Recommendations for improved weed management




Cover photos (*from left to right)*
- Checking the presence of natural enemies on water hyacinth, Namulonge, Uganda.
- Colombian farmers assessing weed bank in soil.
- Post-emergence herbicide treatment in a new citrus plantation, Jagüey Grande, Cuba.
- Counting weeds using a square frame.
- *Wedelia trilobata* stand in Suriname.
- Assessing weed species in the field.

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Acknowledgment

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I. Introduction

1.1 Weeds as agricultural pests

The noxious incidence of undesirable plants, also known as weeds, is one of the major constraints to world agricultural production.

Weeds are plants that under certain conditions cause economic and social harm to the farmers. In the agro-ecological context, weeds are a product of the inter-specific selection brought about by humans since they began cropping, which affected the soil and the whole habitat. The process of selection is continuous and depends on the practices adopted by the farmer. The present use of chemical herbicides has caused important changes of weed flora in cropping areas, including those of prevailing species as well as biotypes of other species becoming resistant to the commonly used chemical herbicides.

The damage caused by weeds is seen in various ways and seriously affects various agricultural processes. Weeds cause problems due to:

– *competition with crops for nutrients, water and light;*

– *the release of root exudates and foliar leachates toxic to crops;*

– *the creation of a favourable habitat for the proliferation of other pests (arthropods, mites, pathogens and others), serving as hosts for them;*

– *interference with the normal harvesting process and contamination of produce.*

Losses caused by weeds may be from 5 to 10 percent in the agriculture of developed countries, while losses can be up to 20 to 30 percent in developing or emerging countries, i.e. those that depend to a greater extent economically on their agricultural production.

1.2 Development of weed management in developing countries

Hot climatic conditions with high solar radiation of tropical and sub-tropical countries favour the predominance of C-4 photosynthesis plants, some of which are very aggressive and undesirable species, generally well adapted to the adverse conditions of high temperatures and drought, and which easily interfere with the growth and development process of crops.

In developed nations, weed control is carried out mainly through the combined use of mechanical operations and chemical herbicides. This practice is also well extended in large areas of crops grown extensively in developing countries, such as sugar cane, wheat and citrus. While these control methods are highly productive, there is concern over their effect on soil fertility and the environment. It is for this reason that several developed countries, particularly in Western Europe, have established policies to reduce or rationalize the use of chemical herbicides by adopting to a greater extent cultural practices and biological control.

> *Most of the dominant weed species in tropical and sub-tropical areas are the C_4 photosynthesis plants, which are better adapted to a hot and dry environment, having enhanced water absorption and a more efficient use of soil moisture and sunlight.*
>
> *In these climatic zones there are two C_4 crops– maize and sugarcane.*

In most of the poor or developing countries, however, the small farmer and his/her family usually spend more than 40 percent of

their time in hand weeding, which limits agricultural productivity and the improvement of their standard of living and culture. It has also been proved that hand-weeding does not always benefit the farmers, because in some circumstances they control weeds out of the "critical period" of weed competition, i.e. when most of the damage caused by the weeds has already been done.

> *While in developed countries weed management is done through* ***the use of herbicides and machinery,*** *in poorly developed or developing countries, particularly at the small farm level, the farmer and his/her family spend more than 40 percent of their labour time in hand-weeding operations.*
>
> *This situation limits the productivity of the farmers and the socio-economic development of their family.*

In the framework of sustainable agriculture development, it is necessary to develop improved methods of weed control, which should provide better productions at economically feasible levels without affecting the environment.

The results of a survey conducted by FAO from 1991–1994 (Labrada, 1996) demonstrated that in general little attention is given to the problem of weed control in developing countries due to:

- Insufficient knowledge of the damage and losses caused by weeds on the part of farmers and officials of the ministries of agriculture and rural development.

- Lack of attention to the problem of weeds by the national plant protection services. An example is that the plant quarantine departments of these services in some countries do not have a list of exotic weed species whose entry into the territory of the country should be avoided. Especially under commercial and trade pressures there is neither control nor analysis of new imported shipments of plant origin for detecting the presence of exotic weed species. Further, no risk assessment of the possible introduction and adaptation of these species is conducted.

- The absence of national research programmes on weed ecobiology and control. In a large number of countries there are only schemes for herbicide trials financed essentially by the agrochemical industry.

- Weak or absent links between the weed research programmes and agricultural extension services, leading to a lack of technology transfer for farmers.

