            |
| 26 fruit         | fruit                             |
| 27 fuelwood      | fuelwood, wood fuel, fire wood, firewood, fuel wood |

[295x32]7
<table>
<thead>
<tr>
<th>Crop use/product</th>
<th>Terms used for screening abstracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>28  genetics</td>
<td>genetics, genetic engineering, genetic modification, biotechnology, gene targeting, gene manipulation, genetic manipulation, genetically modified</td>
</tr>
<tr>
<td>29  grain legume</td>
<td></td>
</tr>
<tr>
<td>30  green manure</td>
<td>green manure, cover crop, ground cover, groundcover, plant mulch</td>
</tr>
<tr>
<td>31  hemiparasite</td>
<td>hemiparasit, parasit</td>
</tr>
<tr>
<td>32  honey</td>
<td>honey, nectar</td>
</tr>
<tr>
<td>33  host for disease</td>
<td>host for organisms, host for disease, host for bacteria, host for fungi, host for insects</td>
</tr>
<tr>
<td>34  industrial product</td>
<td>industrial product</td>
</tr>
<tr>
<td>35  insectrepellent</td>
<td>insect repellent, pest repellent, mouse repellent, rat repellent, rodent repellent, mosquito repellent</td>
</tr>
<tr>
<td>36  insectivorous</td>
<td>insectivorous plant, carnivorous plant</td>
</tr>
<tr>
<td>37  jewellery</td>
<td>jewellery, jewellery, jewelry</td>
</tr>
<tr>
<td>38  medicinal</td>
<td>medic, ethnobotan, pharmac, pharmacognos, herbal, folklore, phytother</td>
</tr>
<tr>
<td>39  model</td>
<td>model organism, model species, model plant</td>
</tr>
<tr>
<td>40  nut</td>
<td>nut, kernel, nuts, edible seed</td>
</tr>
<tr>
<td>41  nutraceutical</td>
<td>nutraceut, dietary, functional food, food additive, health food, gluten-free food, natural food, organic food, whole food, nutrition</td>
</tr>
<tr>
<td>42  oilseed/fat</td>
<td>oilseed, edible fat, lipid, edible oil</td>
</tr>
<tr>
<td>43  ornamental</td>
<td>ornamental, landscape, decorative, garden</td>
</tr>
<tr>
<td>44  paper pulp</td>
<td>paper pulp, wood pulp</td>
</tr>
<tr>
<td>45  pesticide</td>
<td>pesticide, antimicrobial, algacide, disinfectant, fungicide, biofumigant, nematocide, insecticide, plant pest control, bio-control, antiseptic</td>
</tr>
<tr>
<td>46  phytoamelioration</td>
<td>phytoamelior, phytoremediat, removal of toxins, environmental cleansing, toxin removal</td>
</tr>
<tr>
<td>47  phytoextractive</td>
<td>phytoextraction, phytomining, bioaccumulat, bioconcentrat</td>
</tr>
<tr>
<td>48  plant grafting</td>
<td>plant graft, rootstock, scion</td>
</tr>
<tr>
<td>49  plant gum</td>
<td>plant gum</td>
</tr>
<tr>
<td>50  poison</td>
<td>poison, toxi, allerg</td>
</tr>
<tr>
<td>51  pseudocereal</td>
<td>pseudocereal</td>
</tr>
<tr>
<td>52  psychoactive</td>
<td>psychoactive, recreational drug, psychopharmaceut, psychotro, narcotic</td>
</tr>
<tr>
<td>53  resin</td>
<td>resin</td>
</tr>
<tr>
<td>54  revegetation</td>
<td>revegetation, poor soil, mine reclamation, mine rehabilitation, site reclamation, soil reclamation</td>
</tr>
<tr>
<td>55  rubber</td>
<td>rubber, latex, elastomer, mucilage, thermoplastic</td>
</tr>
<tr>
<td>56  seagrass</td>
<td>seagrass</td>
</tr>
<tr>
<td>57  shade</td>
<td>shade, shelter</td>
</tr>
</tbody>
</table>

