Australian Government
Department of Agriculture, Water and the Environment

Fast-tracking and maximising the long-lasting benefits of weed biological control for farm productivity

Meat and Livestock Australia Limited

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This summary is an excerpt from the final report, with minor edits made to ensure it meets departmental style and accessibility requirements.

Summary

Widespread weeds cost Australian agriculture more than $4.5 billion a year.

The Fast-tracking and maximising the long-lasting benefits of weed biological control for farm productivity project (Fast-tracking project) 2016–18, funded under round one of the Rural Research and Development for Profit program, aimed to realise significant productivity and profitability improvements for primary producers by focusing on one piece of the national weed management puzzle – biological control.

History has shown biological control (biocontrol) is the most cost-effective, self-sustaining weed management technology currently available. The collective national return on biocontrol program investment by 2006 was at least 23:1, which is unparalleled for any other widespread weed management

At its most basic level biological weed control can be defined as the use of the invasive plant's naturally occurring enemies, to help reduce its impact.

Plants that have become weeds in Australia are rarely invasive and troublesome in their native (natural) range. In their native range plant populations are regulated by a variety of natural enemies, such as insects and pathogens (disease-causing organisms, such as fungi and bacteria), which attack the seeds, leaves, stems and roots of a plant. When plants are introduced to a location where these natural enemies do not occur, their populations can grow unchecked to a level where they are regarded as weeds.

A key advantage of biocontrol over other weed control options (for example, chemical, mechanical and grazing pressure) is that when natural enemies (biological control agents) are widely established they exist permanently in the ecosystem and are mostly self-replacing.

Objectives

The project aimed to fast-track biological weed control to subsequently improve agricultural production and profitability by:

- conducting research and delivery on six national priority agricultural weeds
  - parkinsonia
  - parthenium
  - blackberry
  - silverleaf nightshade
  - Cylindropuntia spp. and gorse
  - associated biocontrol agents
- improving the efficiency of information generation (via a partnership model for research, delivery and funding) and information exchange (via an online biocontrol repository and smartphone application)
- through eight interlinked sub-projects, the Fast-tracking project aimed to contribute to
  - greatly increasing the on-farm populations of eight weed biocontrol agents
  - reducing weed competition and herbicide use across more than 25 million hectares
  - reducing the densities of the six target weeds across northern and southern Australia
  - increasing long-term annual yield and reducing annual weed control costs
  - improving agricultural natural resource management nationally
  - informing producers of weed management options
  - establishing a new collaborative national approach to weed biocontrol.

Methods – the weed biocontrol discovery-to-delivery pipeline

Delivering biocontrol agents into the field is a key challenge of the discovery-to-delivery research, development and extension (RD&E) pipeline which involves researching and discovery of potential agents, host-specificity testing (to ensure each agent attacks only the targeted weed, not desired plants), rearing and releasing (delivering) biocontrol agents, and monitoring establishment and impact. Where success is achieved, field collections and redistribution can occur to hasten the spread and, hence, impact at scale.

This scientifically rigorous approach applies proven, internationally accepted scientific principles for the discovery-to-delivery RD&E pipeline.

Several of the Fast-tracking sub-projects worked predominantly in the discovery and testing phases of the RD&E pipeline – for example:

- silverleaf nightshade
- blackberry
- Cylindropuntia.

While others focused on rearing and delivery activities including field collection and redistribution, where successful populations of existing agents had been established in other regions during the past – for example,

- parthenium
- parkinsonia, gorse
- Cylindropuntia.

In conventional biological control programs, the discovery-to-delivery pipeline can take many years to achieve on-ground impact. The Fast-tracking project undertook to speed up the process and enable impact at scale by collectively utilising and developing financial, human (expertise and skills) and infrastructure resources in a coordinated and sustained approach.

Improving the consistency of effort for weeds RD&E through a shared investment framework was explored by reviewing existing models locally and internationally and developing a partnership model for research and development funding, which has been piloted in New South Wales (NSW).

The efficiency of information generation and information exchange has been improved by utilising existing information technology approaches to develop a one-stop-shop repository for weed biocontrol knowledge and information, housed on the Atlas of Living Australia (ALA) website (Australian Biocontrol Hub). These information generation and exchange tools have been road-tested with other sub-project teams and more than 200 producers across southern Australia.

