Small Farm Weed Control: An Annotated Bibliography

by: J.A.F. Compton

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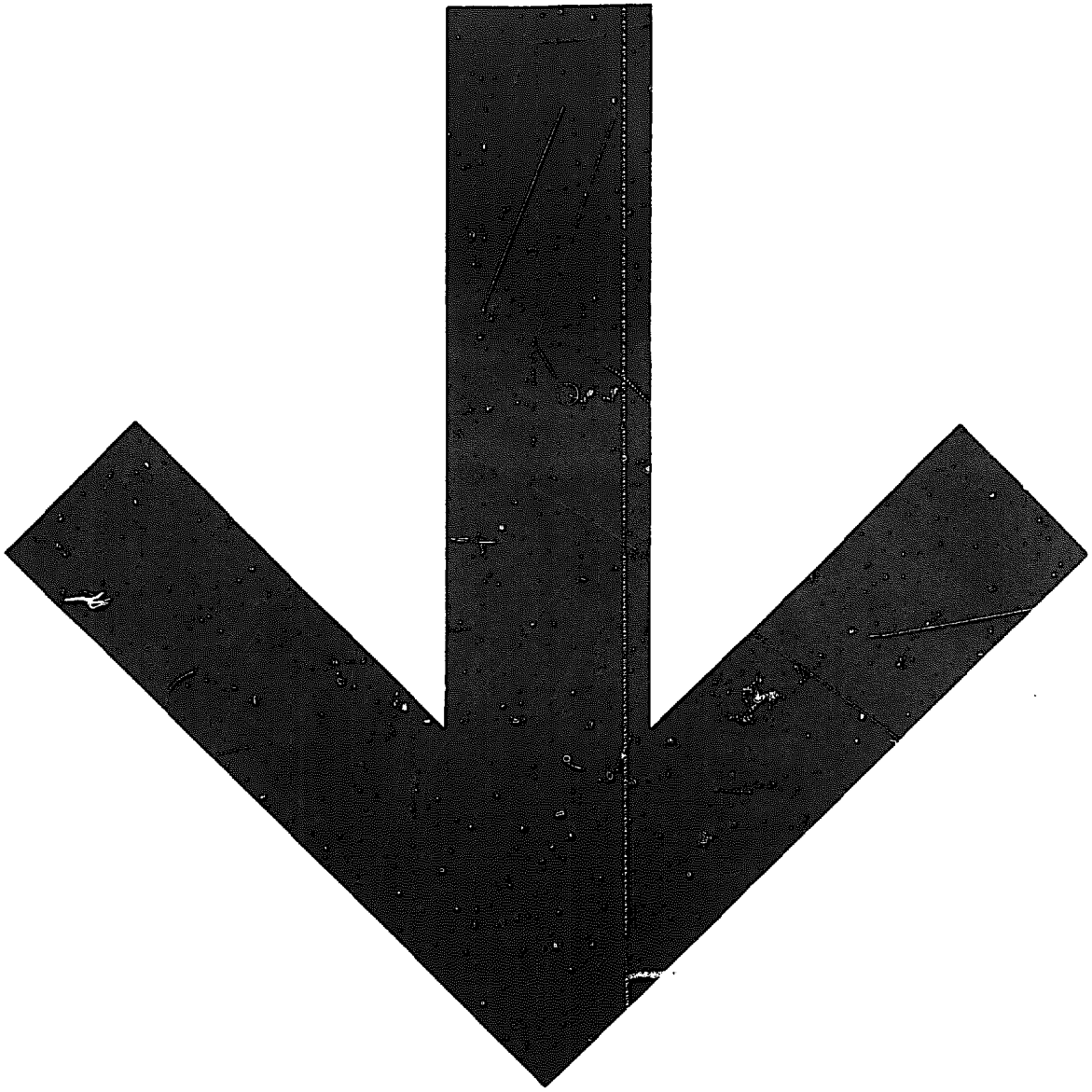

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I. Introduction

Background and purposes

Small-scale farmers, who form the vast majority of agriculturalists in developing countries, have received increasing attention from the agricultural research community in recent years. With the emphasis on raising the production of small farms has come a recognition that weed control stands as one of the most important factors determining small farm yields. Research in this field has burgeoned; as an illustration, 189 of the 298 references cited in this bibliography were published after the beginning of 1976.

This bibliography was initiated by the Weed Control Working Group of the Intermediate Technology Development Group (ITDG) as part of the ITDG agriculture programme. It represents the first attempt to compile literature describing appropriate technologies for the control of weeds on small farms. It does not pretend to include all the relevant literature on the subject (this is an impossible claim for any bibliography); rather, its purpose is to guide the reader through the range of weed control techniques that have been documented and to indicate the scientific workers and institutions currently active in this field of research.

It is increasingly recognized that weed control techniques for the small farm cannot be studied in isolation, but must be seen and studied as an integral part of the farming system. Besides providing information on low-cost tools and techniques for weed control, it is hoped that the references in the bibliography may provide the reader with insights into the kinds of social, economic and environmental factors which influence the choice of techniques to use, as well as demonstrating some of the methods used to study the relationship of weed control to other aspects of small-scale farming systems.

II. Overview

Importance of weed control to small-scale farmers

Weed control is one of the principal factors determining crop production of small farms. Improved weed control often gives a substantial yield/ha increase in the absence of other improvements in farming practices (no. 51307)[1/]. Other 'improvements' such as the introduction of short-statured 'high yielding varieties' and increased fertilisation rarely increase yields if weed control is not improved simultaneously (Allan, 1968).

More land cultivated

Because weed control is often the operation with the highest labour demand in the cropping cycle, the amount of land one farmer[2/] can plant (in regions where land availability is not a limiting factor) is often restricted by the area that can be kept weeded. In these regions, improved weed control may enable an increase in the amount of land that one farmer can cultivate and thus an increase in the total yield of the farm (no. 51303). In other regions the time the farmer 'gains' from improved weed control may be devoted to the cultivation of additional crops or to more profitable off-farm employment (no. 11002).

This overview introduces many of the bibliography's key concepts and highlights some of the significant references therein.

[1/] Numbered references in the text refer to items in the bibliography; other references are listed at the end of this discussion.

[2/] The term farmer, used here, refers to the person or group of persons working a small farm, whether male or female or a family unit.

Choice of farming practice at each cropping stage affects control

Farming practices often affect weed growth and competition with crop, even if they are not operations carried out for the express purpose of controlling weeds. At every stage in the production of a crop--land preparation, planting, fertilisation, cultivation, harvesting--the farming practice used by the small-scale farmer is only one among several possible options. The farmer is thus, in effect, making a choice of technology, although it may be a very limited choice made within a complex framework of economic, social and environmental restrictions.

Individual farming practices occurring at each stage of the cropping cycle are dependent on the overall cropping system and, in practice, it is impossible to discuss a single stage in isolation. However, for purposes of this discussion, the cropping cycle has been divided into:

Stages of the cropping cycle

(1) Choice of crop, variety, and cropping system
(2) Land preparation
(3) Sowing and planting techniques
(4) Fertilisation techniques
(5) Weed control in the growing crop
(6) Water management techniques
(7) Harvesting techniques
(8) Sanitation--prevention of weed reproduction and spread
(9) Control of problem weeds

Factors influencing the choice of technique

For small-scale farmers, the choice of technique is influenced by its cost, in particular the initial investment required; its weed control value; its effect on crop yield; its labour requirements; its reliability; the availavility of required inputs; ecological considerations such as the need to conserve soil fertility and soil moisture; and social considerations such as the level of education required to use the technique and the adaptability of the technique to local tradition.

(1) Choice of crop, variety, and cropping system

Choice of crop and variety

To compete effectively with weeds, the crop must germinate and grow vigorously and form a foliar canopy rapidly. The use of crop varieties which compete well with weeds is especially important for small-scale farmers, who are often unable to practice adequate weed control. Traditional crop varieties usually compete well with weeds, but many commercial varieties are often poor competitors because they are selected for high yields in weed-free conditions rather than for the ability to compete with weeds. Moody (no. 54302) suggests that plant breeders should select new cultivars in the presence of weeds to produce 'weed-resistant' varieties for small-scale farmers; he also suggests (no. 14301) that small-scale farmers may be able to improve the 'weed-resistance' of their own crops by selecting seed from the most luxuriant plants.

Use of crops and varieties that suppress weed growth

Some workers have investigated the production of allelopathic crop varieties which inhibit weed growth (nos. 12301, 12302). Cultivars can also be selected for resistance to parasitic weeds (nos. 53101, 53102, 53111, 53112).

Allelopathic crops... resistance to parasitic weeds

Choice of cropping system

Weed control is only one of the many considerations involved in planning a cropping system. However, a pernicious and persistent weed problem may justify quite drastic temporary changes in a cropping system--it must be remembered that the economic benefit will not be confined to one crop but will be spread out over a number of future cropping seasons. Aspects of the cropping system which affect the control of weeds include the choice of crop rotation, the inclusion of a fallow period in the rotation, and the inclusion of an intercrop.

Crop rotation

Rotation of crops with different production requirements keeps down weed growth by not allowing a buildup of weeds ecologically adapted to one crop. For example, paddy rice is often grown in rotation with upland crops (nos. 21001, 21002, 53101, 53102) or an

Use of crop rotation in weed control

early crop can be included in the rotation with a late crop (no. 23201). Rotation with 'catch' or 'trap' crops is often used to control parasitic weeds (nos. 53101, 53102, 53111). The inclusion in the rotation of a crop of intercrop with allelopathic residues may be able to reduce weed growth in a following crop chosen for its tolerance to the presence of such residues (no. 12303).

Fallow

Use of fallow in shifting cultivation

The inclusion of a fallow in the rotation may allow the natural suppression of arable weeds by ecological succession, as in traditional shifting cultivation systems (nos. 11001, 11008, and others indexed under 'shifting cultivation'), or may allow the farmer to carry out measures to reduce weed growth in subsequent crops. It is common practice to allow animals to graze fields during the fallow season in upland crops. In paddy rice, fish (nos. 22701-22705) or ducks (no. 22716) kept in paddy fields under a water fallow eat weed growth and large weed seeds and greatly reduce weed biomass in the following season. A water fallow (no. 53104) or rotation with paddy rice (nos. 53101, 53102, 53105) can be used to eradicate some species of Orobanche, which have seeds which cannot survive in flooded soil. A bare fallow, where weeds and rhizomes of perennial weeds are destroyed by repeated cultivations, is often used in semi-arid areas (no. 51401). One interesting technique, which has been used experimentally in Israel but is probably too expensive for most small-scale farmers in developing countries, involves using a transparent polyethylene mulch during the fallow season to heat the soil and destroy weed seeds (no. 53106).

Intercropping

Small-scale farmers often grow crops together (intercropping), rather than as monocultures (nos. 11008, 14402, 41104 and others indexed under 'intercropping'). Intercrops grown between plants of the principal crop help to smother or shade out weeds and reduce the weeding labour required. However, intercrops normally also compete with and somewhat reduce the yield of the principal crop. Thus, in choosing an intercrop it is necessary to balance the reduction in the economic return from the principal crop against the economic value and the weed control value of the intercrop.

Choice of intercrop

Weeds as intercrops

Small-scale farmers utilise many wild plants growing in their fields for food, forage or other household uses (nos. 12401-12404, 22801). These 'weeds' should be regarded as intercrops.

Annual intercropping systems

In annual cropping systems, intercrops are chosen to compete as much as possible with weeds and as little as possible with the principal crop. Thus crops with different growth habits are cultivated together to minimise intercrop competition for light and nutrients (nos. 14402, 41106, 51314, 54101). The low-growing 'smother' crops such as Egusi melon (Citrullus lanatus) and sweet potato effectively suppressed weeds in maize, cassava and yam intercropping systems in Nigeria without altering crop yields (nos. 44502-44504).

Intercrops in perennial crops

In perennial cropping systems, annual intercrops are often grown between young plants of the perennial crop (nos. 41101, 42208, 43102, 43104, 44301, 44302). Cover crops grown to smother weeds under perennial crops (nos. 41101, 42201-42207, 42210, 43101-43105, 44301, 54501, 54502) can often be used as forage during part of the year, and can also be regarded as intercrops (no. 42208).

Herbicides for intercropping systems

Since intercropping is common in developing countries and is an effective means of reducing weed and pest problems, workers developing herbicides for use by small-scale farmers should consider their use in crop mixtures. It is likely, of course, that any herbicide which is harmless to a mixture of unrelated crops will also be ineffective against a number of weeds, but resistant weeds could be controlled by supplementary handweeding. A few papers in the bibliography discuss the use of herbicides in intercropping systems (nos. 44502-44504, 51201, 51202, 51317, 53108, 54702).

(2) Land preparation

Weed control: one of the two main aims of land preparation

The two main objectives of land preparation are to prepare a seedbed and to control weeds. Much research has been devoted to the means of preparing land in the quickest, easiest and cheapest way possible, consistent with fulfilling these two objectives.

The two main techniques available for land preparation are first, tillage and/or cultivations, and secondly, minimum tillage techniques in which all or part of the tillage operations are replaced by the use of herbicides. A great variety of low-cost equipment is available for land preparation on small farms; a number of papers in the bibliography discuss and compare the cost, labour requirements and value for weed control of different types of tillage and cultivation equipment (nos. 11006, 12104, 22201, 51302, 52415).

Effect of climate on land preparation

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The climate has an important influence on the cropping system and thus on the technique of land preparation used.

In areas with a marked dry season, where planting is done at the beginning of the rainy season, timing of planting is often crucial, with early-planted crops giving much higher yields. But planting cannot be done until the land is adequately prepared, and conventional (hand or animal traction) tillage operations cannot begin until the ground has been softened by the first rains. Researchers have investigated three methods of speeding up land preparation and crop establishment in these circumstances:

(a) The tractive power available for tillage equipment can be increased so that tillage can be carried out in hard ground during the dry season. The 'Snail' (no. 52401) represents one attempt at designing a relatively low-cost piece of tillage equipment with high tractive power, although it would probably be too expensive for most small-scale farmers in developing countries.

(b) Part or all of the land preparation can be carried out at the end of the previous growing season, in semi-arid areas where very little weed growth occurs during the dry season (nos. 51105, 51305) or as soil moisture permits following dry-season showers (no. 51402).

Speeding up land preparation using improved equipment or herbicides

(c) Tillage operations can be reduced to the minimum consistent with adequate weed control. Some papers in the bibliography describe attempts to speed up tillage operations using the farmers' existing technology (nos. 22206, 22301, 51203, 51301). Other papers describe the replacement of conventional tillage by minimum tillage techniques based on the use of herbicides (nos. 11002, 21014, 22101, 22204, 44401, 51403, 51404, 52410).

In areas with year-round or seasonal high rainfall, conventional cultivations exposing bare soil encourage soil erosion and leaching. A number of minimal tillage systems have been developed for small farmers in these areas:

(a) In mulch tillage systems (nos. 41301-41307, 44501), weed growth is killed by slashing (traditional systems) or herbicides (improved systems) at the beginning of the season. The dead weeds form a mulch which minimises soil erosion and discourages further weed growth. Crop seeds are planted through the mulch. In a variant of this technique, a cover crop is sown following bush clearance. When the cover crop is established, it is killed with herbicide and the crop seeds are planted through the dead remains (no. 44504).

(b) In living mulch systems (nos. 41302, 42201, 44502-44504), the crop is sown directly in a living mulch of an established cover crop, without tillage or destruction of the cover crop. Alternatively, the crop is planted in strips along which the cover crop has been destroyed using herbicides. The cover crop helps prevent weed emergence and soil erosion.

Alley cropping systems

(c) In alley cropping systems, leguminous tree crops are planted parallel to the annual crop rows. These 'alley crops' are cut down at the beginning of the cropping season and their foliage is used as a mulch which controls weeds and soil erosion during crop growth (International Institute of Tropical Agriculture, 1980; Wijewardene, 1981; Ogborn, 1981).

Relay cropping systems

(d) In minimum tillage relay cropping systems, each crop is sown directly into the residues of the previous crop, without tillage. The crop residues serve as a mulch, reducing soil erosion and weed growth (nos. 41101, 54301, 54302).

Stale-seedbed technique

The use of the stale-seedbed technique to smooth out labour demand

The stale-seedbed technique is a special case of the use of tillage to control weeds. In this technique, primary cultivations are followed by a period in which weeds are allowed to germinate, after which they are destroyed by further cultivations or herbicides before sowing the crop (nos. 22102, 44501). The stale-seedbed technique can be useful where the peak labour demand occurs during crop weeding because by spending more time on controlling weeds before the crop is sown it reduces the time required for weed control while the crop is growing, thus smoothing out labour demand over the cropping cycle (no. 22301). It is clearly not suitable for crops which must be sown at the very beginning of the growing season, as are many staple crops in the semi-arid tropics.

(3) Planting

The choice of techniques for sowing and planting is affected both by direct effects of the planting method on weed growth and competition with the crop, and by the demands of the weed control technique to be used in the crop.

Weed emergence, growth and competition with the crop is affected by the quality of the crop seed, the planting date, the spacing of crop plants, and the use of transplanting.

Use of clean seeds

Quality of crop seed and planting material

Healthy crops clearly compete better with weeds than crops weakened by disease. Seeds and planting material should be free from disease and from contamination by weeds and weed seeds.

Timeliness of planting

Planting date

Timeliness of planting is important in weed control. Crops are normally planted as soon as possible after the beginning of the growing season to give them a 'head start' in competition with weeds,

except in the special case of the 'stale-seedbed' technique. Where the planting date is set back by the amount of time taken for land preparation, workers have investigated ways of speeding up land preparation (see previous section). At the extreme, land preparation and planting may be combined in a single operation: examples include the 'plough planting' technique used in some semi-arid areas (nos. 51203, 51301) and some mulch tillage techniques (no. 41304).

Spacing

Choosing correct plant spacing

Crops planted at close spacing compete more effectively with weeds (nos. 14301, 21001, 44103) but too close a spacing may decrease crop yield because of intracrop competition, lodging (no. 54301), etc. Where crop emergence is unreliable, it is not uncommon for farmers to ensure a good stand by sowing thickly and then thinning and weeding simultaneously to produce the desired plant population (no. 24002).