\[Some species were identified as “grain legume” but were actually species frequently associated with grain legumes, such as weeds of grain legume crops\]

\[Some species were identified as “honey” but were actually studies on flower structure or pollination\]

\[Some species were identified as “oilseed/fat” but were actually species frequently associated with oilseeds, such as weeds of oilseed crops\]

\[Some species identified as “pesticide” were not sources of pesticides but were commercial crops whose production requires pesticides\]

\[Some species were identified as “pseudocereal” but were actually species frequently associated with pseudocereals in some manner\]

\[This term referred to plant species that provide or require shade\]
<table>
<thead>
<tr>
<th>Crop use/product</th>
<th>Terms used for screening abstracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>58 smoking⁸</td>
<td>Smok⁹ [This term referred to plant species whose product may be used for smoking but also includes those species whose seeds may require smoke to germinate]</td>
</tr>
<tr>
<td>59 soil amelioration</td>
<td>soil amelioration, soil improv, nitrogen fix, soil condition</td>
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<tr>
<td>60 starch</td>
<td>starch, carbohydrate, polysaccharide</td>
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<tr>
<td>61 sweetener</td>
<td>sweeten, sugar</td>
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<tr>
<td>62 tannin</td>
<td>tannin, tannoid, leather tanning, hide tanning, tanning leather, tanning hide</td>
</tr>
<tr>
<td>63 timber⁹</td>
<td>timber, lumber, wood, joinery, hardwood, softwood, building materials, furniture [This term identified plant species that naturally grow amongst timber in a forest (or on timber, such as a lichen), as well as those with a timber product; it also identified some species whose product may have been described as “woody”]</td>
</tr>
<tr>
<td>64 turf</td>
<td>turf grass, turfgrass, lawn, turf</td>
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<td>65 vegetable</td>
<td>vegetable, salad</td>
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<tr>
<td>66 wastewater treatment</td>
<td>wastewater treatment, biofilt, trickling filter, constructed wetland, natural wetland, slow sand filter, treatment pond, green belt, living wall, riparian zone, riparian forest</td>
</tr>
<tr>
<td>67 weed</td>
<td>weed, noxious weed</td>
</tr>
<tr>
<td>68 wood fibre</td>
<td>wood fibre, wood fiber</td>
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</tbody>
</table>
Results

Trends

An investigation of the number of times a plant species was mentioned in the literature over time was initiated at the University of Queensland Gatton Campus in 1994. The late Greg Ferguson, a new crops postgraduate student at the University, believed that any study of those products likely to appear on Australian supermarket shelves in the future should commence by reviewing what was on shelves in US supermarkets now. This idea was subsequently extended to monitoring mentions in the literature over time.

This practice, subsequently termed research intensity by some users, was designed to identify those plant species that were becoming the focus of attention somewhere in the world. Figure 1 includes an example from the Australian New Crops Info 2014 Website (http://www.newcrops.info/).

![Figure 4](http://www.newcropsuses.info/listing/species_pages_T/Trifolium_pratense.htm) shows (left) the numbers of papers mentioning Trifolium pratense between 1901 and 2013; the line of best fit has been included (since there were sufficient numbers of mentions) and its equation and the percentage of variation accounted for are shown in the box on the left chart in Figure 4.

The right-hand chart in Figure 4 plots a proportional micro index, derived from the numbers of papers mentioning Trifolium pratense in any year, as a proportion of the approximate total number of papers available in all databases screened for that year, scaled as a micro index, by multiplying by one million; a line of best fit (with its equation and percentage of variation accounted for) has also been included.

A link to a larger version of each chart has been included in the Website, if individual year data are sought.

