# Food security for a 9 billion population: more R&D for weed control will be critical

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**Summary** Current world population is 7 billion, expected to reach 9 billion by 2050. In 2011, 925 million people suffered from chronic malnutrition, on average 16% of the population in the developing world, and this can be expected to worsen if there is no increase in world food production (UN 2011). FAO calculate that food production must rise by 70%, including nearly doubling world meat production, to meet the food needs of 9 billion people, and most of this will have to come from increased yields per hectare of arable land.

Australia is the 4th largest net food exporter in the world so our role is critical, in the production of grain crops but also of meat. Humans require protein as well as carbohydrates, and fisheries, including aqua-farming, are increasingly unsustainable. Despite all the adverse rhetoric, grass-fed animal protein, whether from sheep, goats, cattle, or kangaroos, is economically and environmentally sustainable, using land which cannot be economically or sustainably cropped. Australia has a key role in producing and exporting meat, particularly to Asian countries.

Australian agriculture is highly productive and efficient, but relies heavily on chemical herbicides. Herbicide use is threatened by rising prices, both of tractor fuel and of chemicals, by herbicide resistance, and by the challenges of a changing climate. Grazing lands are threatened by new weeds, and herbicide use is largely uneconomic. R&D for Australian farmers is funded by the Development Corporations as well as the chemical companies, with steadily decreasing direct funding from the State or National governments. Australia is a critically important player in reducing world food poverty, and increased funding for weed control research is an essential part of this.

**Keywords** Climate change, northern Australia, meat industry.

## INTRODUCTION

Food security has once again become a major issue for the world (FAO 2011). In the 1970s, the Club of Rome's predictions of future starvation were postponed by the green revolution: new crop varieties, new agricultural techniques and increased input in the form of relatively cheap chemicals, which boosted yields by 3+% per year over many years and ensured plentiful cheap food on a world scale for the next 30 to 40 years (Jain 2010). Famines caused by local droughts, such as Ethiopia in the early 1980s, were the result of local economics and food distribution rather than lack of food on a world scale.

However, increased world population, from 3.5 billion in 1970 to 8 billion in 2011 (FAO 2009), has put pressure both on available cultivatable land and on yields required, and FAO calculates that food production must increase by 70% by 2050 to feed the estimated 9 billion people (FAO 2009). At the same time, the new intensive farming is increasingly unsustainable; withdrawal for irrigation is rapidly depleting groundwater in the major agricultural producing regions of the USA, India, Pakistan and China (FAO 2011a), as well as a host of other smaller countries in Africa and Asia. Intensive agriculture depends on fossil fuels, both to drive the machinery and also as the source of the chemicals needed, chiefly herbicides. Newly-sourced and abundant gas supplies may postpone the price crunch but fuel is still an ever-increasing part of farm costs. As a result, higher world food prices in real terms are expected to continue, and volatility to increase (FAO 2011b p. 81).

In this mix, Australia has an important role, finally being recognised by our governments in this Year of the Farmer (2012). Australia is the fourth largest food exporting country in the world; 3rd in wheat but 1st in meat, both cattle and goat and 2nd after New Zealand in sheep meat (FAO 2012). Other countries, notably China, India, and the USA, produce much more but consume much of it domestically, including the 40% of the US maize crop going to biofuel production (FAO 2012).

## WEED ISSUES

**Crop production** Most Australian crop production is efficient and sustainable, especially when using new techniques such as no-till and controlled traffic farming, combined with flexible crop rotations which take advantage of soil moisture and increasingly accurate short and long-term weather forecasting. Virtually all broadacre farming is rainfed, or uses irrigation water from short-term storage dams, i.e. using rainfall from the previous 12 to 18 months rather than ancient

groundwater. This makes crop yields highly variable on a year-to-year basis but means that the systems are sustainable in the long term, and Australian broadacre grain farms are probably the world's best in yield per mm rain. However, these efficient systems depend on the availability of reliable and cheap herbicides, and these are threatened by rising resistance problems as well as by increased fuel costs.

