Economics of weed control in non-crop areas

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In considering the economics of weed control in non-crop situations an attempt has been made to examine the economic benefits achieved by the destruction of the plant or plant complex in question. While it is fairly easy to compare the relative costs of different methods of controlling a 'weed' in a given situation the more fundamental question as to why that 'weed' should have been destroyed in the first place is not, in many instances, as easy to answer.

All too often one is left with the impression that the only reason a weed is sprayed is the classic one "because it is there"!

This brings us to the basic question of "what is a weed in a non-crop situation?" But worse, since non-crop situations are those primarily concerned, it also raises the question "what is a 'noxious weed'?".

While in a crop the definition of a weed as "a plant which has some significant adverse effect on the production of that crop" would, I think, be generally acceptable. However, to try to use such a criterion, for roadsides or waste areas, would hardly be applicable. The very diverse nature of non-crop situations make any single definition impossible.

However the following cover the majority of conditions which could be considered reasons for defining a plant as a weed.

1. A plant which produces a significant adverse effect on the final yield of the species cultivated or the by-products produced from them.
2. A plant which has an adverse effect on the designed use of land or a facility.
3. A plant which has deleterious effects on the health of people or animals.
4. A plant which presents a threat to, or contributes to, the deterioration of a desirable natural phenomenon or artifact.
5. A plant which prevents or inhibits the enjoyment or utilization of a resource.
6. A plant which is aesthetically unpleasing.

Noxious weeds

There is little or no uniformity of opinion as to what constitutes a noxious weed.

At one extreme the United States Federal Act on Noxious Weeds (Public Law 93-629 of 1975) defines a noxious weed as any plant which "is of foreign origin, is new to or not widely prevalent in the United States, and can directly or indirectly injure crops, other useful plants, livestock or poultry or other interests of agriculture, including irrigation, or navigation or the fish or wildlife resources of the United States or the public health". At the other extreme the Tasmanian Noxious Weeds Act of 1964 makes no attempt to define a noxious weed, plants being so classified by declaration of the Governor.

Since control of noxious weeds is required by law, and the cost of such operations is borne wholly or in part by the landholder, the inclusion of a plant in this category should be undertaken only after a careful assessment of its true noxious potential.

Amor and Twentyman (1974) have proposed a system of evaluation while Moore (1975) proposes that only drug plants and newly established weedy species confined to restricted areas and for which eradication is a practicable proposition should be classed as noxious.

To these should be added plants with a proven serious effect on public health like *Parthenium hysterophorus* (Agarwal, 1977; Lonkar et al, 1974), *Heracleum mantegazziunum* (Clarke, 1975) and ragweed (*Ambrosia artemisiifolia*) (Franklin and Mulligan, 1955).

Few noxious weeds have any significant effect on the utilization of non-crop areas other than pastures, where they may be toxic or competitive; or on recreational areas and in national parks where they may adversely affect the utilization of the area or compete with the native flora. These are discussed below.

In forests, along railways and roads, and in waste areas, the weeds seldom affect any use made of the land. The cost of any control measures required produce no return so far as that land is concerned.

That the owner of the land should be responsible for their control could well be considered unreasonable.

Pastures

While measurement of 'pasture production' in terms of dry matter per ha, divided into the different species components if required, can be used to obtain information on the effects of herbicide programs, these give little information on the cash value of the results achieved.

When dealing with any type of pasture there is a problem in that the pasture has a realizable value only when it has passed through an animal system. The value of a weed control operation must, therefore, be assessed in relation to its effect on the returns from animal products.

The economic viability of weed control is dependent on other factors including seasonal conditions, the stock using it, the landholder's financial and management resources which determine his ability to take advantage of increased forage production, and market prices. In a bad season a 10% increase in pasture may avoid a need to reduce stock carried; in a good season a 30% increase may be of no value.

In the present economic climate attempts to predict economic returns from pasture improvement are hazardous. Over the last decade the prices for meat, dairy produce and wool have fluctuated. More recently the general tendency has been for a levelling out in cash terms in the face of rising costs, or even for a fall in prices.