The proportional micro index charts (Figure 4 (right)) were not included in the earlier versions of the Australian New Crops Website. It became evident that a response like that of Triticum pratense in Figure 4 (left) was not a real indication of increased interest in the species itself, but was more likely to be a reflection of the increased total number of papers over time; this is evident in the different response in Figure 4 (right).

The following sections of this report demonstrate trends of the kind expected to be of interest to new crop entrepreneurs and those species demonstrating a recent focus of attention have been listed in the website (http://www.newcropskey.info/focus_of_attention.htm).
Demonstration of trends showing a recent focus in attention

Figure 5 and Appendix Figures 1-17 show examples of charts selected from the Australian New Crops Info 2014 Website. Each of these pairs of charts demonstrates trends indicating a recent focus of attention (as indicated by the trends in the proportional micro index (right), as well as actual mentions (left)).

Samples of the keyword and crop use/product entries for each species from the Website have been included below, to assist in providing a possible reason for any focus of research and publishing attention. Botanical names for species and families arising as keywords (and the term “Internet resource”) have been omitted from the lists, below (but lists are complete on the website).

A change in focus for any plant species over time may not be related to any commercial crop use or product. For example, the species’ weed status may have changed, as identified by the presence of the “weed” term (Table 1). Alternatively, species names may have changed, as demonstrated in the section below. There can also be confusion about the spelling of a name, as demonstrated in Figures 16-18, below.

The number after each keyword is the number of papers in which the keyword and the species have been mentioned together; larger numbers will be more reliable. The percentages after each crop use/product have enabled the 68 crop uses/products to be ranked for each individual species.

Figure 5  Trends derived for Azadirachta indica (Neem, Nimtree, Indian Lilac) for the years 1901-2013, showing high levels of recent attention in the literature

Samples of the keyword and crop use/product entries from the Australian New Crop Info Website 2014 are as follows:

- Keywords: azadirachtin (275), neem (164), Adsorption (159), insect control (152), plant extracts (123), Medicinal plants (122), India (113)…

- Most likely scope for crop use/product (%): pesticide (27.35), biofuel (20.18), dye (16.42), weed (4.16), medicinal (4.05)…
Demonstration of trends showing a previous focus in attention

Figure 6  Trends derived for Dianthus caryophyllus (Carnation, Clove Pink, Rainbow Pink)
- Keywords: cut flowers (215), cultivars (184), senescence (179), patents (162), Ethylene (145), United States (144), colored varieties (129), plant cuttings (127), cut-flower production (94)…
- Most likely scope for crop use/product (%): cut flower (92.11)…

Figure 7  Trends derived for Digitalis lanata (Grecian Foxglove, Woolly Foxglove)
- Keywords: plant physiology (66), plant biochemistry (65), cardenolides (49), biosynthesis (29), digoxin (26), cardiac glycosides (25), cell culture (23), Biotransformation (18)…
- Most likely scope for crop use/product (%): poison (38.24), medicinal (26.51)…
Figure 8  Trends derived for Festuca arundinacea (Tall Fescue)
- Keywords: endophytes (384), cultivars (315), grazing (262)…
- Most likely scope for crop use/product (%): turf (59.36), forage (32.45), medicinal (1.69), green manure (1.63)…

Figure 9  Trends derived for Veratrum viride (Indian Poke, Indian Hellebore, False Hellebore, Green False Hellebore, American False Hellebore, American White Hellebore, Bear Corn, Big Hellebore, Corn Lily, Devils Bite, Duck Retten, Itch-weed, Itchweed, Poor Annie, Blue Hellebore, Tickleweed)
- Keywords: hedgehog (3), Traditional medicine (3), antiemetic action (2), bryophytes (2), Conservation (2), Cyclopamine (2), Cytokine (2), Dihydroveratramine (2), eclampsia (2), Epilepsy (2), Herbal formula (2), Immunomodulator (2), Interleukin (IL) (2), medicinal plants (2), NMR (2), Pregnane glycosides (2), steroid alkaloids (2), Tumor necrosis factor (TNF) (2), Veratrum alkaloids (2), Verticillosides (2)…
- Most likely scope for crop use/product (%): poison (64.76), medicinal (13.46)…

