

## Impact of weeds on developing countries

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### Summary

Weeds cause drastic yield losses in food production, on average 25% in developing countries and 5% in developed countries, despite the control measures practised. Crop production systems have to be adapted to minimize weed pressure, e.g., inclusion of fallow periods, adaptation of time of planting, selection of crop species and varieties. Weed control is one of the major labour-consuming operations in traditional crop production, amounting from <30 up to about 70% of the total labour input. This needs a major reduction to allow development in traditional societies. The introduction of less-labour consuming technologies, e.g., herbicides, requires the proper adaptation of legislation and its control, education and training, extension, and agricultural trade.

### Introduction

It is difficult to evaluate the impact of weeds on developing countries quantitatively and this can be done for specific cases only. Some general statements can be made, however, and exceptions from these rules have to be taken into consideration.

Frequently, it cannot be stated clearly whether the weeds have an impact on a specific situation or vice versa. Mostly there will be an interaction between the different factors involved. For example, much of the labour force is being tied up by weed control in traditional rural societies at least during parts of the year. To a certain extent, high labour requirement in plant production prevents a proper development in agriculture and hampers its role to provide food for the urban people in the society. This is a major impact of weeds and their control on the possible developments of a traditional society. On the

other hand, people usually prefer alternative jobs to weed control, if they are available. The availability of alternative jobs will therefore have a pronounced impact on the weed problem and its solution.

It is therefore worthwhile concentrating on the interrelationships between weeds and traditional societies in this paper. The impact of weeds on developing countries may be assessed from this.

### Crop production systems

Crop production systems are determined by the corresponding ecosystems and socio-economic systems. Therefore, they are centered on an ellipse around these two focuses (Figure 1). There is no one-way determination, but an interaction between the production systems on the ellipse and the two focuses.

### Harmful and beneficial effects of weeds

I do not intend to review the data available on harmful and beneficial effects of weeds in detail. Weeds may interfere negatively with human interests by:

- causing crop losses in quantity and quality,
- being poisonous,
- hampering harvesting and other operational techniques during crop production,
- contaminating harvest products,
- hosting pests and diseases,
- tying up labour and/or capital for control operations, and
- invading waterways and with this hindering river transportation, fishing, water flow in irrigation canals, and causing waterloss by transpiration.

The amount of food lost through weed competition, despite weed control, has been estimated at 25% of potential production in developing countries, 10% in those with an international level of agricultural technology, and 5% in developed countries, on average 11.5% (12). An extreme example of people being poisoned by weeds is given by Holm (3):

it is estimated that seeds of a *Heliotropium* L. species killed about 3000-4000 people and made thousands ill from one season's harvest. According to Obeid (11), the waterloss due to evapotranspiration of *Eichhornia crassipes* (Mart.) Solms is about 2 to 8 times higher than the evaporation of an open water surface, amounting to  $7.12 \times 10^9$  m<sup>3</sup> in the infested area of the Nile in Sudan. Obeid also mentions that the Sudanese River Transport Department lost more than \$US1 million annually due to water hyacinth infestation in the early seventies.

Beneficial effects of weeds may be their value:

- as food or feed,
- as hosts of beneficial organisms and
- for reduction of erosion during early phases of crop development.

It is often difficult to evaluate these beneficial effects quantitatively. Some more details will be given later in this paper.

### The influence of ecological factors on the role of weeds in production systems

Weed pressure is usually more severe in humid regions than in dry areas. It is most severe under warm humid conditions, such as the humid tropics or irrigation schemes in warm semi-arid regions, where the development of weed populations is highly dynamic and growth of individual plants is rapid and vigorous. Many seeds are produced and they usually have no, or short, dormancy and are able to germinate more or less at any time of the year. The longevity of the seeds of most species is quite short, in many cases less than one year (10).

Even though general weed pressure might be less in dryer areas than in humid ones, specific problems may be extremely severe in dry regions, because weed species specifically adapted to those conditions may take over, e.g., parasitic weeds such as *Striga* Lour. and *Orobanche* L..

Arable land is highly man-made and the natural vegetation has to be kept permanently under control. Therefore, weed pressure is usually more severe in arable crops than in tree crops and on pasture land. The weed flora is usually well adapted to the soil tillage practices. Perennial species, and those annuals which require light for germination, dominate on soils which are little disturbed. This is true

for permanent pastures, many tree crops and on arable land with planting stick cultivation.