Transplanting and direct sowing

Transplanting gives better weed control

Sowing

Transplanted crops have a competitive advantage over weeds; clearly, the larger the transplanted seedling, the better it competes with weeds (no. 21002). Transplanting also allows the destruction of weeds germinating early in the growing season, before crop seedlings are transplanted. Weed growth is thus less in transplanted crops than direct-seeded crops; in rice, the amount of weed growth is an important consideration in deciding whether the crop should be transplanted or direct seeded (no. 22202). Ben-Nun (no. 51313) describes a low-cost method of speeding the transplanting operation in rice.

The requirements of the weed control technique to be used in the crop influence the choice of planting pattern and other aspects of planting techniques.

Planting pattern

Sowing in rows permits inter-row cultivation

Sowing the crop in rows reduces the time taken for subsequent weeding by allowing inter-row cultivation. Several low-cost animal-drawn row planters have been developed (nos. 52404, 52410, 52411).

A number of workers have recommended that crops be planted on the square ('checkrow planting') to allow two-way inter-row cultvations (nos. 21010, 52409, 53301, 53302). However, one author reported several drawbacks to the checkrow system; among these were the increased labour demand for checkrow planting at a time of peak labour need, and the increased silting up in two-way channels leading to shallow planting and weeds becoming established ahead of the crop (no. 51304). One paper in the bibliography gives a useful description of the technique of checkrow planting and the adaptation of an ox-drawn planter for checkrow planting (no. 52101).

Equipment for checkrow planting

Other aspects

Planters for mulch tillage systems

Special jab planters and rolling injection planters which can plant seeds through a mulch have been developed for use with mulch tillage systems (nos. 41302-41304, 44504).

(4) Fertilisation

Placement of fertiliser around crop plants or in the crop row gives the crop a competitive advantage over weeds in the inter-row (nos. 52201, 52202). Timing of fertilisation can be important; for example, in the production of rice, the application time for phosphate is crucial. "Applied before seeding in a dry seedbed, it encourages Echinochloa crus-galli and other weeds. Once rice fields are weed infested, however, phosphate applications made just before the rice is flooded for the first time will reduce weed competition" (National Academy of Scineces, 1968).

Timing of fertilisation

(5) Weed control in the growing crop

The principal techniques available for weed control in the growing crop are handweeding, cultivation, slashing, the use of mulches and cover crops, selective grazing and other biological control techniques, and the use of herbicides. The choice of techniques is dictated by a host of considerations mentioned in the following sections and in particular by the demands of erosion control, soil fertitliy and mositure conservation.

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In areas with year-round or seasonal high rainfall, clean weeding is inadvisable due to the danger of erosion and leaching of the exposed soil. In these areas, suitable weed control techniques include the use of mulches and cover crops and the use of herbicides. Slashing weeds is a low-capital, labour-intensive method of reducing weed growth in the inter-row of annual crops or beneath perennial crops (nos. 42207, 43105, 44303, 52201, 52202, 54502). It is less effective in controlling weed growth than are other techniques, but the roots and dead tops of the weeds left on the soil help to prevent soil erosion and water runoff.

Where there is no danger of erosion of exposed soil, weeds may be pulled by hand, uprooted with hoes and other hand tools, buried by 'earthing-up' (nos. 51314, 52402, 52406, 53301, 53302, 54101, 54601), or destroyed by cultivations. Geese have been used in the USA for selective weeding of grasses and sedges in broadleaved crops (nos. 12304, 12305).

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ultivations

Inter-row cultivation is normally less time-consuming than handweeding (nos. 44103, 54401) but demands row planting of the crop and can sometimes reduce yields by damaging crop roots (nos. 51307, 54102, 54302). Two-way cultivation can further reduce the time taken for weeding, but it demands time-consuming checkrow planting of the crop (no. 51304). The use of most cultivating equipment requires the crop to be planted in straight, parallel rows, which is sometimes difficult on small farms; to overcome this problem, some workers have developed high-clearance, straddle ridge cultivators which follow a single crop row at a time, weeding both sides of the row (nos. 52405, 52407).

se of
traddle ridge
ultivators

Where soil moisture is scarce, weed control is particularly important as weeds compete with crops for water, but cultivations may also increase water loss by disturbing the soil. In these conditions some workers have used sweeps or chisel ploughs, which carry out inter-row cultivations with minimal soil disturbance (nos. 51305, 51306, 52411-52413). Mulching is a very effective means of conserving soil moisture and suppressing weeds (more detail follows). Herbicides are also suitable for use in dry areas, but are relatively expensive, and little attention has been given to the problem of herbicide application for the small-scale farmer.

Timing of weeding operations

Timing: early and frequent weeding until canopy closure is advisable

Ideally, crops should be kept weed-free until canopy closure, after which the crop shades our further weed growth (nos. 44101-44103, 51204, 54105, 54201, 54302). Weeds are more easily mechanically destroyed when they are small, so a series of frequent, light cultivations may in the end demand less labour than a few infrequent cultivations. Druijff (nos. 11003, 52302) describes how the introduction of a light dutch hoe to replace the local heavy hoe ('jembe') reduced overall weeding time in Kenyan cotton farming by allowing early and frequent hoeing.

(6) Water management

A number of water management practices affect the control of weeds.

Use of flooding for weed control

Flooding is often used as a control measure for terestrial weeds (nos. 43105, 53104, 54202); anaerobic conditions in flooded soils inhibit germination of most weed seeds and destroy seeds of many species. Rotation of upland crops with paddy rice, paddy taro (no. 44102) fish or a water fallow inhibits the buildup of weeds adapted to either upland or paddy conditions (nos. 21001, 21002, 53101, 53102).

In paddy rice, precise manipulation of water levels can help reduce weed growth in direct-seeded rice (no. 22203) or can be used to control wild rice (no. 23202). Precise control of water levels is also required for the use of many herbicides in rice, but as this can rarely be achieved by small-scale farmers, some workers have developed herbicides and herbicide application techniques for rice under poor water management conditions (nos. 22601-22604).

Weed seeds can float down irrigation canals and infest irrigated crops. A 'trap' to clean irrigation water of weed seeds has been described (no. 12120).

(7) Harvesting

Most small-scale farmers save their own seed. Farmers may be able to improve local crop varieties themselves by selecting seed of vigorous competitive plants which are not attacked by parasitic weeds (see 'Cultivar selection').

Pre- and postharvest weed control measures

A number of important weed control operations are carried out at harvest time: roguing problem weeds just before harvest prevents them setting seed (nos. 23201, 53302). Burning or cultivating immediately after harvest prevents late-flowering weeds from setting seed (nos. 51305, 54204).

(8) Sanitation--weed prevention

Use of clean crop seed and clean equipment

A variety of measures can be used to prevent the spread and reproduction of weeds. Most farmers carry out some routine sanitation measures, including the use of clean crop seed and of clean tools and equipment.

Preventing weed seeds entering field boundaries or irrigation water

Weed seeds can enter fields in irrigation water or from weeds which are allowed to reproduce on field boundaries. A 'trap' to remove seeds from irrigation water has been described (no. 12120). Regular weeding of field boundaries is desirable but requires much labour; a new approach to this problem is demonstrated in the broad ridge and furrow farming system developed at the International Crops Research Institute for the Semi-Arid Tropics (no. 51311). In this system, boundary field bunds have been eliminated altogether, and farmers mark their property by the number of ridges owned.

Preventing weeds setting seed before and after harvest

Late weeding in the crop prevents weeds setting seed before harvest. Selective roguing of weeds which are taller than the crop can be done with herbicides, using a recently developed range of low-cost herbicide application equipment (nos. 12213-12216). Weeds setting seed after harvest can be destroyed by postharvest grazing (no. 51311), cultivations (no. 51305), or burning (no. 54204).

Fallow season cultivations and grazing

Repeated cultivation or grazing during the fallow season prevents annual weeds setting seed and weakens perennial weeds. In the USSR, fish farming rice fields under water fallow drastically reduced weed seed populations and weed biomass and increased rice yields in the following season (nos. 22702, 22704). Ducks have been used in a similar way in the USA (no. 22716).

(9) Control of problem weeds

Definition of problem weeds

'Problem weeds' can be defined as those weeds not adequately controlled by the farmers' routine weed control practices. Problem weeds include deep-rooted perennial weeds which are not easily removed by hand, some annual weeds (usually those which closely resemble the crop) and parasitic weeds. Aquatic seeds infesting irrigation systems may also present special problems for the smallholder.

Developing measures for control of problem weeds

Techniques for the control of problem weeds are developed on the basis of information from autecological studies about the lifecycle and ecological requirements of the weed. They are similar to the general weed control techniques outlined earlier. Where losses from a particular weed are severe, the entire cropping system may be modified with the aim of reducing its growth and reproduction. Suryatna and McIntosh (nos. 43104, 41101) developed two cropping systems which give good control of the perennial grass Imperata cylindrica, and Vergara et al (no. 23101) suggest a system for the control of the perennial sedge Scirpus maritimus in paddy rice.

Prevention of problem weed buildup

Monitoring population levels of problem weeds

Farmers and extension workers should look out for shifts in weed flora which may signal a buildup of particular problem weeds. For example, the annual grass Rottboellia exaltata can build up in maize where other weeds are controlled by atrazine. R. exaltata is easily controlled by selective handweeding when populations are low, but if allowed to build up can become a major 'problem weed' requiring much labour to eradicate (nos. 53301-53303, 54101, 54103). Similarly, Doggett (1970) states that farmers often allow Striga populations to build up to very high levels at which the weed is very hard to control, because low and moderate popu-

lations of Striga do not appreciably reduce sorghum yields. Better education and extension may prevent this kind of problem developing.

Perennial problem weeds

Methods of perennial weed control

Perennial weeds are often difficult for smallholders to uproot by hand and can present a serious problem if allowed to build up. The bibliography includes two references to traditional tillage tools which are said to aid in the control of perennial weeds (nos. 32002, 52303). The use of small quantities of expensive systemic herbicides (e.g., glyphosate) may be economic for the control of intransigent patches of perennial weeds; low-cost application equipment suitable for this purpose has recently been developed (nos. 12213-12215, 12217).

Annual problem weeds

Annual weeds can be a problem where herbicides are used and populations of herbicide-resistant annual weeds are allowed to build up (for example, Rottboellia exaltata in maize) or where the weed seedling is so similar to the crop seedling that it is missed in manual weeding or even transplanted in mistake for the crop (for example, Echinochloa spp. and wild rices in rice). Selective roguing of annual problem weeds is advisable to prevent them setting seed - this can be done by hand, or by the use of herbicides applied with a recently-developed range of low-cost herbicide application equipment (nos. 12213-12216, 12217).

Parasitic weeds

Controlling parasitic weeds on the small farm

Techniques available for the control of parasitic weeds have been extensively discussed in general terms (see section 5.31 of the bibliography). However, few workers have seriously studied the uses and limitations of these techniques on the small farm; an exception is the work of J.E.A. Ogborn in Northern Nigeria (nos. 53108-53110).

Aquatic weeds

In a special class of problem weeds are the aquatic weeds which infest canals and irrigation ponds used by smallholders. Control methods covered in the bibliography include low-cost equipment (nos. 13101-13103), the use of herbivorous fish (nos. 22701-22710), and finding uses for the aquatic weeds themselves so that harvesting the weeds becomes of economic value (nos. 12405-12407).

WEED CONTROL TOOLS AND TECHNIQUES

Weed control can be accomplished using a variety of techniques--alone, in combination or in rotational sequence. Various general and specialised items of equipment expedite weed control practice.

(1) Tools and implements

A wide range of hand tools, animal-drawn implements and (occasionally) motor-powered implements is used for land preparation and postplanting weed control on small farms. The development of a new weed control system often calls for the introduction of new weed control equipment. The bibliography contains a number of references which may help research and extension workers seeking to import, copy or design such equipment (see sections 1.21, 2.24, 2.25, 3.2, 5.23 and 5.24). They include catalogues listing manufacturers of agricultural equipment; descriptions and drawings of traditional tools and implements from many countries; and dimensional drawings and construction details for a few implements which can be constructed at a local level using only basic metal-working skills. Most references deal with hand hoes and other slashing tools, animal-drawn ploughs, cultivators, and multi-purpose toolbars.

References in the bibliography which describe weed control equipment

Attempts to improve local weeding tools may fail if extension workers underestimate the capacity of local farmers to make innovations; 'improved' equipment may already have been tried and rejected (no. 52301).

(2) Mulches and cover crops

Mulches inhibit weed growth as well as aiding erosion control and soil moisture conservation.

In situ mulching

Mulching with residues of crops or weeds left in situ

In some farming systems, dead remains of weed or crop plants left in situ function as a mulch. In mulch tillage systems, weeds or a cover crop grown for the purpose are killed by slashing or the use of herbicides and crop seeds are sown through the mulch (nos. 41301-41307, 42204, 44501, 44504). For minimum tillage relay cropping systems, each crop is sown directly into the residues of the previous crop, without tillage (nos. 41101, 54301, 54302). In trash mulching systems, fallen leaves and trash from perennial crops are left in situ or packed around crop plants (nos. 54202-54204).

Imported mulches

Comparison of materials for imported mulches

Mulches of organic or inorganic materials can be imported to supplement mulching materials available in situ, although transport and labour costs can be high. Several references compare the value of different organic mulches for weed control (nos. 42202, 42203, 42208, 53201, 54305, 54602). Inorganic mulches are probably too expensive for most small-scale farmers in developing countries; one interesting technique uses a transparent polyethylene mulch to heat the soil during the fallow season to temperatures which kill seeds of Orobanche and other weeds (no. 53106).

Cover crops

Use of cover crops

Cover crops or 'living mulches' are used (mainly in humid and subhumid areas) to suppress weeds, prevent erosion and, in the case of legume covers, to provide additional nitrogen for the crop. They can be planted under perennial crops (nos. 41101, 42202-42207, 42210, 43101-43105, 44301, 54501, 54502) or used as a 'living mulch' for annual or biennial crops (nos. 42201, 42208, 44501-44504) which are sown directly into the established cover crop. However, finding a cover crop which will suppress weed growth but not crop growth is not easy; the most successful cover crops in this regard appear to be low-growing 'smother' crops such as Egusi melon (Citrullus lanatus) and sweet potato (nos. 44502-44504). Several references compare the value of different cover crops for suppressing weed growth (nos. 42202, 42203, 42206-42208, 43103, 54501).

(3) Biological control

Although most biological control campaigns are planned by specialists and carried out over a large area, some agents for the biological control of weeds can potentially be managed by the individual farmer, including domestic animals and certain other organisms.

Domestic animals

Goats, sheep and cattle can be used for unselective grazing of weeds under tree crops (nos. 43101, 43102, 44301, 53202) or during the fallow season. Geese have been used in the USA for selective grazing of grasses and sedges in broadleaved crops (nos. 12304, 12305) and in Bulgaria to control Orobanche in tobacco (no. 51307).

Other organisms

Indirect manipulation of environmental conditions

In some biological control techniques, farmers manipulate some aspect of the environment to encourage increased populations of the organisms which control weeds. For example, some tobacco farmers in Eastern Europe in autumn collect plants of Orobanche ramosa containing pupae of Phytomyza orobanchiae, an agromyzid fly which feeds on reproductive tissues of O. ramosa. They store the pupae over winter and release them in tobacco fields the following spring (no. 53101). Some rice farmers in Japan manipulate paddy conditions to maintain high populations of tadpole shrimp, an organism which 'weeds' transplanted rice (no. 22712).

A number of aquatic organisms have been used to control rooting and floating weeds in irrigation systems and in paddy rice, including herbivorous fish (nos. 22701-22711), tadpole shrimp (nos. 22713-22715), crayfish (no. 12405), ducks (no. 12405) and snails (nos. 12405, 22711). Fish (nos. 22701-22705) and ducks (no. 22716) have also been used to reduce the number of weed seeds in flooded paddy fields during the fallow season.

Allelopathy

Use of allelopathic crops of crop residues

Recent research has identified new biological control techniques which may be of interest to small-scale farmers. Allelopathic cultivars of cucumber that inhibit weed growth have been developed (no. 12302), and it is thought that similar cultivars could be bred in other crops. Crop residues can also be allelopathic; the inclusion in the rotation of a crop or intercrop with allelopathic residues could reduce weed growth in a following crop chosen for its tolerance to the presence of such residues (no. 12303).

(4) Herbicides and their application

Herbicides may be useful on small farms

The situations in which herbicides may be useful for small-scale farmers have been discussed by Parker (1972), Ogborn (no. 51201) and Hammerton (1974), among others. In certain situations, herbicides may be used to replace labour, giving the farmer time to devote to additional crops, increasing the area under cultivation, or off-farm employment. Herbicides may also be used in wet soil where hoe weeding may 'transplant' rather than destroy weeds, in densely-planted crops, in terrain too rough or steep for other methods, or for certain weeds that are not easily controlled by nonchemical methods. However, herbicides can not completely replace other weeding techniques for small-scale farmers; supplementary handweeding will be needed to prevent shifts in weed flora and the buildup of resistant weeds that can only be controlled, if at all, by specialised and relatively expensive herbicides.

Special requirements of herbicides for use by small-scale farmers

Herbicides for use by small-scale farmers should be inexpensive, easy and cheap to apply, nontoxic (Ogborn, 1969) or, at the least, not toxic by absorption through the skin, and provided with warning colours, obnoxious smells, and/or emetics to guard against accidental consumption (Hammerton, 1974). Formulations must not demand much water in regions where water must be carried to the fields (no. 51201) and must require only simple calculations to be made by the farmer. Herbicides should be sold in small containers which farmers can afford and which reduce the risk of farmers decanting toxic chemicals into unlabelled containers. Herbicide application equipment should be cheap and easy to maintain, as well as safe.

Few existing herbicides and types of application equipment meet all the requirements outlined above. The most common type of herbicide application equipment in the tropics is the knapsack sprayer using conventional high volume spraying. The qualities of different knapsack sprayers have been compared (no. 12202); points to consider in selecting a knapsack sprayer are listed (no. 12218).

Suitability of low volume spraying

The conventional high volume knapsack sprayer is not suitable for use in areas where water for spraying has to be carried long distances by hand to the fields. Low volume nozzles have been fitted to knapsack sprayers by several companies (Wijewardene, 1981). Low volume, controlled drop application (CDA) sprayers are also suitable for use in these areas (nos. 12203, 12205, 51102, 51202), but CDA sprayers are not cheap, and calibration may be difficult for farmers unaccustomed to making this type of calculation.