An extract of Veratrum viride (known as alkavervir) was popular as an antihypertensive in the 1950’s and 1960’s (Figure 9) but the plant is extremely toxic.
Demonstration of trends showing both a previous and a recent focus in attention

Figure 10  Trends derived for Digitalis glomerata (Ascherson’s Orchardgrass, Cock’s-Foot, Orchard Grass, Orchardgrass)

- Keywords: forage (164), crop yield (159)…
- Most likely scope for crop use/product (%): forage (82.98), poison (4.80)…

Figure 11  Trends derived for Lolium multiflorum (Italian Ryegrass, Annual Ryegrass, Australian Ryegrass, Short Rotation Ryegrass, Westerwolds Ryegrass)

- Keywords: crop yield (214), nitrogen (119), cultivars (116), forage (107), dry matter accumulation (106)…
- Most likely scope for crop use/product (%): forage (55.48), green manure (12.97), cereal (6.81), weed (3.74)…
Figure 12  Trends derived for Poa pratensis (Kentucky Bluegrass, Smooth Meadow-Grass, Common Meadow-Grass, Spreading Bluegrass)

- Keywords: lawns and turf (272), cultivars (237), turf grasses (169)…
- Most likely scope for crop use/product (%): turf (95.56), forage (1.75)…

Figure 13  Trends derived for Ricinus communis (Castorbean, Castor Oil Plant)

- Keywords: Ricin (178), castor beans (154), enzyme activity (114), lectins (98), lectin (91), seeds (91), castor oil (88), Biodiesel (79)…
- Most likely scope for crop use/product (%): grain legume (24.50), oilseed/fat (15.55), biofuel (10.80), poison (10.31)…
Demonstration of trends following a name change

Figure 14 compares the numbers of mentions over time for the original botanical name for bread wheat (Triticum vulgare) with its current name (Triticum aestivum). Figure 15 demonstrates the numbers of mentions over time for Wollemia nobilis (Wollemi pine) which was discovered and named in 1994.

Figure 14  Trends derived for Triticum vulgare (top) and Triticum aestivum (bottom)

Figure 15  Trends derived for Wollemia nobilis (Wollemi Pine), first discovered in 1994, northwest of Sydney
Demonstration of trends where there may be confusion about a name

Figures 16-18 compares the numbers of mentions over time for three different spellings of the name Ginkgo biloba.

**Figure 16  Trends derived for Ginkgo biloba (Maidenhair Tree)**

- Keywords: Oxidative stress (149), Alzheimer's disease (111), Antioxidant (92), Apoptosis (82), Ginkgo biloba extract (75), Quercetin (70), Flavonoids (67), memory (54)…
- Most likely scope for crop use/product (%): medicinal (49.03), poison (8.00)…

**Figure 17  Trends derived for Gingko biloba (Maidenhair Tree)**

- Keywords: Alzheimer's disease (61), Oxidative stress (42), Dementia (32), antioxidants (31), neuroprotection (27), Flavonoids (25), Memory (24), free radicals (22), Herbal medicine (21), complementary and alternative medicine (19), Dietary supplements (19), EGb 761 (19), Quercetin (17), aging (16), apoptosis (16)…
- Most likely scope for crop use/product (%): medicinal (57.54), nutraceutical (12.63)…
Keywords: Oxidative stress (22), quercetin (12), Alzheimer's disease (11), Flavonoids (11), neuroprotection (11), aging (10), apoptosis (10), memory (9), Antioxidants (8), Chlorophyllase (8), Cytochrome P450 (8), elderly (8), Pheophytinase (8), alternative medicine (7)…

Most likely scope for crop use/product (%): medicinal (27.51), nutraceutical (23.81), psychoactive (9.67), oilseed/fat (5.17)…
Implications

The charts of research intensity and lists of plant species commonly associated with crop uses or products can be an approach to identifying those plant species that warrant a preliminary desk-top investigation for their suitability for commercialisation as new crops.