### The influence of socio-economical factors on the role of weeds in production systems

Weeds are often one of the major limiting factors in traditional plant production, even though they can be controlled without the help of expensive and sophisticated technologies. Usually the production system is adapted to minimize weed pressure, e.g., by fallow periods, time of planting, seed bed preparation, selection of crop species and varieties. Direct weed control is practised by hand, usually with the help of simple hoes or knives; time required for weed control often being the maximum peak of labour input in a production system (Figure 2).

Time required for weed control no longer is a limiting factor in highly "industrialized" production systems. The available technologies are so efficient that the weed potential is being gradually reduced over the years of application. The seed bank in arable soils in Germany has been reduced by 80% or even more during the past decades (Table 1). The weeds now play a completely different role in the production systems for this reason. Economical thresholds, normally surpassed by the weed infestation in the past, and therefore an irrelevant question other than in exceptional cases, now play a major role in weed management. Weed control measures with relatively low efficiency, such as mechanical control, may now be sufficient to keep infestations below the economical threshold, at least for a certain time. In some instances, no post crop emergence weed control may be necessary due to low weed pressure.

*Table 1 Comparison of arable soil (seeds m<sup>-2</sup>) in Germany before 1950 with the situation around 1985*

	Minimum	Maximum
before 1950		
normal situation (5)	< 5.000	> 300.000
very intensive control (17)	1.100	22.800
around 1985 (4)	570	24.300

In traditional societies weeds have beneficial as well as harmful aspects but they have almost completely lost this value in modern

societies. They occur in such low quantities that they cannot counterbalance monocropping effects, reduce erosion or be used as food or feed.

### Interrelationships between weeds and human societies

#### Crop losses

Crop losses may have a completely different significance in economies with a surplus of agricultural products, than in societies with a shortage of such products. The priorities in assessing the impact of weed problems have to be set differently. As a whole, the prevention of losses due to weeds have a much greater impact in developing countries than in developed ones. In developed countries, the individual farmers may be affected but this has little impact on their society. In developed countries, the impact of weeds and their control on the environment is often of greater concern than the effect on crop yields.

#### Labour and urbanization

A major part of the labour of a farmer's family goes into weed control in traditional societies with "low input" plant production:

1. In Togo, yield of maize was reduced by 60% to 90% if weeds were not controlled (15). Weed control required 180 to 300

hours ha<sup>-1</sup> out of about 600 hours ha<sup>-1</sup> for total production (Figure 2). Foreign labour had to be hired during the period of weed control. The area cropped with maize in Togo is 225,000 ha (FAO 1988). Assuming 200 hours ha<sup>-1</sup> for weed control over a period of 3 months, this amounts to about 50,000 worker-days (10 hours a day, 6 days a week). Less than 2,000 worker-days are required for the same acreage under the conditions of maize production in Germany. This means a reduction of labour input for weed control of 95%.

2. The Gezira and Rahad irrigation schemes in Sudan are more than half a million ha in size, mainly cropped with groundnut and cotton. Yield losses would amount to about 80% without weed control (Table 2). Hand weeding requires about 200 to 600 hours ha<sup>-1</sup>. Thus, 100,000 person-hours are required for weed control during a period of three months per year. Herbicide application followed by one hand weeding requires about 20 - 80 hours ha<sup>-1</sup> depending on the density of the remaining weed infestation, a 60 - 90% saving of labour. Application of a sufficiently effective herbicide will reduce labour requirement for weed control by >95%.

Table 2 Effect of weeding on groundnut and cotton yield and time required for weeding (data taken from 2)

Weeding regimes	t/ha	%	time (h/ha) required for weeding
	groundnut*		
weed free all season	4.1	100	total 415
2, 4, 6 (weeks after planting)	3.8	93	372
4, 6, 8	4.4	107	376
4, 8	3.8	93	311
weedy all season	1.4	34	0
	groundnut *		
weed free all season	2.9	100	initial weeding -
weed free from 2. (weeks after planting)	2.9	100	116
4	2.8	98	214
6	1.6	56	218
weedy all season	0.3	9	0
	cotton **		
weed free all season	2.6	100	initial weeding -
weed free from 2 (weeks after planting)	2.5	97	33
4	2.3	78	60
6	1.8	61	93
weedy all season	0.5	18	0

\* t/ha pods

\*\* t/ha seed cotton

Most of the community is engaged in agriculture in traditional societies, e.g., Sudan 62%, Chad 77% (1). Thirty percent (Figure 2) or even more (up to almost 75%, Moody, cited by 3) of the labour input in crop production relates to weed control in traditional plant production, not including bush clearing after fallow, and land preparation which should also be considered. This input has to be concentrated at the critical period of crop weed-competition, which normally means about one third of the crop's growth cycle. Substitution of hand weeding, by less time consuming weed control measures, can mean unemployment where there is excess labour in a society. On the other hand, the area which can be cropped may be limited due to labour availability, unless less labour intensive weed control techniques are available.