Prospects for the immediate future as outlined at the 1978 Australian Outlook Conference are not encouraging with the possible exception of sheep meat. Even here the further development of the export trade in live sheep could be frustrated by trade union action.

In addition to consideration of economic returns the significance of many weed species has been questioned. Studies have indicated that in many cases weed species have a significant nutritive value, and where they are acceptable to stock their elimination may have little or no effect on the feed value of the sward (Jones et al, 1971; Marten and Andersen, 1975; Piggin, 1976).

Proven toxic species present a different problem though the actual cost of losses due to poisoning are not readily accessible. For eleven southern States in the U.S.A., Smith (1974) has estimated annual losses at $US. 200 million as against a total loss of $US. 506 million to weeds for twelve southern States.

However where toxic plants are present at a significant density, control measures become advisable if only as an insurance policy. Measured against the replacement price of animals, herbicide treatment is cheap. It is often adequate to reduce the population to a low level rather than attempt total eradication (Cronin et al, 1976).

Pasture improvement (Pizarro, 1974; Bennedick, 1975), and the use of stock management, where necessary in combination with a herbicide program to reduce the initial population, are recommended for both pasture and range (Cronin, 1972; Dollahite et al, 1973; Dover, 1975; James and Cronin, 1974). With certain species burning can make a significant contribution to control (Wesley-Smith, 1973).

Certain toxic species like ragwort (*Senecio jacobaea*) are normally avoided by cattle which will feed on them only if forced to do so, or if they are present in conserved fodder. In Tasmania (Hyde-Wyatt, unpublished) significant cattle deaths associated with ragwort poisoning have occurred only under these conditions. A similar situation exists with stinkwood (*Zieria* sp.) (Munday, personal communication).

A second group of weeds against which control measures should be undertaken are the strongly invasive plants which are unpalatable or have little or no feed value - many woody weeds, and thistles, cacti, and in particular, serrated tussock (*Nassella trichotoma*) (Campbell and Irving, 1966; Vere and Campbell, 1977a) - and species which are capable of severely downgrading the final agricultural product or of causing stock injury e.g. noogoora and Bathurst burrs (*Xanthium spinosum* and *X. pungens*) and spiny emex (*Emex australis*).

In areas where the species are not present the cost of preventing their establishment is small compared with that of attempting their control or eradication.

To be successful such an exclusion program must be organized by

a government authority which has the power to compel all land owners to follow the required program, and the inspectorial staff and facilities to ensure that it is carried out.

Once land has become infested with a plant like serrated tussock the cost of returning it to a productive state is considerable and may involve an extended rehabilitation program (Vere and Campbell, 1977a and b). In some cases the only long-term solution to such a problem lies in the successful development of a biological control method. Such a solution is only within the financial capacity of the Federal Government or the larger States.

For weeds which do not fall into the above two categories control by management is to be preferred to direct chemical or mechanical methods which are often effective only in the year of use. Increased fertilizer rates, stock management and the use of animals which can be induced to feed on the weeds, the use of alternative pasture species, or the employment of the spray-graze approach advocated in Western Australia should be considered (Michael, 1968; Bendall, 1972, 1973; Donaldson, 1976).

In range land in particular the use of fire is a valuable tool in promoting preferential regeneration of desirable species (Schumaker and Hanson, 1977).

With such a wide range of situations to consider, drawing an overall conclusion is difficult. Where particularly toxic or invasive species are concerned a long-term view should be taken and the potential losses over a 10 to 20 year period be considered when evaluating the cost of control or exclusion.

For species which do not present such a threat, preference should be given to a control strategy based on management practices.

Forestry

The benefits of weed control in forest plantations have been summarized by de Boer (1970) as:-

1. lower percentage mortality
2. increased initial growth rate
3. decreased period of susceptibility to vermin, and
4. decreased period of extreme fire danger in the initial establishment period.

To these Oates (1977) has added:-

5. to allow thinning at an earlier age, and
6. to shorten the final length of rotation.

de Boer (1977) demonstrated initial growth increases of 40% to 60% in the first 2 years with radiata pine (*Pinus radiata*) as the result of herbicide or herbicide plus fertilizer treatment. The treated plots maintained this growth advantage, which represented some 2 to 3 years gain in maturity, until closure and root fusion terminated the experiment (de Boer, personal communication).