- Insufficient publication of scientific papers on the biology of weeds and appropriate methods for their control, and lack of bulletins with practical information for growers.

- Lack of pre- and post-graduate courses on weed management at the university level. Vague aspects of weed control are usually discussed in other subject matters, such as agronomy and general plant protection.

The improvement of weed management practices is neglected in many developing countries due to:

- *lack of information on yield reduction caused by weeds;*
- *lack of courses on weed management in agronomic studies at the university and medium technical level;*
- *lack of applied research programmes in the topic of weeds and of transfer of new technology of weed control for farmers;*
- *weak links between research and agricultural extension.*

1.3 The need to develop improved weed management

Improved weed management in the agriculture of developing countries is needed for the development of Integrated Crop Management (ICM). There is no ICM without a strong component of weed management. Plant protection services, research and agricultural extension must deal with the problem of weed control through the necessary farmer education, and publishing leaflets and bulletins on the subject.

Based on the importance of weed control for sustainable agriculture, FAO has decided to prepare and publish the present practical guidelines as a modest contribution to the efforts of developing countries to secure food for their population.

II. Weed management as part of plant protection services

2.1 The objective of the work on weeds in plant protection services

As a general rule, plant protection services have specialists responsible for plant protection activities in general without being specialized on specific pests. This means the work on weed management is much neglected in all existing phytosanitary programmes. Damage caused by weeds is permanent, but not as spectacular as the one caused by other pests such as insects and pathogens.

Most experts on plant protection usually have very little background and knowledge on weeds and ways to control them. These specialists are generalists in plant protection, with better knowledge of control of other pests. Weeds are often neglected and excluded from the regular programmes of plant protection.

The quarantine of exotic weed species with possibilities of adaptation in the territory of the country is another aspect not well covered by the plant protection specialists. World trade tends to increase, which causes a major risk for more unintentional or intentional entries of exotic plants in the shipments of imported commodities of plant origin.

2.2 Activities to develop

To improve the work on weeds by the phytosanitary services, the following is essential:

(i) A weed management specialist should be on staff of the plant protection service, who would coordinate the activities related to weeds, including systematic evaluation of damage and losses caused by weeds and ways to implement improved methods of control.

(ii) A regular system of weed surveillance in crop areas should be established, which should be carried out with the cooperation of

agricultural extension workers and local plant protection personnel, as well as the farmers. The weed management specialist in the plant protection service should advise on the methods and frequency of these evaluations in close consultation with other institutions concerned.

(iii) On the basis of the above, an updated database on weeds of major importance should be maintained, with indication on economical damage caused to the major crops, and the relevant authorities should be periodically informed on the results.

(iv) Agricultural extension workers should be trained on weed management including the regular organization of field days.

(v) The above trainees should then organize Farmers Field Schools (FFS) with emphasis on weed management or include the subject of weed management in the curriculum of the existing FFS on IPM.

(vi) In some cases, it is possible that awareness campaigns could also be organized to inform farmers and stakeholders of particular weed problems. For example, it is important to disseminate information on biological control of aquatic weeds among the inland fishermen and their families. Another example could be the introduction of an exotic weed species for which a campaign would be necessary in order to avoid its spreading in a particular territory. This campaign should consist of an action programme, publication of leaflets and bulletins for the farmers, radio messages on the topic and systematic assessment of the population of the recently introduced plant population, and direct instructions of its control for all producers.

(vii) A better link between weed research and agricultural extension should be promoted. Plant protection services should regularly inform weed research of the existing problems in the field so they together can find solutions.

(viii) The results of the tests of new herbicides should be supervised and criteria issued for their approval and registration for use.

(vix) Guidelines on weed management for major crops should be prepared, as well as on ways to control highly persistent or difficult-to-control species or those resistant to commonly used herbicides.

As much as 80 percent of the land preparation and other operations carried out during the crop cycle are essentially for combating weeds. It is for this reason that weed management should be part of plant protection or, rather, of the area devoted to plant production.

A weed section in one of the areas of the Ministries of Agriculture or Rural Development compels to have a full-time specialist working on weed management to conduct the following activities:

- *Organize regular surveys to assess the level of weed infestations and losses caused to the crops, and keep an updated database on the weeds in major crops and in different regions of the country.*
- *Organize awareness campaigns on the control of highly abundant weed species.*
- *Establish permanent links between weed research and extension.*
- *Supervise the results of new weed control methods as well as tests of new herbicides in the country.*
- *Promote the publication of educational material on weed management.*

The plant quarantine section of the plant protection services, in close consultation with other
educational and research institutions working on the topic of weeds, should regularly evaluate the likelihood of the entry and adaptation of exotic plants in the national territory of the country, and their invasive potential through various procedures of risk assessment (Figure 1) in order to prepare a list of undesirable exotic plants, which should be updated systematically.