Once a new crop use or product has been identified in this way, links on New Crops Info’s front page lead to summaries of the principles behind new crop commercialisation through individual counselling (The Ten Points), small group processes (The Do Our Own Marketing Research short course) and new crop industry development (The Thirteen Steps). In the past, these pages have ranked between 18 and 28 in the 30 most visited pages on the Australian New Crops Website.

Recommendations

Each page of the Australian New Crops Info 2014 Website carries a warning: “All information is included in good faith but this website does not warrant or guarantee the accuracy of any information on these pages, nor does the website accept responsibility for any loss arising from the use of this information”. It is recommended that the visitor to the website use it to identify plant species worthy of a closer investigation. Any further action will depend on the user’s evaluation of the usefulness and accuracy of this information. It is always important to test all things.
Appendix

Appendix Figures demonstrating trends showing a recent focus in attention

Samples of the keyword and crop use/product entries for each species from the Website have been included below, to assist in providing a possible reason for any focus of research and publishing attention. Botanical names for species and families arising as keywords (and the term “Internet resource”) have been omitted from the lists, below (but lists are complete on the website).

Appendix Figure 1  Trends derived for Betula pendula (European White Birch, Silver Birch)

- Keywords: Leaves (170), Ozone (141), photosynthesis (134), Finland (123), Forest trees (121), Growth (114), Climate change (108)…

- Most likely scope for crop use/product (%): timber (49.14), shade (9.93), charcoal (8.54), medicinal (7.30), weed (3.55)…

Appendix Figure 2  Trends derived for Betula papyrifera (Kenai Birch, Paper Birch, White Birch, Canoe Birch)

- Keywords: forest trees (93), Boreal forest (83), climate change (75)…

- Most likely scope for crop use/product (%): timber (66.46), charcoal (10.37), medicinal (4.26), shade (3.31)…
Appendix Figure 3  Trends derived for Brachypodium distachyon (Purple False Brome)

- Keywords: wheat (37), grasses (29), evolution (26)…

- Most likely scope for crop use/product (%): cereal (40.66), model (36.17), genetics (6.45), medicinal (2.20), biofuel (2.19), breeding (2.07)…

Appendix Figure 4  Trends derived for Curcuma longa (Common Turmeric)

- Keywords: Curcumin (1169), turmeric (218), Oxidative stress (193), Apoptosis (164), Antioxidant (128), inflammation (109)…

- Most likely scope for crop use/product (%): flavouring/spice (27.89), medicinal (12.93), poison (10.86), nutraceutical (6.73)…
Appendix Figure 5  Trends derived for Eucalyptus globulus (Eurabbie, Southern Blue Gum, Blue Gum, Tasmanian Bluegum)

- Keywords: forest plantations (121), Lignin (119), Forest trees (103), leaves (94), biomass (88), Tasmania (71), wood (71)...
- Most likely scope for crop use/product (%): timber (45.00), paper pulp (29.76), essential oil (3.60), medicinal (3.00)...

Appendix Figure 6  Trends derived for Hypericum perforatum (Perforate St John's-wort, Common Saint John's wort, St John’s wort)

- Keywords: medicinal plants (168), hypericin (158), Hyperforin (103), Flavonoids (96), depression (94), St. John's wort (89)...
- Most likely scope for crop use/product (%): medicinal (76.34), timber (4.05), psychoactive (1.94)...