Control of herbicide application rate

In CDA spraying, the amount of herbicide applied depends on the walking speed of the operator; a low-cost audible timer that aids accurate pacing has been described (no. 12204). Another approach to the problem of controlling herbicide application rates is the development of ground-metered sprayers based on peristaltic pumps (nos. 12206-12208).

Some work has been aimed at developing hand-held direct contact application (DCA) equipment, the so called 'weed wipers' (no. 12217).

In the May & Baker 'shaker bottle' technique for weed control in paddy rice (no. 22604), the container itself functions as a low volume herbicide applicator. This technique meets many of the requirements of small-scale farmers: small packaging, cheap and simple application equipment and a herbicide formulation using a low volume of water. However, it is only suitable for herbicide application onto standing water.

Suitability of granular formulations

Granular formulations of herbicide need no water and are easy to apply, taking advantage of farmers' existing skills in even broadcasting. However, they are usually more expensive than other formulations due to high transport costs. It is possible to reduce costs by making homemade granular formulations, although this reintroduces the problem of calibration. Formulations are made by spraying herbicide onto a granular 'carrier' such as sand or fertiliser (nos. 12210, 12211, 22603). The use and construction of an animal-drawn granule applicator which might be suitable for application of granular herbicides has been described (no. 12212).

Equipment for spot application

A range of cheap application equipment has recently been developed for spot spraying or spot wiping particular problem weeds. These include a 'water pistol' (no. 53109), a herbicide glove (no. 12216) and 'weed wipers' (nos. 12213-12215, 12217) which may be suitable for use by small-scale farmers.

Herbicides for intercropping systems

Development of herbicides for small farms cannot ignore the fact that many farmers practice mixed cropping. A few references in the bibliography describe the use of herbicides in small-farm mixed cropping systems (nos. 44502-44504, 51201, 51202, 51317, 53108, 54702).

(5) Cultivar selection

Research workers have developed crop varieties that grow vigorously and compete well with weeds, cultivars that are allelopathic and inhibit weed growth (nos. 12301, 12302) and cultivars which are resistant to parasitic weeds (nos. 53101, 53102, 53111, 53112). However, most small-scale farmers are not affected by improvements in commercial seeds because they do not buy seed, but save their own. In some cases it might be possible for farmers to carry out on-farm selection and improvement of crops. Moody (no. 14301) suggests that farmers could select seed from the most vigorous, competitive plants to produce crops which compete well with seeds. It might also be possible to train farmers to select seed from plants resistant to parasitic weeds; for example, Striga species stunt sorghum growth (Doggett, 1970), and cause chlorotic blotching (Parker, 1980) so it should be fairly easy to avoid saving seed from sorghum plants attacked by these species.

On-farm selection of seed from crops which are competitive with weeds and resistant to parasitic weeds

(6) Utilisation of 'weeds'

Utilisation of 'weeds' as a means of control

Many 'weeds' of smallholdings are used on the farm by the farming family as an integral part of the farming system, and a few may be sold. Thus these 'weeds' effectively function as intercrops. In recent research, the possibilities of increasing the utilisation and commercialisation of these 'weeds' have received increasing attention. A variety of uses for upland and aquatic weeds are listed (nos. 12401-12407, 22801, 41103, 42209).

Overview References

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Hammerton, J.L. 1974. Problems of herbicide use in peasant farming. Adaptation of a paper presented at the Feb. 1974 Annual Meeting of the Weed Sci. Soc. of America, Las Vegas, NV/USA. and published as IPPC Paper A/2.

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National Academy of Sciences. 1968. Weed Control, Principles of Plant and Animal Pest Control, Volume 2. N.A.S. Publication 1597, Washington, DC/USA.

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Ogborn, J. 1981. Criteria for the adoption of 'no-tillage' crop establishment by smallholders. Paper presented to a symposium on 'No-tillage Crop Production in the Tropics., Monrovia, Liberia, August 1981.

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Parker, C. 1980. Parasitic Weeds and Their Control in the Tropics. Weeds and Their Control in the Humid and Subhumid Tropics, 22-50, Proc. Conf., Ibadan, Nigeria, 1978, Proc. Series No. 3, Int. Inst. Trop. Agric., Ibadan, Nigeria.

Wijewardene, R. 1981. Conservation farming for small farmers in the humid tropics (Techniques and tools) IITA Sri Lanka Programme, Colombo, Sri Lanka. 20 pp.

Preparation

The bibliography and abstracting journals searched in the compilation oibliography are listed in Table 1. Additional items were drawn from an ad hoc manual search of the literature collections of the Intermediate Technology Development Group (Reading, UK), the International Plant Protection Center (Corvallis, Oregon, USA), and the Weed Research Organisation (Yarnton, Oxford, UK); as well as references in review papers. This produced a short list of about 1000 titles.

An effort was made to acquire and read every document on the short list, but this was not always possible, particularly for older documents. After reading the documents, 298 of them were selected for inclusion in the bibliography. A few abst icts were included in the bibliography without having read the original documents, where these could not be obtained.

TABLE 1

SOURCES SEARCHED TO COMPILE BIBLIOGRAPHY

A. ABBREVIATIONS USED IN TABLE

CAB - Commonwealth Agricultural Bureaux, Slough, UK
CAB (S) - Commonwealth Bureau of Soils, Rothamsted, UK
CAB (G) - Commonwealth Bureau of Field Crops, Hurley, UK
CBAE - Commonwealth Bureau of Agricultural Economics, Oxford, UK
FAO - Food and Agriculture Organisation of the United Nations, Rome, Italy
IRAT - Institut de Rechèrches Agronomiques Tropicales et des Cultures Vivrières, France
IRRI - International Rice Research Institute, Los Baños, Philippines
KIVDT - Koninklijk Instituut voor de Tropen, Amsterdam, The Netherlands
NIAE - National Institute of Agricultural Engineering, Silsoe, UK
USDA - United States Department of Agriculture, USA
WRO - Agricultural Research Council Weed Research Organisation, Yarnton, Oxford, UK

TABLE 1 (cont.)

B. ABSTRACTING JOURNALS SEARCHED

CAB - Weed Abstracts (WA) 1960-5/1981
CAB - World Agricultural Economics and Rural Sociology Abstracts (WAERSA).....1977-8/1980
CAB - Agricultural Engineering Abstracts (AEA).1976-4/1981
NIAE - Agricultural and Horticultural Engineering Abstracts (AHEA).....1951-1956, 1964-1966
FAO - Agrindex.....1975-8/1980
KIVDT - Abstracts on Tropical Agriculture (ATA)..1975-11/1980

C. BIBLIOGRAPHIES SEARCHED

WRO nos. 1,23,49,77,107,133...Control of Orobanchaceae, 1940-1979
WRO nos. 17,74,86,108,134.....Control of hemiparasitic Santanales and Schropulsriaceae, 1930-1979
WRO nos. 28,75,98,142.....Control of Imperata spp., 1954-1980
WRO nos. 32,51,100.....Control of Cuscuta spp., 1923-1976
WRO no. 33.....Control of Scirpus spp.
WRO no. 37.....Control of Cyperus rotundus and C. esculentus, 1968-1970
WRO nos. 84, 139.....Minimum cultivation, 1959-1979
WRO no. 85.....Weed control in upland rice, 1964-1974
WRO no. 93.....Control of wild Oryza spp., 1949-1976
WRO no. 94.....Weed control in jute and kenaf, 1955-1976
WRO no. 105.....Control of Rottboellia exaltata, 1955-1976
WRO no. 109.....Control of Eupatorium spp., 1956-1977
WRO no. 111.....Control of Mikania spp., 1960-1977
WRO no. 115.....Economics of weed control, 1967-1977
WRO no. 116.....Weed control in temperate and tropical crops, 1970-1977
WRO no. 127.....Weed control with herbivorous fish, 1957-1978
CAB no. 25.....Minimum tillage
CAB (S) no. 1565R.....Minimum and zero tillage, 1958-1972
CBAE.....Economics of plant protection, 1965-1971
CAB (G) nos. 335,335A,335B....Intercropping in the tropics and subtropics
CAB (G) nos. 278(1),278(2) 278(3).....Crop rotations in the tropics

Agricultural Index (H.W. Wilson Co., NY, USA) 1916-1961

Agricultural Engineering Index (compiler C.W. Hall) 1907-1970

Dictionary Catalog of the National Agricultural Library, USDA, USA, Vol. 70 1862-1965

IRRI. International Bibliography of Rice Research, 1951-1960, New York, Scarecrow Press, 1963

Ramos, M.M. International Bibliography on Cropping Systems, 1973-1974 and 1978, IRRI, Los Baños, Laguna, Philippines

Lee, S.A. Preliminary list of references on weed control in Malaysia, 1979

TABLE 1 (cont.)

Yana, M.A.; Basset, A. Elements de bibliographie maghrebine. In: Conference sur le problème des mauvaises herbes et les moyens de lutte, Tunis, 1969

IRAT. Les cultures associées: bibliographie, 1977

Riehl, S.; Kinch, M.; Wolff, A.E.; Khan, S.M.A.; Baker, R.; Deutsch, A.E. Bibliography of Dryland Agriculture, 3rd ed., 1980, Oregon State University, USA

Fisher, H.H.; Locatelli, E.; Anderson, C.; Chase, R. A partial bibliography of weed research and control for South and Central America, the Caribbean and Mexico, 1942-1976, IPPC, 2nd ed.

D. COMPUTER SEARCHES USED

USDA	AGRICOLA	Quick bibliography: 'Mulches'	1/1974-11/1978
USDA	AGRICOLA	Weeds and weeding in rice	
CAB	WAERSA	Weeding on smallholdings	1973-8/1980

Selection criteria

The bibliography focuses on weed control as an integral part of the farming system of the small-scale farm. Thus, papers dealing with new tools, herbicides and techniques of weed control were not normally included unless they contained a discussion of how such innovations fit into the small-scale farming system, or described trials on the small farm. For this reason, papers describing herbicide trials, experiments to determine the optimum timing of weeding operations for a particular crop, and similar research were normally excluded from the bibliography. It is hoped that readers will be able to obtain general information of this nature from the weed science texts listed in section 1.01 of the bibliography. An exception was made for papers describing novel techniques, such as the use of 'weed-wipers' or herbivorous fish to control weeds, which might have some application on small farms and which are not well known or often described in the international literature.

The text of the abstracts used in the bibliography came from several sources, as indicated by the letter at the bottom right-hand corner of each abstract (see: "Anatomy of an Entry" for a list of abstract sources).

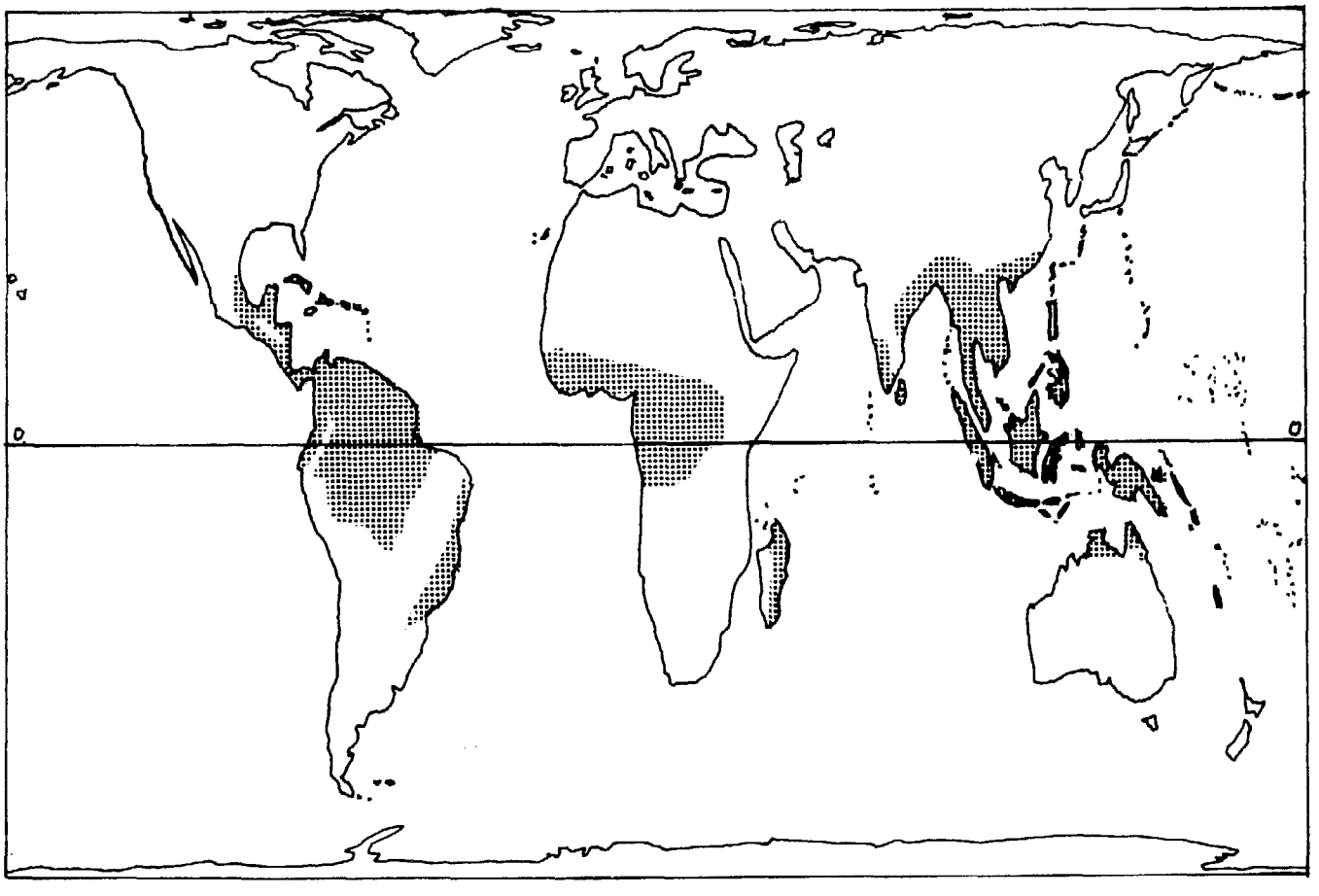
Reference classification

The emphasis of the bibliography is on small-scale farming systems and the introduction of innovations into farming systems. The references are therefore not classified by crop or by type of weed-control technology (e.g. herbicides, equipment, mulches) but by their relevance to different types of farming systems. The farming systems are broadly classified under the following ecological zones: paddy rice, highland and temperate zone, humid tropics and semi-arid tropics.

Most authors did not include climatic information about the site of their research, so the decision to allocate a reference to a particular ecological zone was normally based on the geographical location

of the research site, together with 'clues' in the paper such as the type of crops grown. There is no clear line dividing the extreme ('Semi-Humid') limit of the 'Humid Tropics' from the 'Semi-arid Tropics' - the border was arbitrarily delineated and is shown in Figure 1. When there was any doubt about how to classify a particular reference, or when it appeared to contain information relevant to farming systems in two or more ecological zones, it was allocated keywords for all the relevant ecological zones, or placed in the 'general' section.

Figure 1.
THE HUMID TROPICS



(Based on: The Geographical Review, Vol LI, 1961)

Included indexes

The bibliography contains four indexes (which follow the bibliographic listings) to help the reader search for references: a structured list of keywords; and alphabetical, item referenced lists of authors, institutions, and keywords. The alphabetic keyword list can be used to search for references describing weed control in a particular crop, geographical region, etc. The keywords used were arbitrarily chosen and the alphabetic keyword list contains no cross-referencing; instead, it is intended to be used in conjunction with the structured list of keywords. The structured list of keywords separates keywords into the following categories: Climatic Zone, Geographical Region, Crop, Weed Control System, Weed Control Technique, Equipment and Herbicides, Problem Weeds, Biological Control and Miscellaneous. To use the alphabetic keyword list, the reader should first find the appropriate keyword in the structured list of keywords.

Acquisition of cited documents

To help readers who cannot find documents locally, the bibliography lists for each reference an institution which will send a copy of the original document on request. The institution is indicated by the initials given at the bottom left-hand corner of each abstract:

CAB Commonwealth Agricultural Bureaux,
Farnham House
Farnham Royal
Slough SL2 3BN
UK

Photocopies of most periodical articles abstracted in one of the CAB abstracting journals can be provided on request. The abstracting journal and abstract number should be sited; in the bibliography this follows the letters CAB.

Example: CAB (WA 30-1111)
= Weed Abstracts, Volume 30, Abstract 1111
WA = Weed Abstracts
FCA = Field Crop Abstracts

The cost (as of August, 1981) is 25 p. per page sent overseas (by air); 20 p. per page for the United Kingdom, with a minimum order of £2 per item.

ATA

Abstracts on Tropical Agriculture
Koninklijk Instituut voor de Tropen
Department of Agricultural Research
Mauritskade 63
1092 AD Amsterdam
The Netherlands

Photocopies of any periodical article abstracted in ATA can be supplied on request at a cost (as of August, 1981) of Dfl. 0.75 per page.

WRO

The Library,
A.R.C. Weed Research Organisation
Begbroke Hill
Yarnton, Oxford OX5 1PF
UK

Photocopies of any article marked 'WRO' can be supplied at the same cost as photocopies from CAB (see above).

ITDG

Intermediate Technology Development Group
Agriculture Unit
A.R.S. Shinfield, Shinfield Rd.
Reading, Berkshire RG2 4AE
UK

Photocopies of articles marked 'ITDG' can be supplied on request. The cost (as of August, 1981) is 25 p. per page with a minimum order of £2.00 per mailing.

IPPC

International Plant Protection Center
Oregon State University
Corvallis, OR 97331
USA

IPPC offers a series of free reprints. Also, non-commercial institutions and individuals, working in a less developed country, qualify for a free copy of major IPPC publications as well as free photocopy service of other papers and publications. A schedule of charges for publications and related services applies in other cases.

