Alternatives to
Synthetic Chemical Herbicides

PAN Asia Pacific

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When is a ‘weed’ really a weed?

Attitudes to ‘weeds’ have changed dramatically over the years, and are continuing to change. Once upon a time, many of the plants currently regarded as weeds were thought of as beneficial, or at least not a problem. Ironically, it was the emergence of chemical herbicides that created weeds out of some plants by altering attitudes towards them. For example, in his 1957 book *New Way to Kill Weeds*, US horticulturalist R. Milton Carleton stated that “lawn clover is now considered a weed”. Originally recognised for the ecological services clover provides (nitrogen fixation, bee food, etc), it then became vilified with the advent of a selected herbicide that would kill it without killing the grass. And now, once again, clover is widely understood to bestow great ecological benefits.

Clover only became a ‘weed’ when chemicals were invented to kill it; now it is valued for its ecosystem services

Therefore, the first step is to identify whether a non-crop plant is really a weed in a given situation.

Generally, there are 3 kinds of plants in a field: crop plants, non-crop plants and weeds that above a certain level reduce yields or cause other problems. Many of the plants that are currently called weeds are in fact better viewed as non-crop plants or even beneficial

plants. Many provide valuable ecosystem services such as habitat for natural biological pest control agents.

'Weeds' can provide ecosystem services such as habitat for beneficial insects, Malaysia. Deeppa Ravindran

'Weeds' can provide valuable ground cover, protecting the soil from sun and rain damage and erosion. Balanced weed populations can provide favourable microclimates that assist crop growth. Weed roots can help improve soil biological activity and structure. They can be useful green manures, and in compost. 'Weeds' can also produce chemicals that are beneficial to crop plants—for example, corn-cockle produces the chemical agrostemmin, which can increase the yield and gluten content of wheat (Lampkin 1990).

Corn-cockle, Agrostemma githago*, can increase the yield and gluten content of wheat*

'Weeds' can attract insect pests away from crops and/or provide habitat for beneficial insects that control pest species, for example for ladybirds that control aphids (Lampkin 1990); or the use of the non-crop plant Napier grass in East African maize and sorghum systems: the grass produces an odour which attracts stem borer and a sticky substance which kills the larvae (Ho & Ching 2003).

Indian farmer Poorak Kheti, in Mohanpur, Uttah Pradesh, uses the 'weeds' baru (*Sorghum halepense*), doob (*Cynodon dactylon*), tipatuiya and motha (*Cyperus rotundus*) to improve soil fertility and the yields of his sugar cane (Sciallaba & Hattam 2002).

'Weeds' can also be very useful as prized herbal remedies or valuable additions to the diet because of their nutritive quality. Plants that are called weeds by some are in fact highly

valued plants for others – for example, the Napier grass described above as a non-crop plant is also highly prized as a source of food and fodder by some African communities and can be a lifeline for them.

Napier grass, a non-crop plant that can be a valuable source of food and fodder, as well as attracting and killing pests

'Weeds' can be excellent indicators of problems with soil structure and fertility. 'Weed' species can be read to indicate problems with pH, poor drainage, compaction, low friability of soils and nutrient deficiency (Lampkin 1990). Spraying the weeds with glyphosate or any other herbicide will not fix the problem, but solving the soil health problem will control the weed, as well as increase productivity and resistance to pests and diseases.

Weed problems in non-production areas are another issue. Glyphosate is used globally to control vegetation in public places such as parks and roadsides, schools, hospitals, utilities, and in natural forest and wild land regeneration. The starting point in identifying how to manage weeds in these situations is to first understand the benefits they may be bringing and to identify whether the negative effects of the weed in question may by outweighed by these benefits. Benefits can include erosion control, food for bees and birds, habitat for beneficial or non-pest species, shade for the reestablishment of native species and for waterways, and enhanced soil nutrients. Invasive species can help ecosystems, and people, adapt to climate change by maintaining ecosystem processes such as productivity, carbon storage, and nutrient cycling in a context of altered land cover (Davis et al 1999; Auckland Council 2013; Chandrasena 2014; Tassin & Kull 2015).

Alternative herbicides

There are many synthetic chemical herbicides on the market, but they all have a range of adverse health and environmental effects, such as acute poisoning, endocrine disruption, cancer, neurological damage, reproductive toxicity, groundwater contamination, persistence, etc. Hence, their use is NOT recommended as replacements for paraquat or glyphosate (PAN Germany and Agrarkoordination 2014).

There are some herbicides derived from natural plant extracts that can kill or suppress weeds, such as extracts from pine oil and coconut oil. But care must be taken to ensure that formulations do not include toxic surfactants, solvents or other inert or adjuvant ingredients. Some formulations are permitted in certain circumstances in organic growing systems.

Generally, however, even a natural herbicide should be regarded as the choice of last resort, with the primary focus being placed on alternative weed management practices that prevent the need for a spray.

Extracts from coconut oil are used as a herbicide

Alternative weed management

Alternative weed management focuses on sustainable ecological solutions that minimise the incursion and build up of weeds. It takes a holistic approach to crop management that recognises weeds as an integral part of the whole agroecosystem, forming a complex with beneficial insects, weeds, and crops. The self-regulatory mechanisms of a highly biodiverse farming system help keep both weed and pest species in balance. Although weeds are generally regarded by the modern agricultural institution as reducing crop productivity and encouraging pests and diseases, there are many instances where the reverse is true. So-called weeds can play a vital role in suppressing pest and disease populations, improving soils and increasing yields.