Cromer et al (1977) have shown with the same species that weed

control and fertilization can increase pulpwood production from 13 to 19 m^3/ha/annum over a 25 year rotation.

While de Boer considers that the reduction in mortality from about 20% in the controls to less than 4% following herbicide use is an adequate economic return, the curtailment of rotation time is also significant. Using planting machines with an automatic sprayer attachment the control of grass weeds costs only $4.45 per acre over and above the average establishment cost of $51.00 per acre (in 1966). Weed control thus represents only 8% of overall establishment costs and would be recouped by reducing the rotation time by 2 to 2.5 years on a 25 to 30 year cycle.

Unwin (1977) puts the cost of competitive vegetation control at $75.00 per ha and establishment costs at $400 to $500 per ha (1975) for radiata pine plantations using manual planting and spraying. This is some 13% to 16% of the total establishment cost. Expected returns are $4000/ha for poor sites and up to $6000 for the best plantations. Waring (1970) gives further information on the economics of weed control in radiata pine. In radiata pine plantations weed competition is significant only during the first few years of growth. Once a plantation closes in, the dense shade effectively smothers most other species.

With other species weed competition may influence the crop at a more advanced stage. Boe (1971) demonstrated that control of competing vegetation allowed 3 to 4 year old redwood (*Sequoia sempervirens*) seedlings to grow more quickly than untreated ones, but growth equalized by the end of the fourth season when competition was re-established.

Barrett (1970) found that 40 to 70 year old ponderosa pine (*Pinus ponderosa*) "saplings" showed accelerated diameter and height growth following thinning and the elimination of understory vegetation. Except at the highest stand density of 1000 trees per acre, removal of understory gave an enhanced annual volume increment which increased proportionally as the stand decreased.

Rogers and Brinkman (1965) showed that the removal of hardwood competition increased volume growth of shortleaf pine (*Pinus echinata*) some 40% over a 10 year period. Control over the period cost $US.34 per acre while the increase in production was valued at about $US.47. With the same species Bower and Ferguson (1968) report a 31% growth increase over a 4 year period following the removal of hardwood understory.

Also working with shortleaf pine and with loblolly pine (*Pinus taeda*) Graner (1970) found that hardwood understory removal gave an overall 20.3% yield increase over 14 years in a 53 year old stand and 43.1% increase over 11 years in a 47 year old stand.

In 6 year old Norway spruce (*Picea abies*) a mean height increase of 60% and a mean root collar diameter increase of 88% was found by Damien (1974) in trees which had been kept free of weed competition for the first four years when compared with trees where there had been no weed control.

Béky (1974) considered that weed control in poplar (*Populus* sp.) was economically justifiable.

Dale (1975) failed to achieve consistent results with white and black oak (probably *Quercus ulba* and *Q. nigra* (Usher, 1974)), the greatest response to the removal of understory being in "young" (i.e. 20 year old) stands.

While costs and returns, where quoted, are generally no longer relevant due to the rapid inflation of recent years, in summarizing it appears that control of competitive vegetation is economically justifiable in young stands, particularly of relatively rapidly growing plants, and in particular where these are growing in plantations where closure and subsequent shading out of competitors occurs within a few years of establishment.

Railways

Weed control along railways is carried out principally to preserve the permanent way. Weed growth can choke the ballast, preventing proper drainage, and resulting in deterioration of the sleepers and even collapse of the track bed. In extreme cases vegetation growth over the track itself can cause locomotives to lose traction. Mechanical renovation involving lifting the track, cleaning the ballast and relaying both is slow, expensive and disruptive to normal working.

The use of herbicides for weed control has now been adopted in most countries (Lemos and Koutaki, 1976). The use of "Weedkiller Trains" is wide spread. Being self-contained with their own water supply they are capable of covering substantial lengths of track each day at an operating speed in the region of 10 km/hr.

For the U.S.A. in 1975 Johnson (1975) quotes a treatment cost of $US.67 per mile averaged over 15,000 miles. In Australia herbicide costs would be in the region of $100 per km at present depending on the materials used.