Abbreviations used

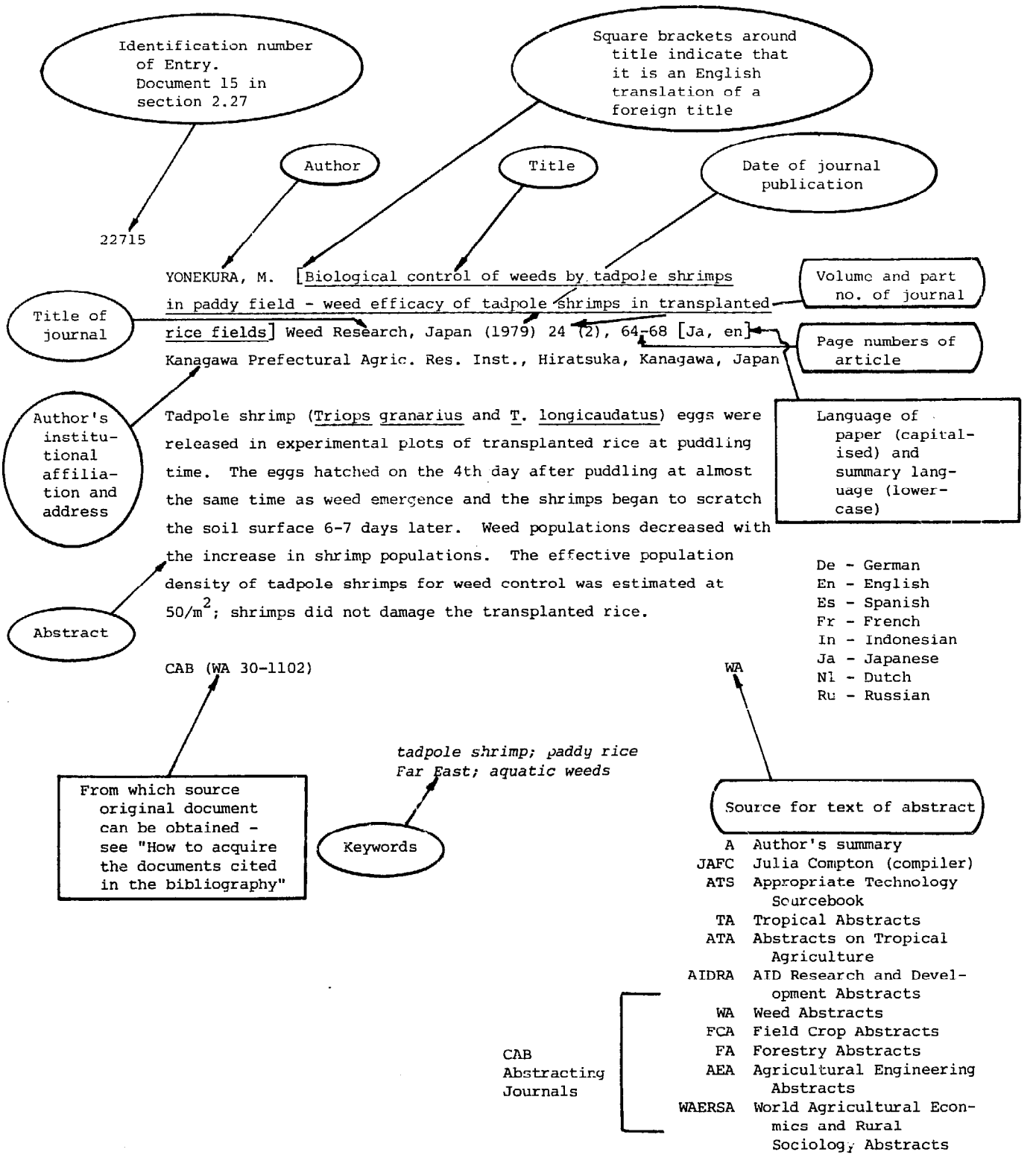
A.i.	active ingredient
Agric.	Agriculture, Agricultural, Agricole, Agrícola
Agron.	Agronomy, Agronmique(s)
Biol.	Biology, Biological
Coll.	College
De	German (Deutsch)
Dept.	Department
Dev.	Development
Div.	Division
D.M.	Dry Matter
En	English
Es	Spanish (Español)
Exp.	Experimental, Experimentation
Fac.	Faculty
Fr	French (Francais)
Govt.	Government
In	Indonesia
Inst.	Institute, Institut, etc.
Int.	International
Lab.	Laboratory, Laboratoire
Mach.	Machinery, Machinisme
Nat.	National
Nl	Dutch (Nederlands)
No.	Number, Numero, etc.
Pre-em.	Pre-emergence
Prot.	Protection
Rech.	Recherche(s)
Res.	Research

Ref.	Reference
Rs.	Rupees
Ru	Russian
Sect.	Section
Sta.	Station
Tech.	Technology
Trop.	Tropical(e)
Univ.	University, Universidad, etc.
Vol.	Volume

Anatomy of an entry

The bibliography contains over 300 references, each containing full bibliographic details including the author's institutional affiliation (in square brackets), an abstract, keywords, and letters indicating the source of the text of the abstract and one source of the original document. Where one author has written two or more closely related papers, only the first is abstracted and the others are cited below it under the heading: "see also -".

Figure 2.
IDENTIFICATION OF ENTRY ELEMENTS



PAGE 38

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1. GENERAL

1.01 Textbooks and reference works

Note: A few of the many good general texts on weed control have been included in this section for the use of readers who require background information or particular herbicide recommendations. For a complete listing of weed science texts, the Weed Science Publication List, published by the International Weed Science Society should be consulted (Int. Weed Sci. Society, c/o Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA).

10101

DEUSE, J.; LAVABRE, E.M. [Weed Control in Tropical Crops]. Désherbage des cultures sous les tropiques. Paris, France; G.P. Maisonneuve et Larose (1979), 312 pp. ISBN 2-7068-0756-3 [Fr] Techniques Agricoles et Productions Tropicales, XXVIII.

This text embodies the experience accumulated by French agronomists and weed scientists working in the tropics, particularly in West Africa, over the past 20 years. There are brief introductory sections on weed biology, crop losses, methods of weed control and herbicide classification and a more detailed chapter on application methods, giving particular emphasis to the use of hand-held CDA (Controlled Drop Application) sprayers.

There are then sections on each of the major (and some minor) tropical crops. As different authors have prepared different chapters, there is no standard method of presentation and the degree of detail varies considerably. In general, there is no attempt to define precise recommendations, but rather to indicate the range of problems in each crop situation and the main herbicide treatments available. There are comprehensive bibliographies at the end of each crop section and a selection of good colour illustrations of equipment, methods and results in a range of situations. Appendices provide useful lists of major reference books, weed floras, research institutes and a glossary of technical terms.

-- From the review by C. Parker (published orginally in the journal of PANS)

10102

GUPTA, O.P.; LAMBA, P.S. Modern weed control in the tropics and sub-tropics. Today and Tomorrow's Printers and Publishers, Desh Bandhu Gupta Rd., New Delhi - 110005, India (1978), 420 pp.

A valuable textbook including chapters on importance, classification and propagation of weeds; weed-crop competition; the principles of weed control; cultural practices for weed control; biological control of weeds; the uses of herbicides, their chemistry and action (9 chapters); and a chapter on the herbicide application equipment used in India. A further section (5 chapters) is devoted to weed control recommendations for a variety of crop and noncrop situations in India. Appendices include data on herbicides, lists of common and scientific names of Indian weeds, and sources of weed control equipment in India.

-- JAFC

10103

JOSHI, N. Manual of weed control. Research Company Publications, 75/1A, East Azad Nagar, Delhi - 51, India (1974), 362 pp.

Includes a short introduction, tables of common and Latin names of Indian weeds, an introduction to the uses and properties of herbicides, and tables showing recommended herbicides for use in various crop and noncrop situations. The main part of the book is devoted to an extensive list of herbicides with a discussion of the chemistry, properties and uses of each.

-- JAFC

10104

KASASIAN, L. Weed control in the tropics. Leonard Hill, London (1971), 307 pp. ISBN 0-249-44097-0.

Separate sections deal respectively with: general aspects of weeds and weed competition; basic methods of weed control; herbicides, and their classifi-

cation, properties, mode of action, formulation, application, persistence in the soil and residual effect in the plant; precautions in the use of herbicides and first aid measures; field experimentation techniques and statistical analysis of herbicide trials; specific weed problems; aquatic weed control; tree and brush control; vegetation control of uncropped land; and, soil fumigation.

There follows a collection of detailed reviews of the effect of weeds on and of weed control in some seventy of the most important tropical crops. Numerous references are provided at the end of each section and there are some excellent photographs. Appendices include selected bibliographies of useful publications, addresses of research centres and manufacturers, maximum permitted residues in tropical and subtropical crops in the USA, and tabulated details of crop responses to herbicides. There is a glossary and an index.

-- WA

10105

KRANZ, J.; SCHMUTTERER, H.; KOCH, W. (eds.). Diseases, pests and weeds in tropical crops. Verlag Paul Parey, Berlin (1977), 666 pp.

Pp. 543-616. Important weeds in tropical crops are listed, grouped by family. The importance and control (mainly by herbicides) of each weed is discussed.

-- JAFC

10106

IVENS, G.W. East African Weeds and Their Control. Oxford University Press, Oxford and Nairobi (1967), 250 pp.

220 important water weeds, grass and sedge weeds, woody weeds and herbaceous weeds of East Africa are listed. Each weed is described and illustrated, and its importance, distribution and methods of control are explained.

-- JAFC

10107

MERCADO, B.L. Introduction to weed science. Southeast Asian Regional Center for Graduate Study and Research in Agriculture, University of the Philippines at Los Baños (1979), 292 pp.

This volume has put together research data and other information on the biology of and damages caused by weeds under tropical conditions, particularly in Southeast Asia, involving such crops as rice, corn, legumes, vegetables, plantation crops, pastures, root and tuber crops, multiple cropping systems and aquatic resources. The book characterises over 70 weed species with a comprehensive study on the morphology, distribution, conditions for growth and methods of control of major species that are considered problematic in many Asian countries where rice is a principal crop. It compares the efficacy of different control methods under tropical conditions with emphasis on the timing of control treatments with respect to size of farm operation, economic status of the farmer, stage of crop growth, and a host of other environmental considerations.

The book also calls attention to the need for the enforcement of pesticide laws in Southeast Asian countries. It provides information on the toxicological requirements for herbicide registration.

-- From the foreword by J.D. Drilon, Jr.

1.1 REVIEWS AND REGIONAL STUDIES

11001

MOODY, K. Weeds and shifting cultivation. PANS (1975), 21(2): 188-194 [Int. Inst. Tropical Agric., Ibadan, Nigeria].

Traditional labour-intensive methods of weed control which are normally associated with shifting cultivation are briefly evaluated and compared with the use of herbicides and improved cultural practices. Problems that occur in shifting cultivation, such as weed seed dormancy, erosion and a changing weed population, are discussed. Suggestions are made for reducing these problems. A large bibliography on traditional farming systems in the tropics is appended.

CAB (WA 25-1136) JAFC

traditional systems; shifting cultivation; fallow

11002

LEWIS, C.J.; WATSON, G.A. Extension work with herbicides in the small scale tropical farm situation. In: Proceedings, 11th British Weed Control Conference, London, UK, British Crop Protection Council (1972), 1078-1083 [ICI Plant Protection Ltd., Fernhurst, Haslemere, Surrey, UK].

Minimum cultivation techniques have been widely adopted by small-scale farmers in the wet zone of Sri Lanka where, in waterlogged paddies often infested with Salvinia auriculata, a precultivation spray with paraquat has reduced the work of land preparation to a minimum and made double cropping possible. Minimum cultivation techniques based on paraquat are also used by small-scale farmers in Japan, Western Malaysia, South India and the Philippines. However, in an extension scheme carried out in 1969-1970 and aimed at introducing paraquat and 2,4-D to the farmers of the state of Orissa, India, most farmers adopting these herbicides were in the larger farm size group (10+ acres) and most repeat purchases came from this group. Socio-economic changes may need to occur if peasant farmers are to benefit from technological introductions of this type.

CAB (WA 23-1193) JAFC

novel systems; minimum tillage; herbicides; social analysis; aquatic weeds

11003

DRUIJFF, A.H. Weed control in small-scale tropical farming. In: Proceedings, 11th British Weed Control Conference, London, UK, British Crop Protection Council (1972), 458-465 [International Land Development Consultants, N.V. ILACO, P.O.B. 33, Arnhem, Netherlands].

The weed problems of some ILACO projects in developing countries are described together with the practical difficulties encountered in introducing new methods and tools. In two projects, six new hoe types were introduced and their efficiency compared with that of the local tool; farmers' attitudes to the new tools are also recorded.

CAB (WA 23-214) WA/JAFC

novel systems; hand tools

see also 52302

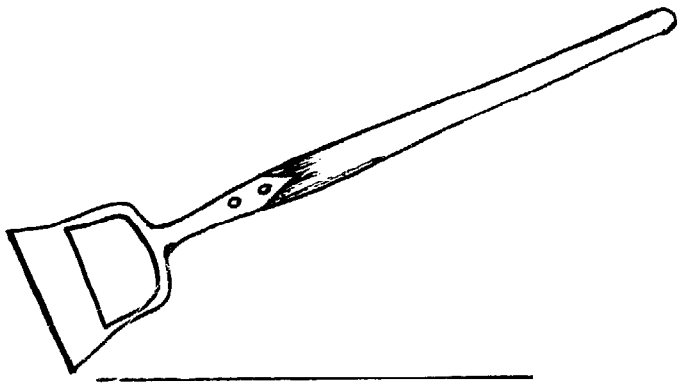


Figure 3. Dutch hoe, ref no. 11003, 32001

11004

AKOBUNDU, I.O. (ed.). Weeds and Their Control in the Humid and Subhumid Tropics. Proceedings of a Conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 1978 (1980). International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria, Proceedings Series No. 3, 421 pp.

Contains many review papers giving some information on cropping systems and weed control practices in Nigeria, Togo, Ghana, Ivory Coast, Sierra Leone, Senegal, Kenya, Tanzania, Uganda, Zambia, and Zaire, as well as papers discussing the economics of weed management in West African cropping systems, the economic constraints to introduction of weed control technology in Latin America, and the practical problems associated with introduction of herbicides to small farmers in West Africa.

-- JAFC

humid tropics; West Africa; East Africa; semi-arid tropics

11005

KLINE, C.K.; GREEN, D.A.G.; DONAHUE, R.L.; STOUT, B.A. Agricultural Mechanisation in Equatorial Africa. Institute of International Agriculture, College of Agriculture and Natural Resources, Research Report No. 6 (1969), 593 pp. 511 refs. [Dept. of Agric. Eng., Inst. Internat. Agric., Michigan State Univ., East Lansing, MI 48823, USA].

This lengthy report on agricultural mechanisation in tropical equatorial Africa is the result of detailed studies conducted in Ethiopia and Ghana, with additional visits to projects in the Gambia,

Ivory Coast, Kenya, Nigeria, Sengal and Tanzania. It encompasses hand tools, animal-drawn implements and motorised equipment. The report is divided into three parts. The first consists of recommendations and guidelines arising from the studies. The second, entitled 'A documentary field study,' includes the following section headings: 'general description of present farming systems in selected equatorial African countries' (a series of case studies of hand-, animal- and engine-powered systems), 'engineering and technical analysis of agricultural production operations' (including a discussion of tillage, pp. 2-166 to 2-197, and of weeding and intercultivation, pp. 2-222 to 2-238), 'analyses of present farming systems,' and 'introduction of improved technology and power into present farming systems.' The third part consists of a comprehensive list of references relevant to agricultural mechanisation in equatorial Africa, type of mechanisation (hand-, animal- or engine-powered), and keywords.

-- JAFC

West Africa; East Africa; traditional systems; hand tools; animal-drawn implements; motor-powered implements; manual implements

11006

CURFS, H.P.F. Systems Development in Agricultural Mechanization with Special Reference to Soil Tillage and Weed Control: A case Study for West Africa. Mededelingen, Landbouwhogeschool, Wageningen (1976), No. 76-5, 184 pp.

This study deals with mechanisation in West Africa. The principles and strategy of mechanisation are reviewed, and present cropping systems in West Africa are described in some detail. Some model studies on mechanisation are reported, which indicate the importance of soil tillage and weed control for most mechanisation levels. The weed growth effects of different tillage practices are reviewed, with emphasis on rice, and the results of a study on a number of manual and mechanical weed control practices in rice are given. Mechanical inter-row weeding of upland rice was not found to be very effective, and did not result in reduced labour requirements compared to manual weeding alone, when used in combination with manual weeding. The highest yields were obtained by chemical weed control methods, either alone or with supplementary handweeding, while the labour requirements were fairly low.

CAB (AEA 2-453) JAFC

semi-arid tropics; humid tropics; traditional systems; novel systems; hand tools; animal-drawn implements; motor-powered implements; upland rice; land preparation; inter-row cultivation; West Africa; herbicides

11007

AKOBUNDU, I.O. Weed control in Nigeria. PANS (1979), 25(3)287-298 [Int. Inst. Tropical Agric., PMB 5320 Ibadan, Nigeria].

This paper reviews the major weeds of field crops and the status of weed control in relation to crop production practices in Nigeria. A brief review of traditional methods of weed control is followed by a discussion of more recent approaches to the problem of weed control in cereals, food legumes and root crops.

CAB (WA 29-1507) JAFC

West Africa; traditional systems; novel systems; cereals; grain legumes; root and tuber crops

11008

MIRACLE, M.P. Agriculture in the Congo Basin: Tradition and Change in African Rural Economies. University of Wisconsin Press, Madison, Milwaukee and London (1967), 355 pp. Library of Congress Catalog No. 67-26628.

A comprehensive review of studies on the agriculture of the Congo Basin, including some original field data. Agricultural systems of the region, including 12 classes of tropical long-fallow systems, ash fertiliser-dependent long-fallow systems, compost-dependent systems, and short-fallow systems, are outlined. Agricultural operations and the way they interlock are described in as much detail as is available in the original studies. Tools mentioned are illustrated. Weeding operations are described for each agricultural system when the information is available. The weeding value of such practices as site selection and clearance practices is recognised by the author. The book emphasises the great

diversity of cropping systems which may evolve to cope with very similar ecological situations and that the amount of weed growth is one of the crucial factors in selecting one cropping system over another.

-- JAFC

Central Africa; traditional systems; shifting cultivation; fallow; hand tools intercropping

11009

AKOBUNDU, I.O. Economics of weed control in the African tropics and sub-tropics. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1980), 911-920 [IITA, PMB 5320, Ibadan, Nigeria].

A review briefly covering weed control methods used in field crops in Africa, labour use in field crops, and giving the results of a trial studying the economics of weed control using hoe weeding and herbicides in Nigeria. In many parts of Nigeria, the opportunity cost of the farmer's time is high and the farmer prefers using herbicides to hiring labour to using family labour for weeding.