Climate change is also a major threat. It is clear that rainfall will reduce in the grain-growing areas of southern Australia, severely in the south of Western Australia and less so but still significant in central and eastern Australia (Australian Government 2012a). Temperature rises will exacerbate the problem due to increased evaporation. Herbicide efficacy can be temperature- dependent, and herbicides may increasingly have to be applied at night. More research is needed on the impact of applications during darkness, when photosynthesis is not occurring. Different weeds will respond differently to increased temperatures, and the weed flora of crop fields will change.

One response to the reduction in rainfall in the southern grain belt is to move production into the wet/dry tropics of the north, where rainfall is predicted to increase (Australian Government 2012b). This will bring major problems, initially political problems from the need to clear land, construct dams and other infrastructure (e.g. controversy over the Wild Rivers legislation of the previous Queensland Government), but also from the need to control pests, diseases and weeds. Losses due to weeds can be dramatic in the tropics; I have seen small-crops in eastern Indonesia completely destroyed by giant sensitive plant *Mimosa diplotricha* C.Wright ex Sauvalle germinating alongside the maize crop and rapidly out-growing it. Modern chemicals can control these weeds, but the application and persistence of herbicides in the wet tropics is relatively unresearched in the Australian context.

**Grazing industries** Australian meat production from cattle, sheep and goats is largely with grass-fed animals, although cattle are typically finished on grain for high-value markets. Grazing lands are often on poorer quality soils unsuitable for cropping. In higher rainfall areas and/or on better soils, land may be unsuitable for cropping because of slopes and in particular, stony and irregular contours which prevent the use of large machinery. Often the only alternative use is for trees, either for tree crops such as bananas or fruit trees or for forestry. Consequently raising grazing animals for meat is the best use of these lands from the food production aspect.

Unfortunately weed management in grazing lands can become economically impossible. Grazing management can help slow weed invasions, though in low value country even this can be economically impossible due to the cost of fencing and labour in moving stock around. Use of goats or sheep on a rotational basis has been recommended (MLA 2007), but the practical and economic difficulties of obtaining animals at the right time usually limit this technique to small areas or higher value production. Use of herbicides is not economic, as has been demonstrated for lantana *Lantana camara* L. in eastern Australia (AEC Group 2007) and for fireweed *Senecio madagascariensis* Poir. in NSW (Sindel and Coleman 2012). In smaller farms, early control of isolated infestations may be feasible, but in larger properties even this is uneconomic.

As a result, biological control is the only economically sustainable method for the control of invasive weeds in grazing lands. From the invasion of prickly pear in eastern Australia in the 1900s to the problems of ragwort and docks in Victoria and Tasmania, thistles and St John's Wort in NSW and Victoria, and parthenium and rubbervine in central and northern Queensland, biological control has resulted in the successful control of many serious invasive weeds of grazing lands and the restoration of huge areas of land to productive use (Julien *et al.* 2012). For example, now that eradication of siam weed *Chromolaena odorata* King & Robinson in north Queensland is seen as unachievable, biocontrol offers the only economically feasible solution. Fortunately, there are proven agents available from biocontrol research undertaken in south-east Asia and South Africa (Day and McFadyen 2012). Even grasses can be successfully controlled: there are preliminary indications of successful control of the giant reed *Arundo donax* L. in the USA using a scale insect (Don Sands pers. comm. 2012) and similar methods are being trialled with other invasive and non-palatable grasses (McLaren *et al.* 2012).

RESEARCH FUNDING

Weed research in the cropping area is largely funded by the GRDC, with funds derived from grower levies matched by Australian Government funding. Priorities are set by GRDC working through regional representatives, and work is done by scientists employed by universities, CSIRO and state departments. There is close cooperation with the chemical suppliers and resellers and, in general, the system works well, both in developing new weed control methods appropriate for Australian conditions and in transferring new techniques to the growers. However, this system is still untested in the far north where there are very few weed scientists, only one university (Charles Darwin University) and a very limited reseller network. The

system also suffers from its dependence on grower levies; in years when the harvest is very poor due to nation-wide drought, the levies, and therefore the matching government funding, drop significantly and important research programs may have to be cut.