Herbicides are also used to eliminate woody growth which can create a fire hazard. Burning-off is still, however, a commonly used method of removing unwanted herbacious growth from alongside the track.

Conservation areas and national parks

Although blackberries (*Rubus fruticosus* L. agg.) and other alien species have been present for a long time (Douglas, 1972) it is only in recent years that the invasion of conservation areas by exotic species has been widely publicized.

Boneseed (*Chrysanthemoides monilifera*) has attracted the attention of conservationists (Anonymous, 1974; Lane, 1976) particularly in Victoria and Tasmania. In Victoria the plant was declared a noxious weed in 1969 (Parsons, 1973).

The control of this weed will not have any effect on productivity since it is not a problem to agriculture. A decision to undertake its control depends on aesthetically based opinions as to whether or not exotic species should be excluded from areas in order to protect native flora from their competition. Whether this is a practicably achievable objective is open to doubt as the acceptable methods of control tend to be labour intensive. So far volunteers

have been responsible for much of the work done. Should this support end the continuation of the program must be in doubt.

Boneseed has been picked out for special comment but similar situations do, and in future probably increasingly will, exist with other species.

Other species like tiger pear (*Opuntia aurantiaca*) or St.John's wort (*Hypericum perforatum*) present a different and more acute problem since they have harmful properties which can readily be identified: the former is capable of causing personal injury which may require hospital treatment, while the latter is considered capable of spreading from park land to adjacent farmed land where it threatens productivity (1977 Australian Weeds Committee field trip).

Dealing with such weeds in national park and recreational areas cannot be analysed in terms of returns from expenditure invested. If a weed like tiger pear is not contained at an acceptable level the whole area concerned may be lost to the community. Since it is a State or National asset which is involved the cost of protecting it should be carried by the whole community.

Recreational situations

By its very nature recreation hardly lends itself to economic analysis. In such situations, the control of weeds is unlikely to bring an economic return.

In gardens and parks weed control in turf or flower beds is largely undertaken for aesthetic reasons, the main return for any expenditure being in terms of the pleasure given.

To a limited extent the suppression of certain plants may achieve the reduction of a nuisance: clover attracts bees, and the elimination of this plant may be considered desirable in areas frequented by young children.

In some sports, particularly golf and bowls, weed control can be said to produce a more measurable benefit. Here, irregularities in the green can upset the run of the ball and seriously affect the results of play. In closely contested professional golf matches where the results may depend on a single stroke failure to have killed a weed which deflects a vital putt could cost a competitor thousands of dollars. In fairways the problem is less severe but still present.

The greenkeepers and curators consulted are all consistent over three points:-

1. where the choice has to be made between weed and disease control the latter will be given priority
2. the better the player the greater the importance attached to turf uniformity and weed elimination, and
3. more money would be spent on weed control if available.

The actual expenditure varies greatly from club to club. Where an attempt is made to control grass weeds such as *Poa annua* costs in the region of $4000 for an 18 hole golf course may be incurred.

Where the emphasis is on broadleaf control, expenditure can be below $500. This is very small when set against overall club turn-over.

A leading public course in Hobart spends $300 to $500 on weed control out of a normal income of some $40,000 (B. Smith, personal communication). A private course in Launceston with an income of some $80,000 per annum normally spends only $250, occasionally this rises to $600 when an intensive program is undertaken. Even this higher figure represents only some 13% of the $4500 paid as greens fees by visitors (Corbold, personal communication).

One of the State's leading courses in Hobart has a similarly modest expenditure of some $800 per annum. It is only fair to note that the level of weed control is excellent and has, undoubtedly, been contributed to by an overall high standard of management which is not costed against weed control. Again, compared with an overall expenditure of some $180,000, weed control represents only a very small fraction of the club's expenditure and is little more than that spent on postage (Anonymous, 1977).

The very modest expenditure on weed control evident in many clubs would indicate that the average player does not attach great significance to the composition of the course's ground cover and is not prepared to demand that more attention be given to weed control.