Too many people are employed in agricultural production and too much of the harvest is consumed locally (Figure 3). Further, not enough farm products reach the urban areas. Consequently, too little capital goes back to the area of agricultural production. Besides low yields, the labour requirement in plant production is a major bottle-neck in the development of the economy of traditional societies. Therefore, subsistence agriculture is unable to feed urban people and suppresses agricultural development. Alternative job opportunities need to be provided. In Germany, for instance, industry needed an increasing number of employees around 1960 and rural people left their fields. When this occurred there was no longer the question about traditional weed control with high labour input, but growing the crop with chemical weed control or no crop at all. This was especially true for sugar beets. So the developments in industry drastically reduced the availability of labour in agriculture. Also the lack of labour enforced the rapid introduction of less labour intensive weed management. Herbicides became an important factor to the chemical industry and in agricultural trade.

For several decades, about 70% of all the pesticides used in Germany have been herbicides. A similar change is now taking place in some of the developing countries and it is beginning in lesser developed countries. Certainly it is just a question of time until more sophisticated weed management measures used in developed countries will be

implemented in developing countries. Precautions have to be taken to ensure careful introduction.

### **Education and training**

Scientific backing was necessary for the introduction of highly sophisticated weed control techniques and weed management strategies in developed countries. Weed science evolved from this and is a relatively young scientific discipline. It is still mainly restricted to the industrialized parts of the world, but it is gradually penetrating into developing countries. For this reason, developments in weed management have a positive impact on education and training of people engaged in agriculture in developing countries.

### **Shifting cultivation and fallow systems**

The need to reduce the weed potential in arable fields is one of the major reasons for the inclusion of fallow periods in traditional plant production systems. Reduction of fallow periods has led to severe weed problems in many instances. For instance, it is relatively easy to keep *Avena sterilis* L. under control in a wheat-fallow rotation in North Africa. Omission of the fallow may lead to a severe *Avena sterilis* L. problem unless herbicides are applied. Those herbicides are quite expensive and the cost-benefit ratio is often negative unless the whole production system is brought to a higher yield potential.

Shifting cultivation reduces *Striga* infestation to a tolerable level if the fallow period is long enough (8,14). The possible time of cropping host plants such as sorghum, millet and maize is limited to a few years only, often less than three years. So far, there is no viable alternative for long enough fallow periods in order to overcome the *Striga* problem. This is severely affecting plant production, and with this human societies, in *Striga* infested areas. The adverse effects of this problem are so severe that national and international working groups have been formed to solve parasitic weed problems. Sauerborn (13,14) estimates the losses due to *Striga*, where it occurs in Africa (44 million ha), to be about 4.1 million tons of cereals, which means >10% loss of the potential yield of the whole area or >20% of the already infested acreage (21 million ha).

Short fallow periods in shifting cultivation and other inadequate crop production measures

often lead to a heavy infestation of *Imperata cylindrica* (L.), Beauv. which can be so severe that fields have to be taken out of production. Hand or chemical weeding is extremely difficult and costly in this case.

#### Minimum tillage

In many areas, mainly those susceptible to erosion, minimum tillage systems would be desirable. This usually drastically increases the weed problem. So minimum tillage systems are only practical in conjunction with adequate weed control measures. Planting stick cultivation is the traditional way of practising minimum tillage and it is an integral part of many traditional societies. This production system often gets out of control with a change in the society, especially when farm labour is reduced by increasing urbanization and alphabetization. Herbicides, or in some instances smother crops, could be a solution. Due to differences in the weed pressure, minimum tillage systems are more promising in arid regions than in humid ones.

#### Weeds as food and feed

In developing countries, weeds and other wild plant species may play a major role in the diet of rural people and as animal feed, especially at periods of food shortage before the new harvest (e.g., 16). In Northeastern Syria, *Gundelia thournesfortii* L. is collected in wheat fields and sold on local markets (7). Certain weed species are left uncontrolled for later collection as food plants in many instances. Plants may be collected after weeding as animal feed, e.g., *Avena sterilis* L. in certain parts of North Africa (9). This is during a time when there is a shortage of other fodder plants. Remaining weeds often play a major role for grazing during the dry season in cereal-fallow systems (7). There exist official regulations in certain countries that the stubble may not be cultivated until some time after harvest. In case of chemical control, a substitute has to be found (for further details see 6).