CAB (WA 30-3766) JAFC

West Africa; economic analysis; social analysis

11010

ALKAMPER, J. [General problems with weed control in Ethiopia]. (Paper at Symposium Arbeisgruppe Unkrautprobleme Warmer Klimate im Arbeitskreis Herbologie der DPG, Stuttgart-Hohenheim, 1972). Berichte aus der Abteilung für Herbologie an der Universität Hohenheim (1972), No. 3, 81-92 [De, en] [Tropeninst., Justus Liebig-Univ. Giessen, German Federal Republic].

Current weed control practices in field crops and scope for development of improved techniques are discussed. Handweeding is very labourious, and herbicides are too expensive for the small farmer. Row planting with the local plough followed by intercultivations with the plough, the introduction of harrows and trials with granulated herbicides are recommended.

CAB (WA 22-7) A

East Africa; traditional systems; novel systems

11011

INTERNATIONAL PLANT PROTECTION CENTER, USA. Terminal Report, Weed Control Systems for Representative Farms in Developing Countries. Terminal Report, Agency for International Development/Oregon State University (1976), No. 18-C-76, 120 pp. [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

An investigation of weed control systems and policies in three ecologic and cultural zones - one in central El Salvador, and two in Northeast Brazil. The weed control systems were investigated to determine their effect on economic efficiency, employment and income distribution. Manual methods were most efficient for small farms producing beans, maize and sorghum. Chemical and mechanical control methods appeared more economical for cassava, sugarcane, and rice grown on larger farms. Evidence from El Salvador demonstrates that, under some conditions, efficient weed control methods can substitute for fertiliser. In areas of labour abundance, manual weed control methods are most economical and efficient in growing food crops on small farms operated by farmers with limited capital and low levels of training. More advanced weed control methods are economical on plantations and large commercial farms where labour costs are higher, capital and credit are more abundant and, generally, government subsidies and support prices are more favourable. Manual weed control methods are generally impracticable for wheat and rice. In situations where land itself is not limiting, the major factor determining how many hectares a farmer will plant is his ability to clear the land before planting and to keep the crop weeded. Adverse weather often delays manual weeding, resulting in yield losses. For the sugar plantations of Northeast Brazil and the large rice farms of central El Salvador, the least cost weed control method is consistently chemical when private prices are used, and manual when social prices are

used. The welfare of small farmers cannot be improved significantly by focusing only on a single problem, such as weed control. Government policies affecting inputs and outputs must be considered.

IPPC WA

Central America; Brazil; traditional systems; economic analysis; social analysis; Phaseolus; maize; sorghum

1.2 TOOLS AND TECHNIQUES

1.21 Tools and implements

12101

HOPFEN, H.J. Farm Implements for Arid and Tropical Regions. FAO Agricultural Development Paper (1969), No. 91, Food and Agriculture Organisation of the United Nations, Rome.

Brief descriptions and clear line drawings are presented for a wide range of tools and implements from many countries. Includes many implements (e.g., a range of ards) not covered in other works.

-- JAFC

hand tools; manual implements; animal-drawn implements; motor-powered implements

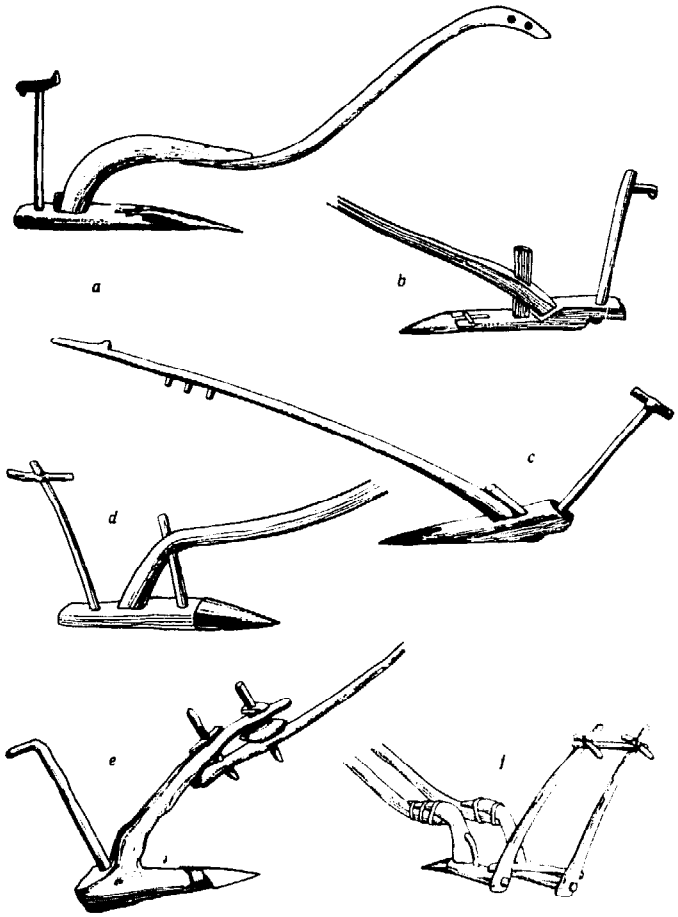


Figure 4. A series of sole ards: a) Pakistan; b) Afghan ard from Kabul Province; c) Nepal; d) Cyprus; e) Kurdistan, Iraq; f) double-sole ard, Syria. (FAO drawings). Ref no. 12101

12102

BOYD, J. Tools for Agriculture: A Buyer's guide to Low-Cost Agricultural Implements. Intermediate Technology Publications, London (1976), 2nd ed., 173 pp.

This guide describes commercially manufactured small farm implements which are available for use in developing countries and gives the names and addresses of the manufacturers. It contains information on hand-operated, animal-drawn and small engine-powered equipment, and supersedes the directory published by the Intermediate Technology Development Group (ITDG)

in 1973 under the title Tools for Agriculture: Guide to hand-operated and animal-drawn equipment. The information contained in this guide is based on that supplied by manufacturers. A photograph or line drawing and brief description of each implement are given. The book includes sections on equipment for tillage and cultivation (pp. 19-40) and for crop protection (pp. 51-91). Sickles and other slashing tools are included with harvesting equipment (pp. 105-106).

The guide is currently being revised and updated by ITDG.

ITDG JAFC

hand tools; animal-drawn implements; motor-powered implements; manual implements; herbicide application equipment

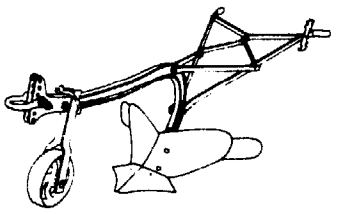


Figure 5. Ox drawn ridger. (ITDG drawing). Ref no. 12102

12103

BRANCH, D.S. (ed.). Tools for Homesteaders, Gardeners and Small-Scale Farmers. Rodale Press, Emmaus, PA, USA, and Intermediate Technology Publications, London, UK (1978), 512 pp. ISBN 0-87857-235-X.

This book, compiled by the editors of the USA journals Organic Gardening and New Farm, is partly based on Tools for Agriculture (no. 12102). It is principally written for small-scale farmers in the United States, but includes a mass of information on agricultural tool and implement manufacturers worldwide, some of it not included in the 1976 edition of Tools for Agriculture. A short description of each implement is given, based on information supplied by the manufacturers, with the manufacturer's address. This information is interspersed with informally-written articles on the design, use, handling and maintenance of some chosen pieces of equipment. The book includes sections on tools for cultivation (pp. 18-86), animal-drawn cultivation equipment (pp. 87-126) and on mulch spreaders (pp. 420-421).

-- JAFC

hand tools; manual implements; animal-drawn implements; motor-powered implements; mulching

12104

CENTRE D'ÉTUDES ET D'EXPERIMENTATION DE MACHINISME AGRICOLE TROPICAL (CEEMAT). The Employment of Draught Animals in Agriculture. English Translation, Food and Agriculture Organisation of the United Nations, Rome (1972), 249 pp.

This manual, originally written for agronomists and technicians in the French-speaking African states, was intended to be used in the preparation and conduct of animal draught mechanisation operations. It includes a detailed consideration of the draught animals available in Africa, the implements involved, the rural skills required to use the animals and implements to best advantage, and the economic aspects. Of particular relevance to weed control are the following sections: animal draught agricultural implements (pp. 73-78); soil preparation in rainfed farming (pp. 79-81); implements for working the soil while dry (pp. 82-124); equipment for the soil preparation of irrigated rice fields (pp. 125-139); equipment for weed control and crop protection (pp. 156-173); and a comparison of the time and cost of cultivation by hand, with draught animals and with power equipment (pp.226-234).

-- JAFC

semi-arid tropics; animal-drawn implements; economic analysis; West Africa; land preparation; inter-row cultivation

12105

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP. Agricultural Green Leaflets. Intermediate Technology Publications, 9 King St., London WC2E 8HN, U.K. (1973-1976) Price (1981): £0.75 each.

The following review is taken from the Appropriate Technology Sourcebook (eds. K. Darrow and R. Pam), Volunteer in Asia Publication, 2nd edition (1978), 304 pp., Stanford, California, USA:

The following plans, called 'Agricultural Green Leaflets,' are offered by ITDG. Most of these tools were designed for agricultural conditions in Africa.

These leaflets were originally intended for distribution to experienced agricultural engineers in the field, and the descriptive text is often brief. This is unimportant in most cases, but for some of the equipment the precise use is unclear to anyone unfamiliar with African agricultural practices. Construction details are quite easy for anyone to understand.

#4-Kabanyolo Toolbar, dimensional drawings, 5 pages.
MATERIALS: mild steel flat/pipe/bar/channel/angle/box section.
PRODUCTION: some welding.
Dimensional drawings with English and metric units. Simple but sufficient for local construction. Basically, this is a locally-built (and locally-repairable) steel plough that also functions as a cultivator/weeder. A simple skid is used instead of a depth wheel.

#5-Chitedze Ridgemaster Toolbar, dimensional drawings, 6 pages,
origin: Malawi.
MATERIALS: mild steel tube/bar/box/angle/ rod, 7" diameter castiron wheel.
Dimensional drawings with English and metric units. Simple but sufficient for local construction. This is a locally-built and repairable combination steel plough, ridger, and cultivator. "The unique design of this toolbar is that it combines lightness with adequate structural strength, the main parts being fabricated from rectangular hollow section mild steel."

#6-Prototype Multi-Purpose Ox-Drawn Tool, dimensional drawings, 3 pages, origin: Nigeria.
MATERIALS: thick mild steel, nominal bore pipe.
PRODUCTION: some welding, metal hole drilling, cutting flat steel along curves.
Dimensional drawings with English and metric units. Simple but sufficient for local construction. This is a prototype of a tool to be used for ridging, splitting ridges, cross-tying, weeding, and breaking capped soil in the furrows. The tool frame was designed with an offset beam to avoid blockage when lifting groundnuts. The share is adjustable to allow these different operations to be carried out.

#11-Ox-Drawn Tie-Ridger/Weeder Implement, dimensional drawings, 3 pages, origin: Malawi.
MATERIALS: steel pipe, flat steel, steel bar, angle iron, and an old plough disc.
PRODUCTION: some welding and metal bending.
Dimensional drawings with English and metric units. Fabrication is straightforward, and uncomplicated, requiring some welding. The instructions for field use are vague.
"This implement is an attachment only, designed for use with the 'EMCOT' ox-drawn ridging plow." It can be used for cross-tying during ridging, and for both cross-tying and weeding after ridging. Precisely what 'cross-tying' means is not made clear for anyone unfamiliar with the technique. Ridging and cross-tying, it is claimed, have resulted in substantial crop yield gains on certain free-draining soils in Africa. This attachment (with the EMCOT plough) cut the labour requirement for use of this technique in land preparation and weeding by an estimated "60% when compared with cultivation by hand."

#12-IDC Weeding Attachment for EMCOT Plow, dimensional drawings, 3 pages, origin: Nigeria.
MATERIALS: flat steel, sheet metal, thick high-grade steel, steel square bar.
PRODUCTION: some welding, cutting, and bending metal.
Dimensional drawings with both English and metric units. "This attachment enables weeding in ridged row crops to be carried out by animal power instead of by hand." However, this is only an attachment, to be used with the EMCOT plough. "The tool...can be adjusted for height, and also for width according to the row spacing. The sides of the ridges are remade by the ridger body following behind." Essentially, the attachment consists of two steel blades that are pulled along through the earth on the sides of the ridges.

#16-Rotary Weeder for Row-Planted Rice, photoprints, 1 page.
MATERIALS: metal angle/flat bar/ rod; 1/8" and 3/32" flat plate; wood handle.
PRODUCTION: some welding and hole cutting.
A single page with four photos. The rotary weeder is a very simple piece of equipment, only about 1½ feet long at

the base, with a long handle. Measurements are English units only. Two rotary, star-blade clusters are pushed along between two rows. A blade follows the two clusters.

#17-Multi-Action Paddy Field Puddling Tool, photoprints, 1 page, origin: Japan.
MATERIALS: wood frame, steel sheet, steel bars, 2" and 3" diameter pipe.
PRODUCTION: some welding, steel cutting, riveting.
Photoprints with English units only. Some imagination would have to be used by whomever would build from such plans. However, the basic principles are quite clear from the photoprints. Ox-drawn. Apparently, the farmer simply follows along behind, controlling the animal only. Some weights may need to be attached for effective use.

#31-IT Expandable Cultivator, dimensional drawings, 7 pages, origin: Nigeria.
MATERIALS: hardwood beams, mild steel plate/pipe/spring leaf.
PRODUCTION: a village blacksmith can make this with a forge, anvil, hammer, tongs, punch, and chisel.
Dimensional drawings with metric units only. Simple but sufficient for local construction. This design requires a lot of hole drilling or punching, and thus accuracy in measurement.

"A lightweight cultivator designed for weeding of crops planted in 70-90 cm spaced rows in sandy soils, to be pulled by one or two oxen or donkeys. Tines are individually adjustable for depth, making the implement suitable for flat or ridge cultivation." The width is also adjustable for the unit as a whole.

#33-IT High-Clearance Rotary Hoe, dimensional drawings, 7 pages.
MATERIALS: steel bars, metal water pipe, hardwood, some bolts.
PRODUCTION: some welding, metal bending, metal hole drilling. Dimensional drawings with metric measurements only; brief but sufficient.

"This animal-drawn implement is designed for seeding of crops grown on ridges at 75-90 cm spacing. It cultivates both sides of one ridge at a time and therefore, unlike cultivators drawn between the ridges, does not require straight and parallel ridges for efficient weeding....This implement is not suitable for use in very hard soil conditions. It can be used in wet soil and has been used successfully for weeding cotton while water was standing in the furrows."

#36-The Weeder-Mulcher, dimensional drawings, 3 pages, origin: India.
MATERIALS: wood beam, mild steel (flat, plate, rod and pipe), (2) 125 mm diameter metal wheels.
PRODUCTION: metal bending, cutting, drilling; welding optional.
Dimensional drawings with metric measurements. "This animal-drawn self-cleaning weeder was originally developed for use in sugarcane plantations (by the Indian Institute of Sugarcane Research). It is designed to destroy weeds, leave a mulch on the soil surface to conserve moisture and give a high work output per day (up to 5 or 6 acres of row crop work per 8 hour day). It can be used on most row crops with a spacing of 30 inches (75 cm) or more....The blades can easily be replaced by a village blacksmith."

see also nos. 52416, 54202

#41-Harrows: High-Clearance Peg Tooth (East Africa), Triangular Spike Tooth (India), Flexible Peg Tooth (Iran), and Japanese Harrow, dimensional drawings, 8 pages.
MATERIALS: hardwood, steel pieces for teeth, steel chain, eyebolts.
PRODUCTION: metal bending, cutting and drilling for two of the designs; only use of simple hand tools for the other two designs. Dimensional drawings with English and metric measurements. This leaflet is a combination of what were formerly offered as Agricultural Green Leaflets 7, 8, and 9. Construction is quite simple and evident from the drawings.

These harrows can all be pulled by animals. The function of a harrow is to prepare seedbeds by breaking soil clods, cover seeds after broadcast seeding, and control weeds. Several of these harrows are designed to leave weed residue on the soil surface to conserve moisture.

ITDG ATS

manual implements; animal-drawn implements

12106

CHEZE, B. [Weeding machines adapted to the levels of mechanisation in certain tropical countries]. Matérial de désherbage adapté aux niveaux de mécanisation de certains pays tropicaux. In: 3e Symposium sur le Désherbage des Cultures Tropicales, Dakar, 1978. 8, Av. du Président Wilson, 75116 Paris, France; Columa. (1978), Vol. II, 507-513 [Fr, en] [C.E.E.M.A.T., Parc de Tourvoie, 93160 Antony, France].

A review of the role of machinery in controlling weeds, from the ox-drawn hoe to CDA sprayers. The suitability of the latter to conditions in tropical countries, particularly in West Africa, is discussed.

CAB (WA 28-3836) WA

West Africa; animal-drawn implements; motor-powered implements; herbicide application equipment

12107

CENTRE D'ÉTUDES ET D'EXPERIMENTATION DE MACHINISME AGRICOLE TROPICAL (C.E.E.M.A.T.). [Cultivation of annual rain-fed crops with animal-drawn implements]. Cahiers d'Agriculture Pratique des Pays Chauds (1966), 2:103-112 [Fr] [C.E.E.M.A.T., Parc de Tourvoie, 93106 Antony, France].

Descriptions and diagrams are given of ox-drawn and ass-drawn implements suitable for cultivations in tropical crops, and their uses are explained.

CAB (WA 16-1085) WA

West Africa; semi-arid tropics; animal-drawn implements

12108

MENGESHA, A.H.; LEE, B.; ZEWGE, A.H.Y. Domestic implements of Ethiopia. A brief survey of hand tools, household and farming implements of Harar Province. Imperial Ethiopian College of Agriculture and Mechanical Arts (1960).

Largely concerned with household implements, but includes a number of drawings and informal descriptions of hand tools and ox-drawn implements for land preparation and weeding.

-- JAFC

East Africa; hand tools; animal-drawn implements

12109

ISHIHARA, A.; ABWALLI, A.; ARBABI, S. Farm implements in Iran. Agricultural Mechanization in Asia (1977), 8(4):59-63 [Agric. Mach. Inst.; Fac. of Agric., Tottori Univ., Kozan-cho, Tottori, Japan 680].

Brief descriptions of some traditional Iranian farm tools and implements are given, including spades, digging hoes and digging hooks, ploughs, multipurpose implements, intercultivation implements, sickles, forks and rakes. Photographs and line drawings are included.