The phytosanitary plant quarantine department or section should also prepare instructions in the analysis of the presence of weed seeds or other propagules in shipments of imported commodities of plant origin, which will be used by the quarantine and plant protection inspectors involved in these types of activities.

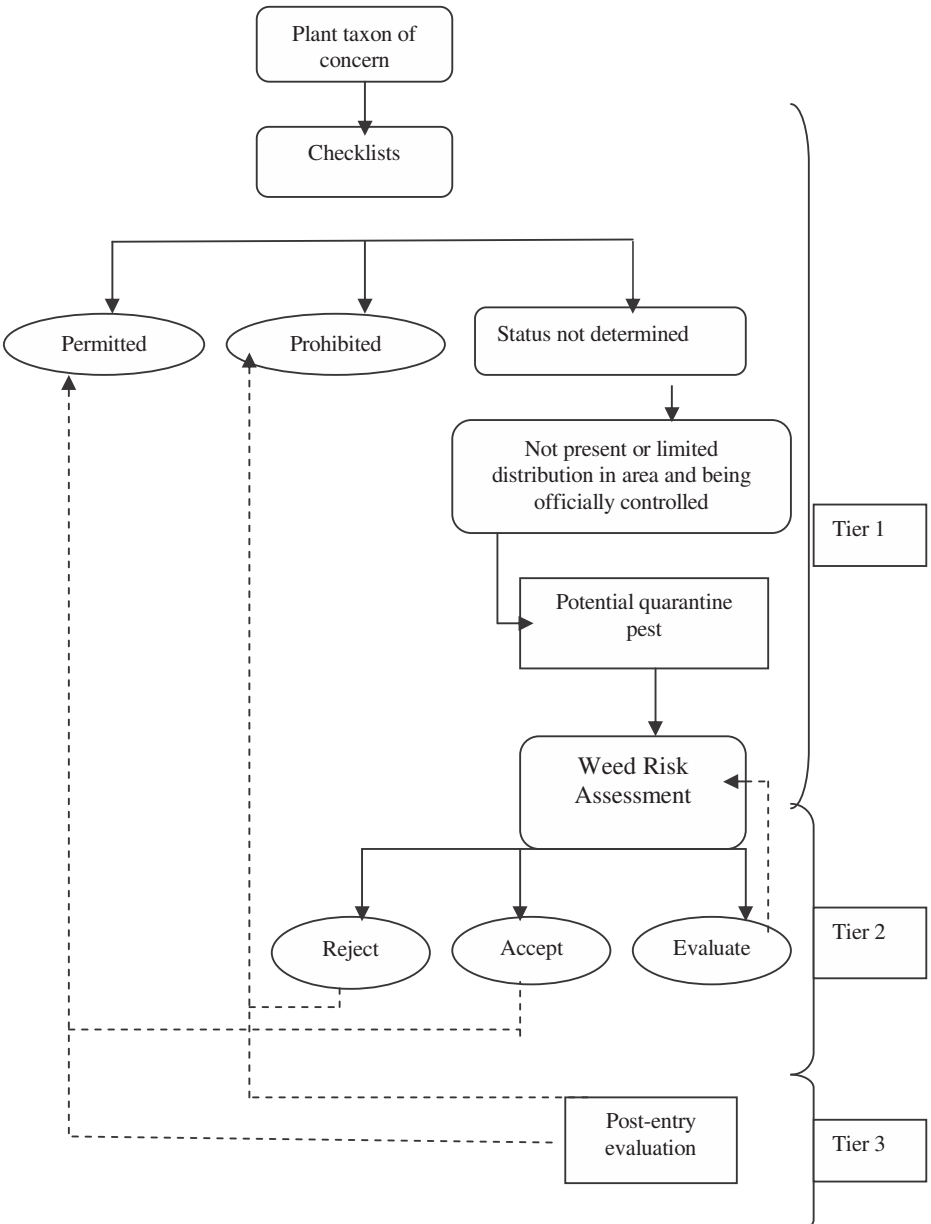

Figure 1. A flow chart for screening plant introductions incorporating the permitted list approach (Panetta *et al.* 1994, taken from Williams (2003).