#### Negative side effects of weed control measures

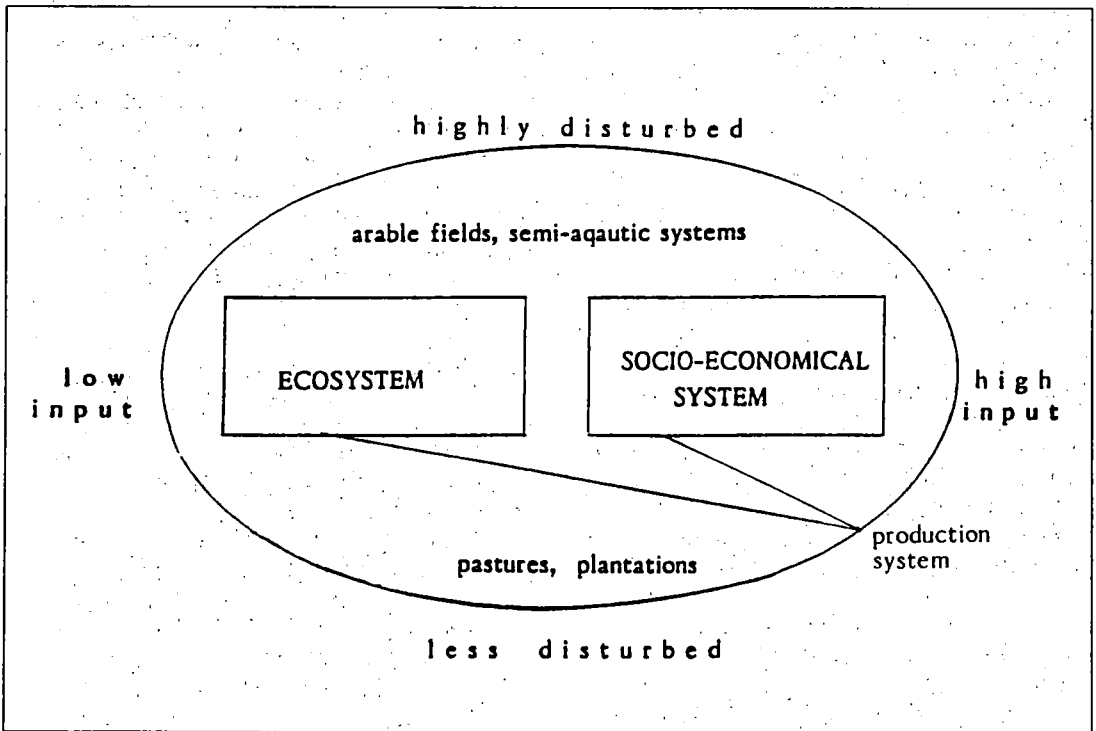
Each weed control measure has its negative side effects. Bare soils and disturbed soils are more susceptible to soil erosion. Herbicides may be poisonous to humans and animals. They may contaminate the environment for

certain times. They may be found in plants, soils, ground water and air. Together with other pesticides, herbicides are a major concern with regard to people and their environment. Highly potent selective weed control measures may reduce the diversity of the flora and as a result also the fauna, which may have ecological and even ethical consequences. Decisions have to be made about what is tolerable, and precautions have to be taken to avoid risks. Relevant institutions have to be established or strengthened.

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**Figure 1** Production systems based on ecosystems and socio-economical systems