ITDG JAFC

Middle East; hand tools; animal-drawn implements

12110

ALI, N.; PATRA, S.K.; LALL, R.R. Catalogue of Improved Agricultural Tools, Implements and Equipment of India. Central Institute of Agricultural Engineering (ICAR), Bhopal, India (1979), 192 pp. [Indian Council for Agricultural Research (ICAR), Nabi Bagh, Berasia Road, Bhopal, M.P., India].

Agricultural tools and implements developed and available in India are described individually under the following headings: function, specifications, where developed, test results (suitability for crops and soils, work rate, labour requirement), approximate cost, general information, and address of manufacturer (in India).

Of particular relevance to weed control are the following manually-operated tools: interculture tools (pp. 19-28); plant protection equipment (pp. 29-34); the following animal-drawn implements: tillage implements (pp. 47-60); interculture implements (pp. 77-78); and the ultra-low

volume sprayer (p. 101). A detailed line drawing, with measurements, is given for each implement.

-- JAFC

Indian subcontinent; hand tools; animal-drawn implements; herbicide application equipment

12111

APPROPRIATE TECHNOLOGY DEVELOPMENT ASSOCIATION (INDIA). Appropriate Technology - Directory of Tools, Equipment, Machines, Plants, Processes and Industries. (1977), 280 pp. [Approp. Tech. Dev. Ass., Post Box 311, Gandhi Bhawan, Lucknow 226001, U.P., India].

This directory of equipment includes the following tools and implements of relevance to weed control: double hoe with three prongs, seedbed leveller, spade, weeding hoe (pp. 3-8); multi-purpose hand-operated implement (pp. 23-24) and a paddy transplanter (pp. 29-30).

The use and operation of each implement is explained and a method of constructing it is described in detail, aided by clear line drawings with measurements (in inches).

-- JAFC

Indian subcontinent; hand tools; manual implements; motor-powered implements; animal-drawn implements

12112

INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR). Indigenous Agricultural Implements of India: An All-Indian Survey. Indian Council of Agricultural Research, New Delhi (1960), 401 pp.

A catalogue of the indigenous agricultural implements of India based on a country-wide survey. Following a chapter on the geographical features of the states participating in the survey, and another discussing the parts and uses of ploughs, the work catalogues the ploughs (pp. 53-128), harrows (pp. 128-174), hoes (pp. 175-228), sowing devices, clod crushers, rollers, levellers, ridgers, and harvesting implements in use in different states.

For each implement, a photograph and line drawing (with measurements) is accompanied by a listing of English and local names, states and districts where used, manufacturers and sources of availability, materials used, implement weight, operating power, cost, service life, usage, method of use, whether repaired locally or otherwise, annual maintenance charges, work rate, cost of operation per acre, season of use, total number of working days in year, percentage of farmers using it, country of origin, and other remarks. Apendices give tables of comparative cost, weight, power required, cost of operation, etc. for representative types of ploughs, harrows and hoes.

-- JAFC

Indian subcontinent; hand tools; manual implements; animal-drawn implements

12113

TRACTOR TRAINING CENTRE. Guide to selected improved hand tools. [Guide prepared] for the participants of [the] International Agricultural Machinery Manufacturing Development Clinic (A joint UNIDO-India project), New Delhi, October 1974 (1974), Bulletin Series 11 (Preliminary Issue), 32 pp. [Audiovisual Aids Sect., Govt. of India, Tractor Training Centre, Hissar, India].

27 common Indian hand tools and implements are roughly illustrated, with brief notes on their use, material of construction, maintenance requirements, cost in Rs and availability. Includes hoes, khurpa, kudali (= local short-handled weeding hoes and forks), rakes, 'spades' (= mattock or heavy hoe), hand ridgers, a jute seed drill, hand dusters and sprayers, shears, sickles, and harvesting and threshing equipment. A list of Indian manufacturers of agricultural equipment, by state, is appended together with the names of hand tools supplied.

-- JAFC

Indian subcontinent; hand tools; manual implements; herbicide application equipment

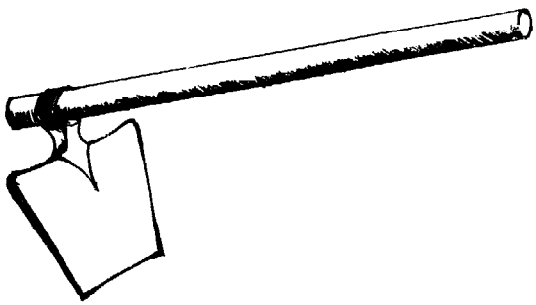


Figure 6. Heavy hoe (mamooty). Ref no. 12113, 54401.

12114

TRACTOR TRAINING CENTRE. Guide to selected animal operated implements. [Guide prepared] for the participants of [the] International Agricultural Machinery Manufacturing Development Clinic (A joint UNIDO-India project), New Delhi, October 1974 (1974), Bulletin Series 12 (Preliminary Issue), 37 pp. [Audiovisual Aids Sect., Govt. of India, Tractor Training Centre, Hissar, India].

32 common Indian bullock-drawn implements are roughly illustrated (line drawings) with brief notes on their use, material of construction, adjustment in use, maintenance requirements, cost in Rs and availability. Includes country and mouldboard ploughs, ridger ploughs, cultivators, harrows, a puddler, a green-manure trampler, seed drills, a (manual) paddy weeder, a 'persian wheel' (for irrigation) and a thresher. A list of Indian manufacturers of agricultural equipment. by state, is appended together with the names of animal-drawn implements supplied.

-- JAFC

Indian subcontinent; animal-drawn implements; manual implements

12115

RASTOGI, R.A.; MITTAL, J.P. Performance of some improved implements compared to some conventional implements. Indian Journal of Agricultural Economics (1975), 30(2):54-61 [Dept. of Agric. Engineering, Coll. of Technology, G.P. Oant Univ. of Agric. and Tech., Pantnagar, District Nainital, India].

Six improved implements, including the bullock-drawn paddy puddler and the hand-operated planet junior for interculture operations (both described and pictured in no. 51313) were compared with local implements in trials on the fields of farmers with small and medium size holdings in eight districts of Uttar Pradesh. The study concludes that the paddy puddler and planet junior improve weed control and reduce human- and bullock-hours over the traditional implements (deshi hal plough and Khurpi or Kudali (short-handled weeding hoes and forks), respectively).

Additional profits accrued from the use of the improved implements means that their cost can be recovered by using them on less than one hectare of land.

CAB (AEA 1-72) JAFC

Indian subcontinent; animal-drawn implements; economic analysis

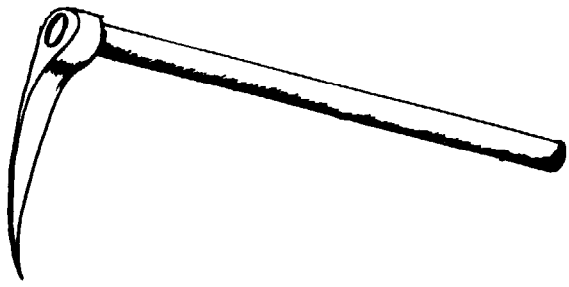


Figure 7. Indian kudali. Ref no. 12115

12116

HORIO, H. Farm tools in the "Nogu-Benri-Ron". Intensive hoe-farming during the Edo period in Japan. Tools and Tillage, (1974), 2(3):169-185 [595, Omiya-Chō, Fushimi-Ku, Kyoto-Shi, Japan].

This paper describes some of the farm tools which appear in the 'Nogû-Benri-Ron' (Treatise on Farm Tools) written in 1817. Each tool is illustrated by a line drawing, with measurements, and its use is described in the context of the two farming systems of the period, hoe tillage and animal tillage. Both traditional tools and 'improved, labour-saving tools' of the period (e.g., a double-bladed plough for inter-row cultivation) are included.

ITDG JAFC

Far East; hand tools; animal-drawn implements

12117

MA, F.C.; TAKASAKA, T.; YANG, C. A Preliminary Study of Farm Implements Used in Taiwan Province. Chinese-American Joint Commission on Rural Reconstruction, Plant Industry Series: No. 4, Taipei, Taiwan, China, 2nd ed. (1958), 326 pp. Plant Industry Division, Joint Commission on Rural Reconstruction.

Part 1: Study of Taiwan Farm Implements Pp. 18-22 Variations in structure of Taiwan farm implements and variations in size, shape and usage of hoes and harrows in different districts of Taiwan are tabulated and discussed.

Part 2: Description of Taiwan Farm Implements
Local and introduced farm implements are individually describedunder the following headings: cost, weight, usage, operating power (number of persons or animals), material, season of use, service life, method of application, work rate, origin and additional observations. A line drawing of each is given, with measurements. Of particular relevance to weed control are the following sections:

(1) manual implements: land preparation (pp. 53-73), intertillage (pp. 100-128), plant protection (pp. 158-168)
(2) animal-drawn implements: land preparation (pp. 259-300), intertillage (pp. 301-308)
(3) mechanical-powered implements: land preparation (pp. 327-329), plant protection (p. 331).

ITDG JAFC

Far East; hand tools; animal-drawn implements; motor-powered implements; herbicide application equipment

12118

SAR, T., VAN DER. [The use of scythe and machete for mowing grass]. Het gebruik van zeis en houwer bij het maaien van gras. Surinaamse Landbouw (1974), 22(1):40-43 [Nl] [CELOS, Paramaribo, Surinam].

This study reports data on the working times and physical workload of a labourer mowing grass stands of different ages, using several types of scythes and the traditional Suriname machete. On flat ground, the scythe is quicker and demands less stooping; but on rough ground or where many creepers are present, the machete is to be preferred.

CAB (WA 25-1124) ATA

northern South America; hand tools slashing

12119

KULKARNI, S.D.; SIROHI, B.S. Effect of improved sickle on field capacity and wheat harvesting drudgery. Agricultural Mechanization in Asia (Summer 1980), 71-74 [Agric. Eng. Div., Indian Agric. Res. Inst., New Delhi 110012, India].

The improved 'Krishi Udyog' sickle was compared with traditional sickles in trials of field performance and worker satisfaction. The Krishi Udyog sickle was more efficient and generally preferred, although female workers had some complaints about its handle. It could not be used efficiently by left-handed workers. Dimensional drawings of a local sickle and the improved sickle are included. Although this study concerned the use of sickles for harvesting wheat, it is possible they could also be used for slashing weeds in certain situations.

ITDG JAFC

Indian subcontinent; hand tools slashing

12120

MARIE, P.; GRILLARD, K.; SEGUY, S.L. [A "trap" for weed seeds in rice fields]. In: 2e Symposium sur le Désherbage des Cultures Tropicales, Montpellier, 1974; organisé par.... COLUMA, 8 av. du Président Wilson, 75116 Paris, France; Comité Francais de Lutte contre les Mauvaises Herbes (1975), 142-145 [Fr, en] [Lab. du riz, Sta. d'Amélioration des Plantes, Centre Rech. Agron., 34 Montpellier, France].

The principle of a relatively simple 'trap' to catch seed brought into rice fields by irrigation water is explained and problems discussed. A diagram of the

trap is included. The control of Echinochloa spp. in particular is the object of the experiment but, once perfected, the 'trap' could be used for other weed species.

CAB (WA 25-894) A

weed seed source reduction; irrigated crops; paddy rice; annual problem weeds

see also Weed Seed Screens for Irrigation Systems, PNW Bulletin 43. 1961, prepared by W. Bergstrom. Profusely illustrated, this 8-page leaflet describes various simple weed screens and their construction. (Photocopies available through IPPC).

1.22 Herbicides and herbicide application

see also nos. 12102, 12106, 12110, 12113, 12117

12201

MATTHEWS, G.A. Pesticide Application Methods. Longmans, New York (1979), 335 pp. [Overseas Spraying Mach. Centre, Imperial Coll. Field Station, Silwood Park, Ascot, Berks, UK] £20.00 (1981 UK price). ISBN 0-582-46054-9.

This is an expensive but comprehensive, lucidly written and well illustrated book on all aspects of pesticide application. After a discussion on the formulation of pesticides and movement of spray droplets, the main part of the book comprises detailed descriptions of the various types of application equipment available, with discussions on their use. A chapter is devoted to hand-operated hydraulic sprayers, another to dust and granule application, and another to the techniques of controlled droplet application (CDA). The final chapters deal with the maintenance of equipment, safety precautions, and the selection of the right machinery for the right job. Includes two tables comparing spraying times (including time spent fetching water) and operating costs of conventional knapsack sprayers and hand-carried CDA sprayers. The book includes over 500 up-to-date references and an excellent index.

-- JAFC

herbicide application equipment; herbicide application (high volume); herbicide application (low volume); herbicide application (granules)

see also BINDRA, O.S.; SINGH, H. Pesticide Application Equipment, Oxford and IBH, India (1977), 2nd ed., 464 pp. [Punjab Agricultural Univ., Ludhiana, India] Describes application equipment with particular reference to India.

12202

FRASER, F.; BURRILL, L.C. Knapsack sprayers: Use, Maintenance, Accessories. International Plant Protection Center, Corvallis, Oregon (1979), Document 29-A-79, 31 pp. [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA] (1981 price - $3.00).

Hand-held and knapsack sprayers are described together with use (knapsack sprayers), functions and types of nozzles. Extensive information and construction details are provided for constructing multi-nozzle booms. There are notes on calibration, safety precautions, pesticide storage and disposal, and application problems.

IPPC WA

herbicide application equipment; herbicide application (high volume)

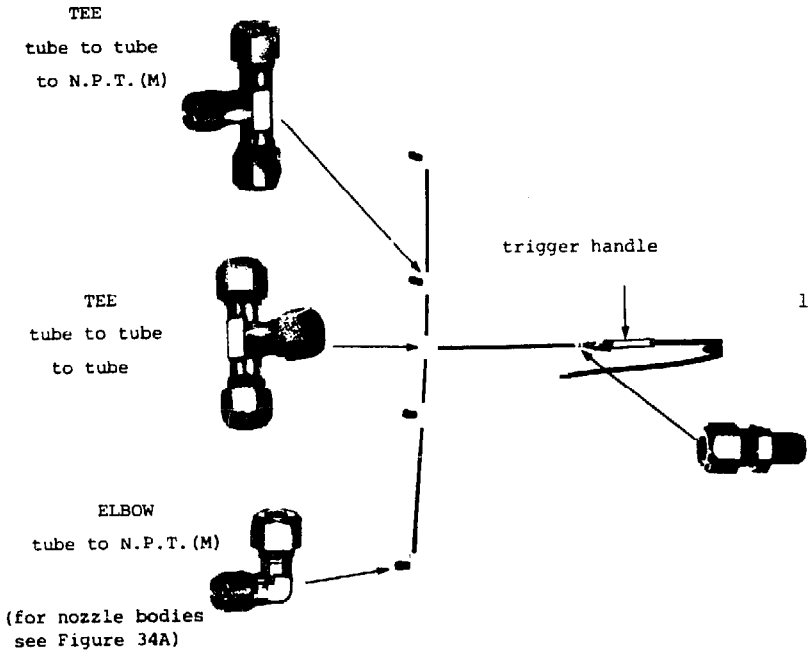


Figure 8. A diagram for constructing a multi-nozzle boom. (IPPC illustration). Ref no. 12202.

12203

MATTHEWS, G.A. Taking the work out of spraying. Appropriate Technology (1976), 3(3):4-6 [Overseas Spraying Mach. Centre, Imperial Coll. Field Sta., Silwood Pk, Ascot, Berks SL5 7PY, UK].

The use of the ultra-low volume sprayers for pest and weed control, in areas where the limitation to conventional spraying is water scarcity, is described; with diagrams.

ITDG JAFC

herbicide application equipment; herbicide application (low volume)

12204

ARNOLD, A.C.; THORNHILL, E.W. An aural aid to govern walking speed. PANS (1979), 25(1):71-72 [Imperial Coll. Field Sta., Silwood Park, Ascot, Berks SL5 7PY, UK].

A simple, lightweight, low-cost audible timer is described which aids accurate pacing when a portable controlled drop sprayer is being used. A circuit diagram and photograph of assembly are given.

CAB (WA 29-4301) WA

herbicide application equipment; herbicide application (low volume)

12205

MINISTRY OF AGRICULTURE AND WATER AFFAIRS, DEPARTMENT OF AGRICULTURE, ZAMBIA. Annual report of the weed control research and extension team, 1979. Mt. Makulu Research Station, P.O. Box 7, Chilanga, Zambia (1980), 58 pp.

Pp. 7, 51-58. CDA herbicide applicators. Turbair 'Forester,' Micron 'Handy' and Micron 'Herbi' sprayers were tested using Primagram 500 FW (atrazine + metolachlor). In the laboratory, satisfactory rates of herbicides were delivered by each sprayer assuming a 1 m swath width. Altering the angle of the sprayer (and hence the head of liquid) significantly affected the output. The spray pattern from all 3 sprayers was somewhat eccentric. In the field, all 3 gave good weed control in maize. At wind speeds of 80 m/min some drifting occurred. The 'Forester' produced the most drift and the 'Handy' was considered the best applicator for the small farmer in Zambia.

CAB (WA 30-415) WA

Southern Africa; herbicide application equipment; herbicide application (low volume)

12206

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE, IBADAN, NIGERIA. Annual Report, 1975. (1976) 219 pp. [PMB 5320, Ibadan, Nigeria].

P. 62. Weed Control and Herbicide Applicators. The possible advantages to West African farmers of a 'wheelbarrow' or 'peristaltic-pump' type sprayer for conventional high volume herbicide application are discussed. These include the possibility of local

manufacture, which would make them much cheaper than knapsack sprayers imported from the USA, shields of variable width mounted on either side of the nozzle for inter-row spraying, and an adaptation for use on ridged crops. The advantages of ultra-low volume and controlled drop application equipment are also discussed.

CAB (WA 26-865) WA

West Africa; herbicide application equipment; herbicide application (high volume); herbicide application (low volume)

12207

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP. Polyrow Peristaltic Pump Sprayer. ITDG Complete Technical Drawings #23, dimensional drawings, no text, 3 large sheets, 1972, Intermediate Technology Publications, 9 King St., London WC2E 8HN, UK (1981 price - £2.25).