Elements of alternative weed management in crops can include:

- designing a farm ecosystem that encourages biodiversity, providing habitats for beneficial insects, and utilising 'weeds' as an element of useful biodiversity whilst minimising the need for intervention to control them;
- understanding which weeds are a problem in the specific growing situation and then using physical, cultural and ecological methods to control the most harmful ones where needed and over time to alter the vegetation balance to favour more beneficial and neutral plants;
- in appropriate situations, e.g. coffee groves, planting good varieties at high density to provide a close canopy cover that shades out weeds;
- polycropping to reduce weed growth between rows; use of under-sown species;
- reading 'weeds' to identify soil problems and then making the necessary improvements to soil health;

Agroecological coffee grove with plantain, ground cover and diverse vegetation, Central America. Stephanie Williamson

Mulching, as in this Cook Islands taro patch, suppresses weeds. Meriel Watts

MASIPAG organic farmers using wooden weeders in rice fields. Achim Pohl

- timely and appropriate cultivation prior to sowing the crop, to either bury weed seeds or encourage their germination before crop sowing, although mechanical disturbance of the soil should be minimised in order to protect the soil structure;
- crop rotations;
- selection of optimum planting dates with respect to crop choice, lunar cycles and weather patterns;
- increasing competitiveness of the crop through appropriate nutrient use and improving soil health;
- use of crop waste, grass cuttings and most herbaceous plant material as mulch to suppress weed seed germination and growth; such mulch is also moisture conserving and encourages beneficial ecosystem services from natural enemies of insect pests, including frogs,

Weeder designed by H.M. Premaratna, Sri Lanka. Gamini Batuwitage

spiders, parasitic wasps and predatory insects, along with active microbes in the soil;

- sowing of green manures between crops helps prevent weed seed germination; then turning in the green manure and weeds before they seed provides added soil benefits;
- controlling the spread of weed seeds through good sanitation practices, such as cleaning machinery, cleaning seeds for saving, careful use of animal manures, good composting practices, and avoiding letting weeds go to seed;
- appropriate mechanical methods such as hand and mechanical weeders, smothering methods, thermal weed control e.g. with hot water, steam, hot foam or flame weeders, or solarisation;
- controlled grazing, e.g. introducing ducks into rice growing systems to eat weed seeds and seedlings; grazing sheep to control grassy weeds and herbs in coffee groves, vineyards and orchards;
- introduction of selected biological control organisms that target certain invasive, exotic weeds. (Lampkin 1990; Ho 1999; BIO-GRO 2001; Watts & Williamson 2015; Williamson 2015; PAN UK 2016)

Hand weeding in rice grown by the Sustainable Rice Intensification method, Cambodia. CEDAC

Elements of alternative weed management in the built and natural environments can include:

- design of roads, paving, sports fields, parks and landscaping to reduce the potential for weed invasion and maximise ease of management;
- ongoing maintenance of infrastructure to prevent weed invasion;
- regular street-sweeping to prevent silt build-up in channelling inhibits weed growth;
- identify what level of weed and vegetation management is really necessary;
- selection of appropriate species in gardens and turf;
- increase mowing height on turf to reduce the potential for weed invasion;
- ensure appropriate fertility and drainage in turf to improve grass vigour;
- cultivation and re-sowing of sports fields to remove weeds and achieve a desired species mix in a grass sward;
- 'weed hygiene' to prevent spread of weeds by people or machinery;
- use of thermal methods such as flame weeders, hot water or steam on hard edges of paths and roads and for turf replacement;
- use of mechanical methods such as mowers, slashers and strimmers;
- hand removal including grubbing, pulling, cutting, hoeing;
- plant-based products such as extracts of pine, coconut or palm oils;
- mulching of gardens, ornamental trees, and in natural areas after weed removal;
- smothering, e.g. with weed mat, carpet or cardboard covered with mulch;
- introduction of selected biological control organisms that target certain invasive, exotic weeds;

Privet lacebug** (Leptophya hospita) **released as a biological control for the invasive tree weed, privet, in New Zealand. Landcare Research

Hot water weed control, New Zealand. Biothermal

- ensuring areas cleared are replanted with appropriate species to prevent reinvasion by weeds;
- use of stable and self-sustaining groundcovers, native grasses and shrubs that can reduce or eliminate management particularly on roadsides and right of ways;
- creation of native wildflower areas and corridors for wildlife, bees and other pollinating insects;
- use of browsing animals to control weeds in some situations.

(Davis et al 1999; Auckland Council 2013; Chandrasena 2014; Tassin & Kull 2014)

Dozens of towns across Europe have compiled valuable experience in viable alternatives to herbicide use in parks, playing areas and other public spaces (see case studies at **http://www.pesticide-free-towns.info/stories-principles**).

Ubiqutek, an electrical method of killing weeds, UK. Nick Mole

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PAN Asia Pacific (PANAP), one of five regional centres of the Pesticide Action Network, is dedicated to the elimination of harm upon humans and the environment by pesticide use and the promotion of sustainable biodiversity-based agriculture. In addition, PANAP helps strengthen people's movements in their assertion of rights to land and livelihood; advancing food sovereignty and gender justice.

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