[A clarification has been added to each list of “Most likely scope for crop use/product” on each webpage; it reads: “…a mention may relate to the use of a species, or the context in which it grows, rather than a product”. Hypericum perforatum would have a medicinal use or may be found growing naturally amongst timber.]
Appendix Figure 7  Trends derived for Jatropha curcas (Barbados Nut, Purging Nut, Physic Nut, JCL)

- Keywords: biodiesel (686), Transesterification (266), Biofuel (93), Biofuels (67)…
- Most likely scope for crop use/product (%): biofuel (97.13), nut (0.36)…

Appendix Figure 8  Trends derived for Panax ginseng (Chinese Ginseng, Ginseng)

- Keywords: Ginseng (141), Ginsenosides (141), Medicinal plants (111), ginsenoside (107)…
- Most likely scope for crop use/product (%): medicinal (63.69)…
Appendix Figure 9  Trends derived for Phragmites australis (Common Reed)

- Keywords: Constructed wetlands (196), wetlands (145), Wastewater treatment (111), Constructed wetland (107), wetland (96), invasive species (94), phytoremediation (90)…

- Most likely scope for crop use/product (%): wastewater treatment (66.64), aquatic (15.55)…

Appendix Figure 10  Trends derived for Physcomitrella patens (Physcomitrella Moss)

- Keywords: evolution (105), mosses and liverworts (82), Chloroplast (65), gene expression (65), Moss (58)…

- Most likely scope for crop use/product (%): model (34.26), genetics (24.40)…

Appendix Figure 11  Trends derived for Pinus pinaster (Maritime Pine, Cluster Pine)

- Keywords: forest trees (126), France (116), Spain (109), Portugal (70), forestry (68)…

- Most likely scope for crop use/product (%): timber (54.56), charcoal (10.91), resin (7.54)…
Appendix Figure 12  Trends derived for *Populus tremula* (European Aspen, Aspen, Common Aspen, Eurasian Aspen, Quaking Aspen)

- Keywords: hybrids (134), Transgenic plants (88), forest trees (86)…
- Most likely scope for crop use/product (%): timber (55.26), wood fibre (6.02), medicinal (4.90)…

Appendix Figure 13  Trends derived for *Punica granatum* (Pomegranate, Granada, Granatapfel, Grenadine, Grenade, Granatäpple, Gránátalma, Pomogranã)

- Keywords: pomegranates (157), Pomegranate (149), antioxidant activity (118), Antioxidant (94), Medicinal plants (87)…
- Most likely scope for crop use/product (%): fruit (19.68), tannin (16.17), medicinal (11.63)…
Appendix Figure 14  Trends derived for Quercus ilex (Holly Oak, Evergreen Oak, Holm Oak)
- Keywords: Spain (204), Drought (151), Climate change (127)…
- Most likely scope for crop use/product (%): timber (21.77), shade (16.80), charcoal (12.79), ornamental (11.79), bioindicator (10.14)…

Appendix Figure 15  Trends derived for Quercus robur (English Oak, Pedunculate Oak, French Oak)
- Keywords: forest trees (165), leaves (130), Climate change (119)…
- Most likely scope for crop use/product (%): timber (51.68), tannin (7.60), charcoal (6.86), medicinal (5.93), shade (3.40)…
Appendix Figure 16  Trends derived for Rosmarinus officinalis (Rosemary, Anthos)

- Keywords: rosemary (256), essential oils (230), Essential oil (185), Antioxidant activity (171), Antioxidants (156), Antioxidant (114), plant extracts (111)...

- Most likely scope for crop use/product (%): essential oil (65.65), flavouring/spice (9.27)...

Appendix Figure 17  Trends derived for Zingiber officinale (Garden Ginger)

- Keywords: ginger (286), Medicinal plants (110), Antioxidant (75), essential oils (65), rhizomes (64), plant extracts (56)...

- Most likely scope for crop use/product (%): medicinal (46.72), flavouring/spice (21.10), essential oil (6.52)...
What is the next new crop? Review of the Australian New Crops 2014 Website

By Dr Rob Fletcher
July 2015
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