Dimensional drawings with English units. This hand-pushed unit is designed so that the single large wheel pumps the liquid by means of rollers that compress a plastic hose. This action takes place only while the unit is actually moving. The drawings are clear enough, but the lack of any explanatory text is a limitation. Good if you already understand the principle of the peristaltic pump. Some substitution of materials would be possible.

ITDG ATS

herbicide application equipment

12208

CHOUDHURY, M.S.; OGBORN, J.E.A. Towards the development of a ground-metered, shrouded, controlled droplet herbicide applicator (GMSD-CDA). In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979. London, UK; Commonwealth Secretariat (1980), 43-47 [Dep. Agric. Eng., Inst. Agric. Res., PMB 1044, Zaria, Nigeria].

The GMSD-CDA applicator was designed in Nigeria to overcome the difficulty of controlling the Herbi hand sprayer. The sprayer consists of a peristaltic pump and shrouded Herbi disc head powered by batteries, the pump compounded with a ground wheel for metering the spray solution; the shroud facilitates the collection and recycling via the pump of surplus spray. The average spray rate was 0.763 ml/m and the swath width constant. The sprayer head performed best at an angle of 45° to the horizontal. At the maximum efficient disc loading of 1.5 ml/s, the maximum ground speed was 0.83 m/s at a spray volume rate of 10 litres/ha on 90 cm ridges; the forward speed was about 1.2 m/s. Tests showed that the maximum disc capacity should be increased to 3.6 ml/s. The minimum application volume to ensure adequate plant cover with 250 mm droplets was 10 litres/ha. Postemergence application in growing crops reduced the forward speed to 1 m/s. Herbicides were selective at 10 litres spray volume/ha, but left visible crop damage at heights up to 30 cm, indicating a necessary change in the disc configuration for post-em. application.

CAB (WA 30-1264) WA

herbicide application equipment herbicide application (low volume)

12209

GARNETT, R.P. A low-volume herbicide applicator for tropical small-holder farms. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1980), 629-636 [Overseas Spraying Machinery Cent., Imperial College, Silwood Park, Sunninghill, Berks SL5 7PY, UK].

A wheelbarrow sprayer suitable for use on smallholdings in the tropics is described. Two peristaltic pumps, driven off the ground wheel, deliver the spray liquid to a Micromax spinning cup, giving an application volume of 20 litres/ha. The swath width is controlled by a shroud mounted around the cup with two variable shutters. Patternator tests show a variation across the swath of 10-25% over a range of walking speeds and flow rates for a swath up to 1.5 m. Above this width the swath has the horned pattern characteristics of spinning discs and hollow-cone nozzles. The sprayer has performed successfully in trials under laboratory conditions and in the field and has provided weed control similar to that obtained with knapsack sprayers.

CAB (WA 30-1995) WA

herbicide application equipment; herbicide application (low volume)

12210

ZAHRAN, M.E.; IBRAHIM, T.S. Improved application technique for chemical control of barnyard grass in transplanted rice. PANS (1975), 21(3):304-307 [Arig. Res. Centre, Min. of Agric., Orman Giza, Cairo, Egypt].

Two field trials were carried out at Hamoul in the Nile Delta to test the effectiveness of 12 herbicides for the control of Echinochloa crus-galli in transplanted rice cv. Giza 170. In the 1972 season, granular were superior to liquid formulations. In 1973 and 1974, a herbicide + gypsum (hydrous calcium sulphate) mixture was broadcast by hand on flood water. All herbicide applications were superior to one handweeding.

To make the granular formulations, the appropriate rate of herbicide was mechanically mixed with sand or 50 kg/feddan of gypsum (1 feddan = 4200.83 m^2 = 1.05 acres) to produce very fine granules.

CAB (WA 25-1493) WA/JAFC

herbicide application (granules); herbicides; paddy rice

12211

ZAHRAN, M.K.; IBRAHIM, T.S.; EL-MAGHRABY. A new approach towards easy application for cotton herbicides in Egypt. In: Proceedings, 13th British Weed Control Conference, London, UK, British Crop Protection Council (1976), 159-163 [Weed Control Res. Sect., Plant Prot. Inst., Agric. Res. Centre, Min. of Agric., Egypt].

Trials in Egypt in 1976 showed that granular herbicide/superphosphate mixtures gave good selective weed control in cotton, while reducing the labour involved in more conventional treatment methods, since incorporation was not necessary. To make the granular formulations, the appropriate rate of commercial formulation of herbicide (fluometuron, trifluralin, dinitramine and penoxalin were used here) plus a small quantity of water were mixed thoroughly with the desired rate of superphosphate fertiliser by hand. The granules were applied by hand while still moist.

CAB (WA 26-2185) WA/JAFC

herbicide application (granules); herbicides; cotton

For homemade granular formulations, see also no. 22603

12212

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP. Agricultural Green Leaflets. Intermediate Technology Publications, 9 King St., London WC2E 8HN, UK (1981 price - £0.75).

#30-IT Granule Applicator, dimensional drawings, 14 pages, origin: Nigeria
MATERIALS: mild steel sheet, water pipe, reinforcing rod.
PRODUCTION: welding.
Dimensional drawings with both English and metric units. Some of the drawings are not very clear, but the unit should be reproducible. The materials and dimensions can be altered to fit local conditions.

There is a metering mechanism in place of a mechanical weeder. These plans include a calibration chart for the applicator at various flows and row spacings.

ITDG ATS

herbicide application equipment; herbicide application (granules)

12213

DALE, J.E. A non-mechanical system of herbicide application with a rope wick. PANS (1979), 25(4):431-436 [USDA-SWSL, Stoneville, MS 38776, USA].

A nonmechanical system of applying herbicides to weeds taller than crops by a simple rope wick device is described. The herbicide applicator requires no pumps or moving parts to deliver the herbicide, and can be built by the farmer at a very low cost. Selective control

of Johnsongrass (Sorghum halepense) in soyabeans with glyphosate was demonstrated in two experiments under field conditions.

CAB (WA 30-1270) A

herbicide application equipment; perennial problem weeds; weed seed source reduction; herbicides

12214

DALE, J.E. Application equipment for Roundup - the rope wick applicator. In: Proceedings of the Beltwide Cotton Production Conference, 3rd Cotton Weed Science Research Conference, January 1979, Phoenix, Arizona, USA. 8 pp. [USDA-SWSL, Stoneville, MS 38776, USA].

The initial development of the rope wick applicator is described. Details for construction of one of the early models are given and the materials needed are listed together with sources of supply (in the USA). The unit consists of a reservoir boom which can be made from a number of materials including wood and bamboo, and soft nylon 'marine' rope wicks held into holes in the front of the boom by inert glue or rubber grommets. Results of three experiments demonstrating selective control with glyphosate of tall weeds in soyabeans and pastures are tabulated.

-- JAFC

herbicide application equipment; perennial problem weeds; weed seed source reduction; herbicides

12215

DALE, J.E. Specialized equipment for on-target application of herbicides. Paper presented at the Working Group Conference on Determination and Assessment of Pesticide Exposure, Harrisburg, Pennsylvania, USA, October 1980. 10 pp. [USDA-SWSL, Stoneville, MS 38776, USA].

This paper briefly describes advances in herbicide application techniques and some of the special equipment developed since 1970 for on-target application of herbicides, including: recirculating sprayers, controlled droplet applicator (spinning disc) sprayers, hooded sprayers, roller applicators, the Stoneville wiper, solenoid-equipped sprayers and plant sensors, and the rope wick applicator. Of these, the controlled droplet applicators (see nos. 12203-12206, 12208 and 12209) and rope wick applicators may be of interest to smallholder farmers in developing countries. A number of companies now make and sell hand-held 'home-and-garden' rope wick applicators.

New equipment has also been developed for the precise placement of herbicides in soil, including the 'emulsifiable paste injector' and chemical-laden string (CLS). The use of CLS to apply pesticides is a new concept developed by J.E. Dale (U.S. Patent Application No. 082-326). Biodegradable string laden with chemicals is dispensed from a reservoir that contains a pool of string immersed in the chemical solution. As the CLS is dispensed from the reservoir, it is placed in a slit or shallow trench in the soil. The string may be placed in the furrow with seed at planting, beside planted rows and established plants, or in a ring around individual plants. A hand tool designed for application of CLS is illustrated.

-- JAFC

herbicide application equipment; perennial problem weeds; weed seed source reduction

12216

HOLROYD, J. The herbicidal glove - a new concept for the localised application of herbicides to weeds in susceptible crops. In: Proceedings of the North Central Weed Control Conference (1972), Volume 27, 74-76 [A.R.C. Weed Res. Org., Yarnton, Oxford OX5 1PF, UK].

The development and use of a glove for the localised application of nonselective herbicides to weeds are described. Results of trials using dalapon 10% wt/vol. to control wild oats (Avena spp.) in cereals are given. (UK Patent 1282002)

CAB (WA 23-2731) WA

herbicide application equipment; perennial problem weeds; weed seed source reduction

For low-cost equipment for spot-spraying weeds, see also no. 53109

12217

COOPER, A.S.; FRASER, F.; BURRILL, L.C.; DEUTSCH, A.E. Hand-held wiping devices for herbicide application. IPPC Paper #A/8 (1981) [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

The use of rope wicks as a means of applying herbicides is now an established commercial practice in U.S. agriculture. The technique selectively applies glyphosate to tall growing weeds rising above the crop canopy. International Plant Protection Center staff members, as well other researchers, recognized that the concept also holds promise for use on small farms in developing countries. Prototype hand-held versions of rope wick and carpet wipers were designed, constructed, and tested, particularly for between-row weed control. Effective weed control was achieved, but accompanied by an unacceptable level of injury to small maize and bean plants. Results indicate that various hand-held, wiper-type applicators, when properly used, may provide small farm operators with an alternative method of applying herbicides that reduces hazards to man and the environment while lowering capital costs below those of conventional application techniques.

IPPC A

novel systems; hand tools; herbicide application equipment; herbicides

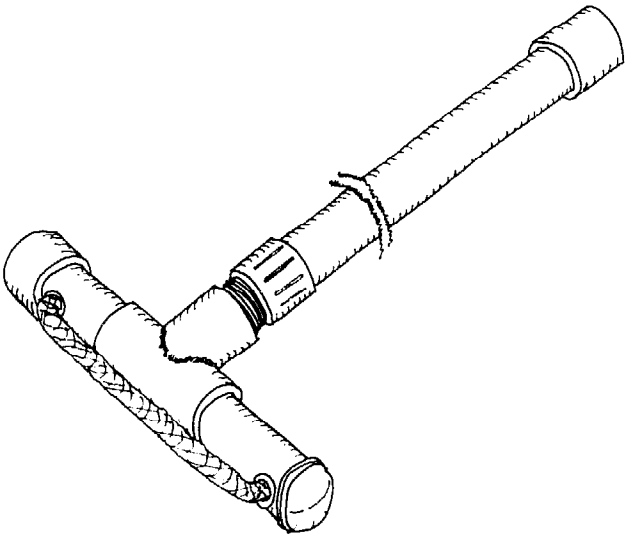


Figure 9. Prototype hand-held DCA "wick wiper". (IPPC drawing). Ref no. 12217.

12218

DEUTSCH, A.E. So you're considering a knapsack sprayer. IPPC Paper A/7 (1981) [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

The characteristics of a knapsack sprayer are defined and a comprehensive list of checkpoints, for use in selecting a unit, are presented. Most of the world's manufacturers of knapsack sprayers are listed, including address.

IPPC A

herbicide application equipment

12219

HAMMERTON, J.L. Problems of herbicide use in peasant farming. IPPC Paper A/2, adapted from a presentation at the 1974 annual meeting of the Weed Science Society of America [Caribbean Agric. Res. and Devel. Inst., Bridgetown, Barbados].

Herbicides can assist peasant farmers through: increasing yields from improved and more timely weed control; releasing labor from the time consuming drudgery of manual weeding to devote more attention to additional crops or increased acreage; providing more time to seek supplemental

income. Ignorance of the losses caused by weeds, a fatalistic acceptance of weeds, and the tedium of hand control--allied with a lack of cash for purchase of spraying equipment and herbicides--impede increased herbicide use by peasant farmers. Where family labor is available, there may be little inducement to spend money on weed control materials. Use of herbicides alone may be uneconomic unless the entire system of production is improved. Errors in herbicide use may have serious consequences on family diet and income. Improved education and extension services and provision of credit, are steps toward solving some of these problems. Dribble bars and granular formulations can simplify application and reduce overall costs. A single herbicide, suitable for all the crops grown in an area, would be the ideal; it need not possess a wide weed spectrum but should control major weeds during critical periods of growth.

IPPC A

traditional systems; herbicide application (low volume); economic analysis; social analysis

12220

DEUTSCH, A.E.; POOLE, A.P. (eds). Manual of pesticide application equipment, Int. Plant. Prot. Center (1972), no. 72-2, 132 pp. Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA.

An illustrated guide to the various classes of pesticide application on the world market including small, hand-held and manually-powered units. A list of manufacturers, with addresses, is also presented.

IPPC A

herbicide application equipment

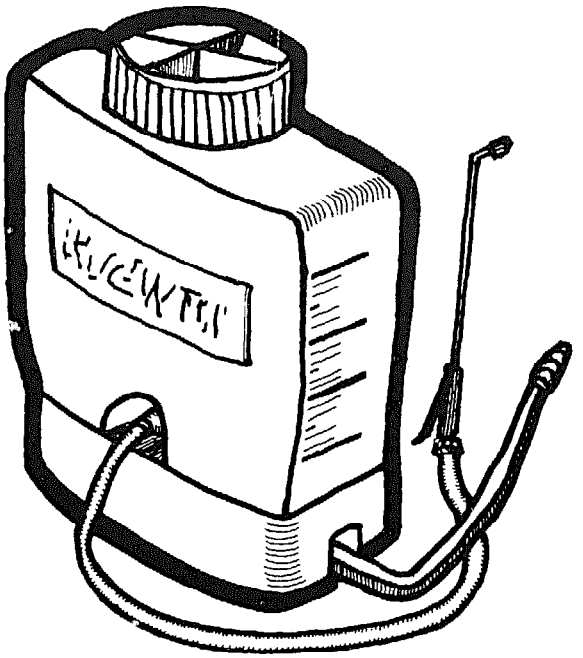


Figure 10. A representative knapsack sprayer. (IPPC drawing). Ref nos. 12218, 12220.

12221

DEUTSCH, A.E. Small pesticide application equipment--its selection, use and maintenance. World Farming (1974), IPPC Paper B/3 Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA.

Choosing, using, and servicing information is presented, with emphasis on safe methods.

IPPC A

herbicide application equipment

see also Equipos pequeños para aplicar plaguicidas--su seleccion, uso y mantenimiento, Agric. de las Americas (1974), IPPC Paper B/4.

12222

SUTHERLAND, J.A. Non-motorised hydraulic energy sprayers. Center for Overseas Pest Research, College House, Wrights Lane, London W8 5SJ, UK (1979) 40 pp. (1979 price - £2.00).

This illustrated booklet describes various types of manually operated equipment and suggests points to consider when buying a new sprayer.

-- A

herbicide application equipment

1.23 Biological control of weeds

12301

PUTNAM, A.R.; DUKE, W.B. Allelopathy in agroecosystems. Annual Review of Phytopathology (1978), 16, 431-451 [Dept. of Hort., Pesticide Res. Center, Michigan State Univ., East Lansing, MI 48824, USA].

An introduction to the concept of allelopathy ('detrimental effects exerted by higher plants of one species (donor) on the germination, growth or development of another species (receptor), through release of a chemical by the donor') and the nature and production of allelopathic chemicals is followed by a review of the role of allelopathy in crop production and a discussion of the methodology of allelopathy studies. The possible uses of allelopathy in agriculture are discussed. Crop plants could be bred for their ability to suppress weeds by allelopathy; selectively allelopathic companion plants (intercrops) or mulches, which do not interfere with crop growth, could be utilised; or an allelopathic plant could be incorporated into a crop rotation to control weeds in the following crop.

CAB (WA 29-1119) JAFC

allelopathy

12302

PUTNAM, A.R.; DUKE, W.B. Biological suppression of weeds: evidence for allelopathy in accessions of cucumber. Science (26 July 1974), 185, 370-372 [Dept. of Hort., Pesticide Research Center, Michigan State Univ., East Lansing, MI 48824, USA].

Cucumber (Cucumis sativus L.) accessions from 41 nations were grown with two indicator species in a search for superior competitors. Of the plant introductions tested, one inhibited indicator plant growth by 87 percent and 25 inhibited growth by 50 percent or more. The toxicity of leachates from pots containing inhibitory cucumbers to indicator plants germinated in separate containers suggested allelopathy. Incorporation of an allelopathic character into a crop cultivar could provide the plant with a means of gaining a competitive advantage over certain weeds.

IPPC - free reprint on request A

allelopathy; cultivar selection

see also LOCKERMAN, R.H.; PUTNAM, H.R. Evaluation of allelopathic cucumbers (Cucumis sativus) as an aid to weed control. Weed Science (1979), 27(1): 54-57.

12303

ALTIERI, M.A.; DOLL, J.D. The potential of allelopathy as a tool for weed management in crop fields. PANS (1979), 24(4):495-502 [Tall Timbers Res. Sta., Tallahassee, FL 32303, USA].

The increasing emphasis now placed on weed management as opposed to weed control raises the question of the role of allelopathy in agricultural systems. Evidence of allelopathic interactions between crops and weeds is briefly reviewed and two experiments designed to demonstrate the allelopathic effects of plant residues on seed germination are described. From these experiments it can be seen that Tagetes patula, Amaranthus dubius, bean (Phaseolus vulgaris) and cassava (Manihot esculenta) residues have widespread inhibitory effects on the germination of seeds of other species, while maize, Cenchrus brownii, Eleusine indica and Portulaca oleracea show

considerable tolerance to the presence of such residues. Suggestions are made as to how the potential of allelopathy in weed management can be investigated and how the process can be exploited. A considerable quantity of research remains to be done in this area.

CAB (WA 28-4136) A

allelopathy; maize; Phaseolus, cassava; crop rotation

12304

CONLEY, C.C.; PETERSON, I.L. Use of geese for grass control. California Agriculture (1957), 11(11):12 [Farm Advisors, Merced County, Univ. of California, USA].