For the grazing industries, funding for weed research is not as well established. Australian Wool Innovation manages levies from the sheep industry, and Meat & Livestock Australia from cattle; both receive matching Australian government funding on the same basis as the GRDC. However, the grazing industries do not give the same priority to weed research, largely because losses due to weed invasion in pastures can be insidious and not as immediate as lost income due to animal health or meat quality issues. Weeds typically are also regional, with each weed only affecting a section of the industry. As a result, biological control research for weeds of grazing lands, such as parthenium, ragwort, or thistles, has largely been funded by state governments or CSIRO, with only partial support from the rural industries concerned (Julien *et al.* 2012). As biological control is necessarily long term, typically taking 10 to 20 years before results are achieved in the field (Julien *et al.* 2012), it is increasingly hard to persuade governments to continue this funding.

Direct funding for weed research from the Australian government has fallen significantly in the last 10 years. The Australian Weed Research Centre was supposed to replace the Weeds CRC as a source of longer term research funds and coordination: instead, it has been reduced to handing out short-term funds for small projects. These are commissioned after a call for submissions involving significant work by applicants; the grants are typically for $200 000 to $250 000 spread over two years; and the projects have to be completed within 24 months (RIRDC 2012). As a result, these funds can support existing projects undertaken by universities, CSIRO or government agencies, but not the employment of permanent career scientists nor the commencement of new long-term projects. The 'Caring for Our Country' national program funds only on-ground weed control, or production of support publications, also through small short-term grants often given to community groups (Australian Government 2012c). These may be worthwhile activities but are reliant on the results of past research with no support for new research into new weeds or new areas. Yet if Australian growers are to move north into the wet/dry tropics, there must be funding for research to develop effective and economically sustainable weed control methods for these new regions.

Funding for new biocontrol programs is also seriously restricted. Typical programs cost between $0.5 and $0.2 million per year and may need to run for 10 or more years, yet the return on investment averages 23:1 even when unsuccessful programs are included (Page and Lacey 2006). This compares with the much-praised returns of 2.65:1 for national infrastructure programs (Albanese 2012). Despite this, the Australian government is no longer directly funding any biological control programs in Australia, though still supporting some in Asia and the Pacific through ACIAR and/or AusAID. State governments continue to fund weed biocontrol programs but are under pressure to reduce budget deficits—and weed research is an easy target with little overt public support. Both AWI and MLA continue to provide some funding for biocontrol programs, though usually requiring an equal contribution from the organisation undertaking the work. As a result, the number of new programs commenced against new weeds of grazing lands continues to fall, except where effective agents have already been identified by work undertaken, and paid for, by other countries (Day and McFadyen 2012).

## DISCUSSION

Internationally, governments and people are becoming increasingly concerned about food security. It is recognised that much of the instability and violence which led to the 'Arab Spring' and thus led to the continued fighting in Syria, Mali and possibly Egypt, were triggered by high food prices impacting on poor communities (Lagi *et al.* 2011). There is a real danger that another spike in prices of basic food items will lead to mass violence and political instability in other countries dependent on imported food, or whose domestic production is only just sufficient. Further, FAO (2009) estimates that annual meat production will need to rise by over 200 million tonnes to reach 470 million tonnes by 2050 to supply the protein requirements for the world. This may be an underestimate, because at present in many countries the main source of protein is from fish, but the world's fisheries are increasingly unsustainable (Mullon *et al.* 2005), and fish will be a rapidly diminishing part of the human diet. In the same publication, FAO (2009) estimated that 'much of the increase in cereals demand will be for animal feed to support the growing consumption of livestock products', hence meat from animals fed largely or exclusively on grass will be critically important.

The role Australia plays in this needs to be more widely acknowledged. We are a major food exporter, and, being in the southern hemisphere, we are independent of weather events affecting the northern grain growing countries. Furthermore, because our grain growing areas extend right across the continent, it is rare for the whole Australian harvest to fail, so for example it is unlikely that Australia will ever need to

ban grain exports completely to protect our domestic supply, as did Russia in 2010 (Andersen 2012). Australia is already one of the world's largest exporters of meat, and Australian meat comes from animals largely pasture-fed on land which does not compete against crop production.

Food production will be critical to world stability in the coming decade, and Australia has a vital role in this. Weed control is and will continue to be critical for the production of both grains and meat, and increased funding of weed research, particularly the long-term funding needed for biological control research, is essential if Australian growers and graziers are to have continued access to economically-viable weed control methods in the future. I call on governments, both Federal and State, and industry bodies to ensure that this long-term funding is available. There will be few better value investments for the taxpayer dollar in the coming decades.

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