"It's impractical and unrealistic to expect a halt in spread or any significant retraction in a weed's infestation, effected by biocontrol agents, within a fraction of the time it took to become problematic." (Survey participant, Australian Government)

Outcomes

The Fast-tracking project drew together stakeholders across regional, state and international boundaries, bringing together resources from more than 120 organisations and working alongside more than 200 land managers.

The investment in the Fast-tracking project has provided a range of agents for the control of Cylindropuntia spp., gorse, parkinsonia and parthenium weed, and these biocontrol agents are expected to deliver more profitable grazing over the next 30 years.

The Cylindropuntia sub-project achieved the mass rearing and redistribution of four biotypes of a sap-sucking bug or cochineal insect. Releases of these biotypes resulted in significant impact in less than twenty months, with mortality of the target weed observed. Work in this area also resulted in the development of a molecular diagnostic tool that identifies plants to the cultivar level.

The gorse sub-project resulted in the successful collection, mass rearing and redistribution of gorse soft shoot moth to 83 sites. Monitoring has shown a promising fungus has infected plants previously damaged by the moths and may become a significant factor in suppressing the spread of gorse in the future.

Two agents were reared and released at 100 sites to assist with the integrated management of parkinsonia. The insects established at more than 50% of the sites and spread considerable distances on their own, indicating they are likely to find and attack parkinsonia plants across the rangelands. This work has also improved the efficiency of mass-rearing processes, and identified optimal locations for releases in Australia, which will improve survival and establishment rates and associated weed impacts.

The project expanded previous investment and releases of agents on parthenium. All but one of these agents have established across central Queensland with most agents causing substantial

damage to, and control of, parthenium. This work also helped to train more than 36 community group members in the rearing and field release of various parthenium biological control agents.

In addition to delivering higher than expected numbers of control agents across vast tracts of northern and southern Australia (nine agents on five weeds across more than 270 sites, the Australian Biocontrol Hub ensures the legacy of knowledge gained through historical, current and future biocontrol activities remains up-to-date and accessible beyond the life of any given project.

The failure of prospective agents for two weeds (silverleaf nightshade and blackberry) was identified through the host-specificity testing process. While a setback for the biological control of these particular weeds, the rigorous process of testing agents on a diverse range of plants and consultation with potentially impacted stakeholders is vital in maintaining broad community support for biological control options, and is equally applicable to both pest plants and animals.

A shared investment funding model has been piloted in NSW. The model has effectively laid the foundations for maximising the delivery of multiple biocontrol agents on the ground, while fostering a more sustainable and collaborative user-pays model for biocontrol services for the future than any other model developed in Australia.

A cost–benefit analysis (CBA), undertaken as part of the project, has estimated the value of total benefits at $13.91 million (present value terms) and an estimated net present value (NPV) of $9.44 million – a benefit–cost ratio (BCR) of approximately 3.1 to 1, an internal rate of return of 16% and a modified internal rate of return of 9%.

Conclusions and recommendations

In some weeds, impact at scale from biological control agents can require 30 years and for other weeds the time to impact is much shorter. The Fast-tracking project has demonstrated that human intervention in weed biocontrol systems, supported by a dynamic and collective knowledge base and innovative technologies, can, through a collaborative and consultative approach, hasten the impact and scale of biocontrol efforts. The collaborative efforts from organisations working alongside the core sub-project teams was critical to achieving impact at scale over a relatively short timeframe – this type of impact is not practical or feasible without this level of collaboration.

For primary producers, the collective impact of the cumulative achievements across the Fast-tracking project is: greater engagement with, and improved access to, best-practice weed management information and technology, a superior range of biocontrol agents, and enhanced confidence in the biocontrol RD&E pipeline, which will deliver faster impacts at landscape scale. With this collective impact will come associated increases in profitability through higher productivity and lower costs.

The ability to identify, rear and release a multitude of agents, each acting on different parts of the plant and across seasons, also will increase impact. To that end research to facilitate an efficient and time-effective discovery-to-delivery pipeline, supported by consultative and collaborative processes, has the greatest opportunity for cumulative success. That is, a coordinated approach at scale is critical to success and maximising efficiency of resource use.

This type of research process – a coordinated and expanded R to E pipeline – is recommended as a future model; not an exception, rather the norm to enable future impact at scale. Combined with a developing knowledge of rate of spread of agents, greater precision can be added into the future planning (where/when to release) in concert with a dispersed deliverers' network to ensure success.

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