A SUMMARY OF COSTS AND RESULTS OF BIOLOGICAL CONTROL OF WEEDS PROJECTS IN AUSTRALIA

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Summary. In 1986 a questionnaire was sent to all members of the Australian Weeds Committee seeking information on biological control of weeds programs. Thirty-nine responses listed eight secondary programs (applying results of others' research) and 31 primary programs, being conducted by six Australian research bodies. Information supplied by respondents included the history and results of programs, and problems faced during the research. Collaborative research was common. Between 9 and 14 years of research was commonly required to achieve control and benefits over one year exceeded costs by 16 to 1. Some problems encountered were common to several programs and a few had origins within Australian bureaucracy.

THE QUESTIONNAIRE

In 1986 an Information Paper was prepared at the request of the Plant Production Committee for an analysis of progress and achievements in current and recently completed programs in biological control of weeds. The data were obtained through a questionnaire sent to all Australian Weeds Committee members. A questionnaire was chosen so that the content of responses would be more comparable and to facilitate collation of information. Key information comprised types of problems caused by the weeds, areas where the weeds occur and results of the biological control programs.

The questionnaire also sought information on (a) the stage current programs had reached and results to date, (b) difficulties encountered in biological control research within Australia and elsewhere, (c) extent of collaboration between research bodies, (d) advantages to a program of previous research, and (e) benefits resulting from a program, other than control of the target weed. In addition, respondents were asked to estimate weed costs and research benefits and to comment on the relevance of determining cost/benefits ratios prior to commencing the research.

RESPONDENTS

Thirty-nine responses (i.e. completed questionnaires) were recevied from six research bodies:

11 - Division of Entomology, CSIRO (CSIRO)

10 - Alan Fletcher Research Station, Qld. Department of Lands (AFRS)

7 - Department of Primary Production, N.T. (DPP)

7 - Keith Turnbull Research Institute, Victorian Department of Conservation, Forests and Lands (KTRI)

2 - Plant Research Division, W.A. Department of Agriculture (WADA)

2 - N.S.W. Department of Agriculture (NSWDA)

PROGRAMS

Thirty-one programs were regarded as primary. These included four (2 for each of 2 weeds: Spiny emex, *Emex australis*, CSIRO & KTRI: and silverleaf nightshade, *Solanum elaeagnifolium*, CSIRO & KTRI) in which institutions were working on different aspects but not actively collaborating at this stage. Eight programs were secondary or subsidiary programs i.e. programs which had evolved from primary programs conducted by other institutions.

The responses covered 30 weeds or weed groups (two responses involved more than one weed, viz, sida, *Sida acuta*, *S. cordifolia*, *S. spinosa*, *S. rhombifolia*, and the thistle genera *Carduus*, *Cirsium* and *Silybum*. All targets except one fiddle dock, *Rumex pulcher*, were weeds declared noxious in all or part of their Australian range.

Twenty-three programs were directed at weeds of grazing land. The numbers in other broad, overlapping categories were: crops, 8; forests and National Parks, 4; freshwater, 4; roadsides, stock watering sites, disturbed land, 6; and bore drains, creek and river banks, river flats, 7.

A table listing all programs on which the report was based, areas and situations in which the target weeds are problems, their origins, the research institutions involved, duration of programs and results, is available from the authors.

COLLABORATION

Collaboration between research institutions was in progress or planned for the following 14 weeds or weed groups:

Parkinsonia	AFRS/DPP/WADA
Pistia	CSIRO/DPP
Noogoora burr	AFRS/DPP
Salvinia	CSIRO/DPP/NSWDA/AFRS
Silverleaf nightshade	CSIRO/KTRI (with Victorian Department of Agriculture and Rural Affairs)
Spiny emex	CSRIO/WADA/KTRI (with Victorian Department of Agriculture and Rural Affairs)
Skeleton weed	CSIRO/KTRI
Mimosa pigra	CSIRO/DPP
Hyptis	CSIRO/DPP
Sida	CSIRO/DPP
Ragwort	CSIRO/KTRI
Carduus/Cirsium/Silybum	CSIRO/KTRI
Rumex pulcher	CSIRO/WADA
Xanthium	NSWDA/University of Arkansas, U.S.A.

Although some of the remaining 16 programs involved contractual arrangements (e.g. CSIRO and KTRI blackberry program) these did not involve active collaboration.

RESULTS OF PROGRAMS

Only eight programs were sufficiently advanced to enable a critical assessment of their outcome. A direct result of these programs was a considerable redution or cessation of other control methods and the programs were rated as highly successful. Salvinia, harrisia cactus, and floating alligator weed were entirely controlled by biological control agents, while infestations of water hyacinth, pistia, tiger pear and ragwort were substantially reduced by biological control agents. Control of groundsel bush was less advanced but it appeared that biological control would replace chemical control in the near future. Some respondents gave projected control ratings for incomplete programs and were generally optimistic regarding the results.

Benefits extended beyond actual control of the target weeds. Respondents cited 23 of the 31 primary programs as having resulted in acquisition of new information relating to weed biology, agent/plant interactions, taxonomy, weed species other than the target, insect ecology etc. Accrual of benefits beyond actual control was correlated with the time that a program had been in progress. The eight programs for which this claim was not made were all recent, having commenced since 1983. Clearly this "spin-off" is an important feature of biological control programs.

Nineteen of the primary programs were undertaken following research by other Australian or overseas institutions. In 11 of these, earlier research contributed materially to expediting or reducing the cost of the program.

In three programs, parthenium weed, tiger pear and harrisia cactus, control agents were used to control other closely related weeds.

Agents used in nine of the primary programs were supplied to overseas research institutions in eight countries.

PROBLEMS, COSTS AND RESOURCES

Five programs had problems resulting from devaluation of the A$ or from its fluctuating value, four from delays in obtaining wildlife or quarantine permits for importation or liberation of agents, four from policies tending to restrict the importation of pathogens, and three from conflicts of interest over weed status. There were several other problems in individual programs and these ranged from illegal introduction of an agent by the public to a research site being sprayed with herbicide by a local authority.

Problems experienced during research overseas included: politics; bureaucracy; terrorists; riots; inflation; differing priorities of contracted scientists; restrictions on travel within the country; exclusion of scientists from entering the country; and difficulty obtaining approval for research.

The estimated number of years to achieve successful control, using insect agents, was 14 (n = 4; range 6-23) for programs starting from scratch, and nine years (n = 2; range 7-11) for programs where work had been done elsewhere prior to the start of the program in Australia. However, for most programs monitoring was still in progress.

Considering all programs listed, the average number of scientists per project was 1.3. The efficiency and speed of biological control research could be

expected to increase if this level was increased. Ten of the thirty nine respondents indicated that the programs suffered from restrictions in resources (manpower, facilities, travel funds, equipment).

The average cost of all programs which started from scratch and for which figures were available was $659,000 (n = 6); where programs were based on previous research the cost was $148,000 (n = 2). The estimated average annual weed costs, or losses, was $10.8 million. Clearly, the cost to benefit ratio for biological control programs is very favourable with average costs/losses over one year being 16 times the total average cost of a program starting from scratch.

Only four respondents regarded estimation of cost benefit ratios as a useful exercise prior to implementing a program. Fifteen regarded it as undesirable, as the target weeds are usually declared noxious and funds would be better directed towards the research program rather than into cost/benefit studies.

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