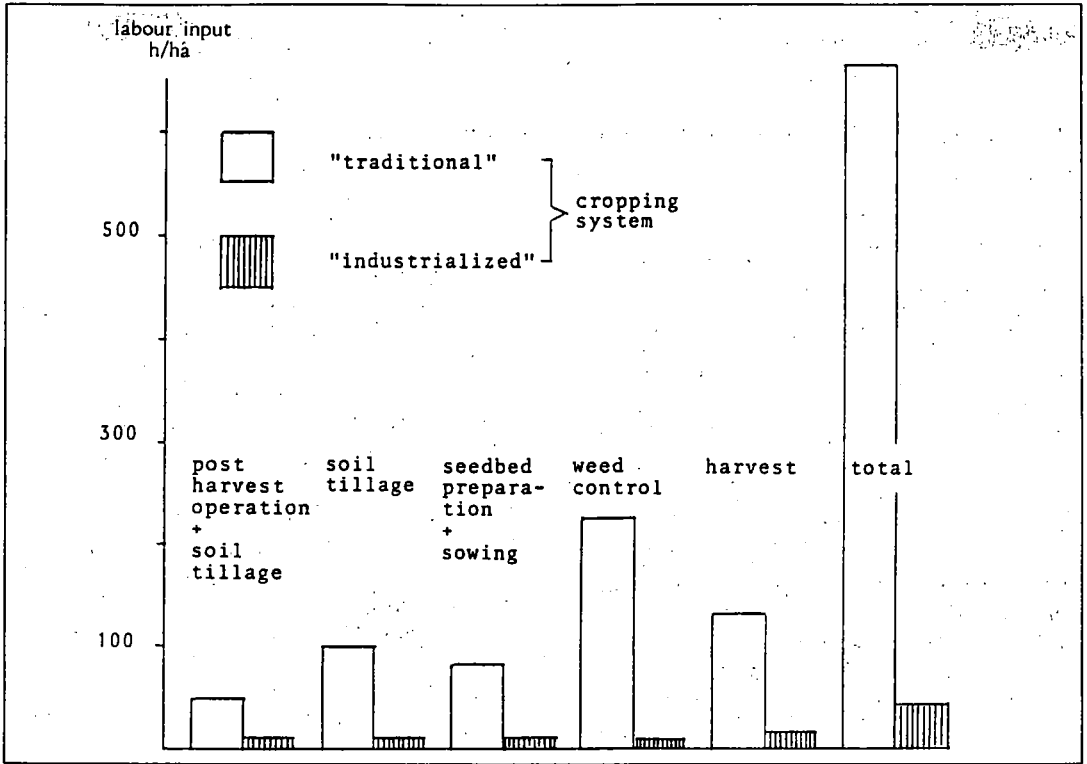


Figure 2 Labour input in "traditional" (Togo, Africa) and "industrialized" (Germany, Europe) maize production

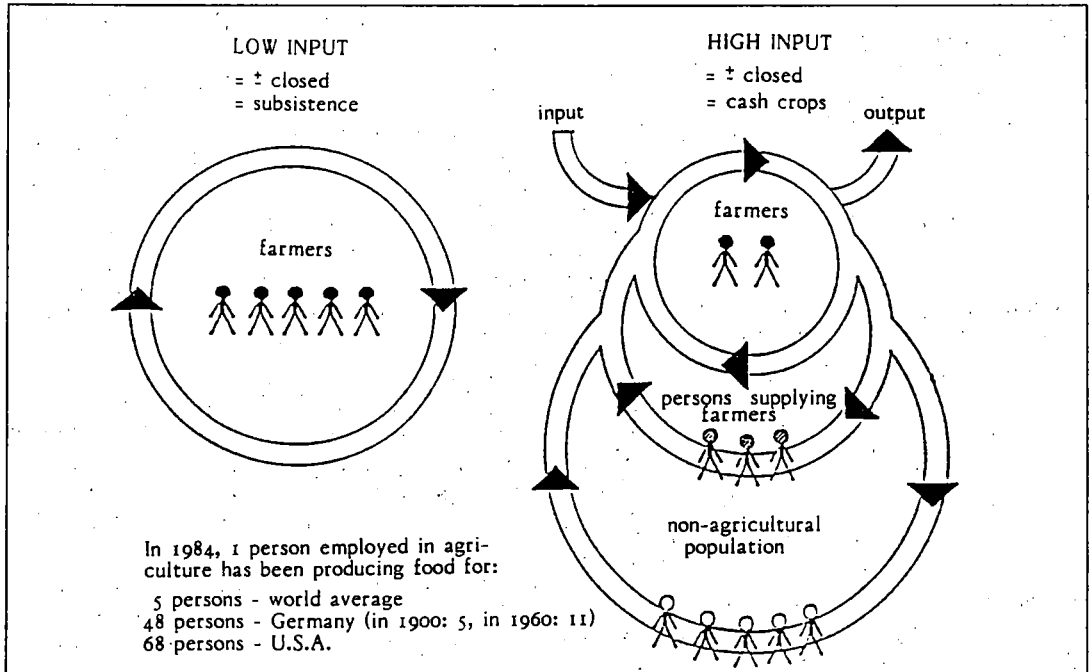


Figure 3 The principle of "low input" (closed) and "high input" (open) cropping systems