By comparison, bowling clubs appear to achieve a far higher level of control for broadleaf weeds, at least. Seriously infested greens are usually encountered only where management is poor and in inexperienced hands, or where there is a shoe-string budget.

For the larger ball games, rugby, soccer and Australian rules, and to a large extent cricket, weeds have little effect on the run of the ball provided the area is properly mown. Weed problems which do occur are usually the result of inadequate fertilizer programs, inadequate drainage, or overuse which prevents the grass species from recovering and maintaining a good ground cover. In such situations control of the weeds will achieve little and to a large extent be a waste of money unless steps are taken to rectify the conditions which caused the problem in the first place.

One problem which has arisen within the last few years is that patches of weeds can spoil the appearance of a ground when matches are relayed on colour television (W. Goodman, personal communication).

Aquatic situations

Aquatic weeds cause problems in irrigation and drainage channels, in irrigation and stock dams, in reservoirs for town water supplies and in water used for recreational purposes. They reduce the flow in channels, reduce the capacity of dams and may severely affect the quality of water for consumption.

Bowmer et al (1976) state that aquatic weeds can reduce the design capacity of channels by more than half. They use water intended for the crop, can cause back-ups of the water resulting in channel blow-outs, and make the maintenance of water levels - essential for the control of some weed species - difficult (Woodlands, 1977).

They are also a source of seed to infest the irrigated crop.

By far the best control is prevention where possible. Emergent species like cumbungi (*Typha* spp.) can be prevented from establishing by regular inspection and the immediate removal of all seedlings and newly established plants. This is practicable for farm dams, if not for extensive irrigation systems.

Dam and water storage design is important. Steep sides and deep water are inimical to weed establishment. Farmyard manure and fertilizer should be kept out of the water whenever possible. Drainage facilities should always be built in to enable the water level to be controlled should chemical treatment become necessary.

The cost of channel treatment is quoted at $84.00 per km for a 2.5 m wide channel (Woodlands, 1977). The cost of constructing a 2 m x 300 mm water capacity channel is quoted at $8000/km (personal communication, Tasmanian Rivers and Water Supply Commission) based on a charge of $1.50/m^3 for soil excavation.

Roadsides and industrial areas

Roadsides are traditionally cited as a means of weed distribution and a source of weeds invading adjacent land. Doubt has been cast on this by Chancellor (1969). There is, however a significant difference between the European situation and that in Australia where the majority of weed species are of exotic origin, and here the spread of some species, at least, has been facilitated by roadsides and vehicular movement.

Control of certain weedy species e.g. gorse (*Ulex europaeus*) and blackberry, which are invasive, create a fire hazard during the summer and obstruct vision on corners, can always be justified. Control of plants in drains is also essential. Indiscriminate spraying to eliminate grasses and herbaceous plants is a different matter, and community successions of plants which are progressively harder and harder to kill is the result of ill advised use of so-called 'total weedkillers'.

Way (1973) records that in England and Wales weed control is carried out because weeds are unsightly, impede visibility or are subject to statutory regulations. Roadside vegetation management rather than indiscriminate plant killing is the modern approach. Duell (1969) lists the importance of roadside vegetation as the protection against erosion and rutting, provision of firm ground for cars which leave the road and a contribution to the scenic qualities of the highway.

New growth retardants are being evaluated (Hield and Hemstreet, 1975) though their use is not necessarily cheaper than that of mechanical control (Way, 1973).

In urban areas residual herbicides are used for ground treatment prior to sealing footpaths to protect the surface from damage by weed breakthrough.

The treatment cost in the region of $300 to $500 per treated ha can be justified, when set against labour costs of $30 or more a day, if protection is given for a 4 to 5 year period.

The control of weeds in industrial areas may be undertaken

simply as a matter of pride or to maintain good public relations, or because unwanted vegetation has a definite harmful property. Where inflammable material is stored or handled, removal of vegetation which could create a fire hazard is important. In timber yards plant growth round the base of racks interferes with airflow and creates a moist micro-climate which impedes drying. While there is a benefit from weed control in these situations it cannot be calculated in cash terms.

Control of trees and shrubs under main grid transmission lines to protect the lines from fire is almost universal and frequently carried out by aerial application.

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