The use and economics of geese for the control of perennial weeds such as Johnsongrass (Sorghum halepense), Bermuda grass (Cynodon dactylon) and nut grass (Cyperus spp.) is discussed. Geese have been used successfully for weed control in cotton, beets, beans, sweet potatoes, onions and a number of fruit crops. Young geese are more economical and make better selective weeders. Two to four geese are sufficient for an acre of broadleaved row crops. In cotton, geese should be put in the field as soon as the cotton and weed seedlings emerge. Geese do not like old grass. Fencing and supplementary feeding are additional costs. The use of geese for two consecutive years in heavy Johnsongrass can eliminate the weed.

IPPC JAFC

North America; cotton; Phaseolus; sweet potatoes, vegetable crops; perennial problem weeds; grazing; economic analysis

12305

GEIGER, G.; BIELLIER, H. Weeding with Geese. Leaflet, Science and Technology Guide, University of Missouri Extension Division (1979 reprint), 2 pp. [Cooperative Extension Service, U.S. Dept. of Agric., Univ. of Missouri, Clark Hall, Columbia, MO 65211, USA].

The management and use of weeder geese in cotton, strawberries, nurseries, maize, orchards and other crops is outlined.

ITDG JAFC

North America; grazing; cotton vegetable crops; maize

see also JOHNSON, C. Management of Weeder Geese in Commercial Crops. Leaflet, Field Crop File, Agricultural Extension Service of the University of California, Madera County (1972), 2 pp. [128 Madera Ave., Madera, CA 93637, USA] which includes similar information.

ITDG

1.24 Utilisation of 'weeds'

see also no. 22801

12401

SOEWARDI, B.; TJITROSOEPOMO, G.; WIRJAHARDJA, S. Alternative control through utilisation of weeds by farmers. In: [Proceedings], BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 10 pp. [Center for Natural Resource Management and Environmental Study, Bogor Agric. Univ., Indonesia].

Utilisation of weeds as an alternative method of control has received increasing attention in line with development of the concept of integrated control and progress in the ecological approach to natural resource management. Utilisation of weeds by small-scale farmers has been practised as an integral part of their farming systems, which is also dictated by their socioeconomic conditions. An appendix lists uses of 82 tropical weeds of importance, based on a scrutiny of the 9 cited bibliographical sources.

CAB (WA 28-2946) WA

utilisation

12402

MISHRA, M.N. Economic utilisation of weeds in India. Labdev Journal of Science and Technology (Part B) (1969), 7(3):195-199. [Central Arid Zone Res. Inst., Jodhpur, Rajasthan, India].

The medicinal properties of 17 common weed species are listed. Weeds are listed which are considered as potentially useful for horticulture (flowers, lawns, etc.), for eating, for manuring, for fodder, for soil conservation, for fibres, for oil, for plant breeding, for packing and thatching materials, for pesticides, for perfumes, dyes and tannins, for fuel and for religious, military and miscellaneous purposes.

CAB (WA 19-2384) WA

utilisation; Indian subcontinent

12403

MAIDEN, J.H. The Useful Native Plants of Australia. London, Turner and Co. (1889), 696 pp.

The uses of Australian plants for human foods, forages, drugs, gums and resins, oils, perfumes, dyes, tans, timbers, fibres and other products are described, including use by both white colonists and aboriginal peoples.

-- JAFC

utilisation; Australasia

12404

PEREZ ARBELAEZ, E. Plantas Útiles de Colombia. Contraloria General de la Republica, Bogotá, Colombia (1947), 537 pp.

Includes drawings and descriptions of the economic uses of many weeds and other wild plants.

-- JAFC

utilisation; northern South America

12405

NATIONAL ACADEMY OF SCIENCES, USA. Making aquatic weeds useful: some perspectives for developing countries. (1976) 176 pp. [En, es, fr] [Commission on Int. Relations (JH 215), Nat. Acad. Sci.-Nat. Res. Council, 2101 Constitution Ave., Washington, DC 20418, USA].

The subject is considered under the following headings: (1) The grass carp Ctenopharyngodon idella). (2) Other herbivorous fish, (3) Manatees, (4) Crayfish, (5) Ducks, geese and swans, (6) Other herbivorous animals, (7) Harvesting, (8) Dewatering, (9) Soil additives, (10) Processed animal feeds, (11) Pulp, paper and fibre, (12) Energy, (13) Wastewater treatment using aquatic weeds, (14) Aquatic plants for food, and miscellaneous uses and Appendix A) Duckweeds and their uses. Nearly every chapter gives a description of techniques, limitations and research needs, plus selected readings and addresses of research contacts.

Two novel means of weed control in rice paddies discussed here are crayfish (used in California and Louisiana rice paddies, but research is needed before they could be used elsewhere) and ducks (used in the People's Republic of China).

Abstracts of chapters 2, 6, 10, 12, 13 and Appendix A are given in WA 27, 885-890.

CAB (WA 27-884) JAFC

utilisation; aquatic weeds; herbivorous fish; biological control

12406

EDWARDS, P. Food potential of aquatic macrophytes. ICLARM Studies and Reviews 5 (1980), 51 pp. International Center for Living Aquatic Resource Management, Manila, Philippines [Div. of Agric. and Food Engineering, Asian Inst. of Tech., P.O. Box 2754, Bangkok, Thailand].

Present and potential uses of aquatic macrophytes as human food, livestock fodder, fertilisers, food for herbivorous fish and other aquatic and amphibious

herbivores are discussed, as well as the potential for recycling waste into aquatic macrophytes. A number of recommendations for research are made.

-- JAFC

utilisation; aquatic weeds; paddy rice; herbivorous fish

12407

MEHTA, I.; BOONLA, D.S. Weed out weed with a weed. (Mulching with aquatic weeds, esp. Typha). Intensive Agriculture (1980), 18(6):23-24 [Soil and Water Management Station, Kota, Ragasthan, India].

Weeds are a serious problem in the Chambal Irrigation Project and amount to 250-350 t submerged, 400-500 t immersed and 350-1700 t floating weeds/ha. In 1975-76, aquatic weeds were used as mulches in sunflower crops. Weed mulches 15 cm deep gave 85-93% control of weeds and Typha spp. were the most effective; moisture retention in soil was increased by 17% under the mulch. The farmers near the irrigation canals can profitably use the aquatic weeds at the time when the weeds are removed annually by the Irrigation Department.

CAB (WA 30-2339) WA

utilisation; aquatic weeds; mulching sunflower; imported mulch

see also LITTLE, E.C.S. Handbook of utilisation of aquatic plants. A review of world literature. Rome, Italy; FAO (1979) FAO Fisheries Technical Paper No. 187, 176 pp. [Kerikeri, Bay of Islands, New Zealand] Abstracted in WA 30-424.

1.3 PROBLEM WEEDS

1.31 Aquatic weeds

For references to biological control of aquatic weeds, with special reference to paddy rice, see nos. 22701-22711. See nos. 12405-12407 for utilisation of aquatic weeds.

13101

DEUTSCH, A. (ed.). Some equipment for mechanical control of aquatic weeds. Int. Plant Prot. Center, Oregon State Univ. Corvallis, OR 97331, USA (1974), No. 74-2, 17 pp.

Illustrated details of commercially available weed cutters and rakes are given.

IPPC WA

aquatic weeds; hand tools; motor-powered implements

13102

DRUIJFF, A.H. Manual and mechanical control of aquatic weeds in watercourses. Berichte aus dem Fachgebiet Herbologie der Universität Hohenheim (1979) No. 18. Weed research in Sudan. Vol 1: Proceedings of a symposium: ed. by M.E. Beshir and W. Koch, 137-145 [Beaulieustr. 22, 6814 DV Arnhem, Netherlands].

An account is given of manual and mechanical methods of weed control in waterways. Five types of aquatic weeds are distinguished, each requiring different approaches to control. The most widely used methods are manual and mechanical; these are discussed on the basis of experience in arid and semi-arid climates. Manual methods are inexpensive and require little foreign exchange. Commonly used tools include the chain scythe, clearing scythe, ditch bank knife, digging fork, and longhandled rake; methods and productivity figures are given for each of these based on experience in Egypt. Mechanical methods are more expensive and require considerable expertise in proper application. They are developed for different conditions, and often operate below expectation due to lack of spares and repair facilities, lack of properly trained operators, and in practice, poorly accessible watercourses in the tropics and subtropics. Detailed study is essential before their introduction to avoid expensive failures.

CAB (WA 29-3270) A

aquatic weeds; hand tools; motor-powered implements; North Africa

13103

DRUIJFF, A.H. The chain scythe, a simple tool for controlling aquatic weeds in

irrigation canals. PANS (1973), 19(2): 216-218 [ILACO N.V., 35 Utrechtsestraat, P.O. Box 33, Arnhem, Netherlands].

The chain scythe is an almost forgotten tool which was once fairly widely used for weed control in irrigation canals. It consists of scythe blades loosely bolted together in a chain, with a rope fastened to each of the two outer blades. Two people stand on opposite bank of the canal, each holding one of the end ropes, and pull alternately on the ropes as they walk slowly forward, causing the blades to zig-zag forward and cut off the aquatic weeds. The scythe operates closely parallel to the bottom of the canal; thus only the aquatic weeds are removed and not those which protect the banks from becoming eroded. A third person collects the cut plants. Each weeding operation involves comparatively little effort and cost, although regular weeding rounds are necessary to maintain control. Estimates of time spent operating and maintaining the chain scythe are given in the paper.

CAB (WA 23-1433) A/JAFC

aquatic weeds; hand tools

1.4 WEED CONTROL IN PARTICULAR CROPS

1.41 Root and tuber crops

14101

PEÑA, R.S. DE LA. Weed control in root crops in the tropics. In: Symposium, Weed Control in Tropical Crops, Manila (1978), 169-188 [Dep. Agron. Soil Sci., Univ. Hawaii, Honolulu, HI, USA].

The situation with regard to weed control in the major tropical root and tuber crops is reviewed. Results of cultural and chemical methods of control are summarised for cassava, sweet potato, yams, taro (Colocasia esculenta) and tannia (Xanthosoma sagittifolium). An integrated weed control programme, utilising thorough land preparation and a combination of pre-em. and post-em. herbicides is highly recommended for all the major tropical root and tuber crops. In lowland taro, timely and proper management of irrigation water together with thorough land preparation and application of a pre-em. herbicide is recommended.

CAB (WA 29-3602) WA

root and tuber crops; cassava; yam; taro; sweet potato

1.42 Cereals

14201

MOODY, K. Weed control in rice and sugarcane cropping systems. In: Symposium, Weed Control in Tropical Crops, Manila (1978), 56-74 [Dep. Agron., Int. Rice Res. Inst., Los Baños, Laguna, Philippines].

Weed control in dry-sown, rainfed bunded rice is reviewed together with such aspects as land preparation during the dry season, the use of the stale seedbed technique and herbicides. Weed control is also reviewed for wet-sown, transplanted and upland rice and for sugarcane.

CAB (WA 29-3560) WA

paddy rice; novel systems; sequential cropping; upland rice; sugarcane

14202

MILLER, S.F.; BURRILL, L.C.; DOLL, J.D. Economics of weed control in maize, dry beans and soybeans in Latin America. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1980), 921-929 [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

A review. Farmers of small landholdings in Latin America produce most maize and dry beans, although some large-scale maize production occurs in Argentina, Uruguay and parts of Mexico. Presently, small farmers rely on family or hired labour for weeding and other farming operations. While peak demand periods and seasonal labour scarcities exist, unemployment and underemployment prevail throughout Central America and most of

South America. The resulting low-cost labour and relatively low product prices often preclude herbicides as an option to handweeding. In contrast, large farms, which are the main producers of soyabeans, possess enough land and capital to use herbicides.

IPPC A

Central America; northern South America; Brazil; southern South America; maize; Phaseolus; economic analysis; social analysis

1.43 Grain legume crops

14301

MOODY, K. Weed control in tropical legumes. In: Symposium, Weed Control in Tropical Crops, Manila (1978), 112-146 [Dept. Agron., Int. Rice Res. Inst., Los Baños, College, Laguna, Philippines].

Research on 6 legumes, namely mung bean (Vigna radiata), cowpea (Vigna unguiculata), asparagus bean (Vigna unguiculata ssp. sesquipedalis), pigeon pea (Cajanus cajan), groundnut and soyabean, all of which are grown in or are of potential interest to the Philippines, is reviewed, including research of the effects of competition, moisture, different crop cultivars and crop density. Farmers rarely use herbicides and are unlikely to do so until the yield potential of the crops or labour costs increase substantially.

CAB (WA 30-1674) WA

soyabean; Vigna; Cajanus; groundnut

1.44 Vegetable crops

14401

WILLIAM, R.D. Weed management in vegetable crops. In: Symposium: Weed Control in Tropical Crops, Papers presented at the 9th Pest Control Council of the Philippines, Manila (1978), 149-163 [Veg. Crops Dept., IFAS, Univ. of Florida, Gainesville, FL 32611, USA].

Methods of improving weed control in tropical vegetable crops including manual weeding, cultivations, crop rotations, flooding, placement of fertiliser and irrigation water near vegetables, transplanting, mulching, herbicides, competitive cropping, cover crops, selection of cultivars and planting time are briefly described.

CAB (WA 29-3615) JAFC

vegetable crops

14402

WILLIAM, R.D.; CHIANG, M.Y. Weed management in Asian vegetable cropping systems. (Paper presented at a Symposium of the Weed Science Society of America, San Francisco, California, February 1979). Weed Science (1980), 28(4):445-451 [Asian Vegetable Res. and Development Centre, P.O. Box 42, Shanhua, Tainan 741, Taiwan].

A variety of successful weed management practices in Asian vegetable cropping systems are briefly described, including sequential cropping systems, crop rotation, intercropping in annual and perennial crops, planting patterns and other cultural practices. Research and training needs associated with the need for weed management in vegetable cropping systems are identified.

CAB (WA 30-1593) JAFC

Far East; Southeast Asia; vegetable crops; grain legumes; upland rice; perennial crops; crop rotation; intercropping; sequential cropping

1.45 Weed control in multiple cropping

14501

MOODY, K. Weed control in multiple cropping. Philippine Weed Science Bulletin (1977), 4, 27-38 [Int. Rice Res. Inst., Los Baños, Laguna, Philippines].

Weed control in dry-sown, rainfed bunded rice through land preparation, the stale seedbed technique and the use of herbi-

cides in upland rice, in mixed crops, in intercrops and under relay cropping is reviewed.

CAB (WA 28-2615) WA

paddy rice; novel systems; intercropping; sequential cropping

14502

MOODY, K. Weed control in multiple cropping. In Symposium on Cropping Systems Research and Development for the Asian Rice Farmer, International Rice Research Institute, Manila, Philippines (1977), 281-294 [Int. Rice Res. Inst., Agron. Dep., Los Baños, Laguna, Philippines].

Each of the possible means of intensifying crop production (mixed, sequential, inter-, relay and ratoon cropping) on a given area of land is discussed separately with regard to weed control. The present status of weed control in multiple cropping is reviewed and future areas of research are suggested.

CAB (WA 28-3861) WA

novel systems; intercropping; sequential cropping

see also MOODY, K. Weed control in multiple cropping. Lecture prepared for participants in a training course for extension and production personnel, Cooperative (CRIA-IRRI Program, Bogor, Indonesia, 1977 (the same paper with more detailed examples)

14503

MOODY, K. Weed control in intercropping in tropical Asia. In: Weeds and Their Control in the Humid and Subhumid Tropics; Proceedings of a conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 1978 (1980), 101-108, I.O. Akobundu, ed. [IRRI, Los Baños, Laguna, Philippines].

A review covering the competitive ability of intercrops and weed control in intercrops. It is concluded that further research is needed to determine weed control methods that are economical and acceptable to the small farmer.

CAB (WA 30-2988) WA

Southeast Asia; intercropping

2. WEED CONTROL IN PADDY RICE

2.1 PRINCIPLES AND REGIONAL STUDIES

21001

MOODY, K. Weed control in rice. Lecture presented to participants attending a Weed Control Short Course, Jan. 15 - Feb. 2, 1979, at the National Crop Protection Center, Univ. of the Philippines at Los Baños, Los Baños, Laguna, Philippines. [IRRI, Los Baños, Laguna, Philippines] 23 pp. + 25 tables.

Weed control methods in rice, including land preparation, preventing seeding of weeds and using clean rice seed, planting methods, cultivars grown, plant density, fertiliser application, water management, crop rotation, manual weeding by hand, foot and hand tools, mechanical weeding, biological control, and herbicides are discussed. Details of recommended practices (for example, "during puddling do two or three harrowings at 7-and 10-day intervals") are given.

ITDG JAFC

paddy rice; novel systems; Southeast Asia; herbicides; crop rotation; land preparation; planting techniques; weed seed source reduction; water management; biological control

This information (excluding that on herbicides) is included in abbreviated form in MOODY, K. Weed control in irrigated rice using non-chemical methods. Lecture at a short course on Integrated Pest Control for Irrigated Rice in South and Southeast Asia, Oct. 16 - Nov. 18, 1978, Philippines, (IPC / SP-91, 10-19-78) 11 pp. + 18 tables.

21002

MOODY, K.; DATTA, S.K. DE. Integration of weed control practices for rice in tropical Asia. In (Proceedings) BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 15 pp. [Dept. Agron., Int. Rice Res. Inst., Los Baños, Philippines].

The importance for weed control of proper land preparation (deep ploughing, repeated harrowing and puddling before transplanting), often inadequately performed by farmers, is emphasised. The use of traditional tall varieties, close spacing and transplanting all help the rice compete with weeds; however, mechanical transplanting, which transplants young seedlings (about 15 cm tall as opposed to about 23 cm tall for hand transplanting), is much less effective in suppressing weed growth. A water depth of at least 15 cm is recommended for maximum suppression of weed growth. The rotary weeder reduces the time and effort required for good weeding in transplanted rice, but it operates best in soft saturated mud, and may give inadequate control in paddies with dry soil or standing water. Seeding at a high rate followed by harrowing in two directions (in and across the rows) reduces the need for manual weeding in the rows. This method is also employed with broadcast-seeded rice in Bangladesh and West Bengal. Growing corn and mung beans in rotation with rice reduces subsequent weed stands.

CAB (WA 28-2617) JAFC

paddy rice; land preparation; planting techniques; water management; manual implements; crop rotation

21003

DATTA, S.K. DE. Weed problems and methods of control in tropical rice. In: Symposium: Weed Control in Tropical Crops, Papers presented at the 9th Pest Control Council of the Philippines, Manila, 1978 (1979), 9-44 [Dept. of Agron., IRRI, Los Baños, Laguna, Philippines].

The discussion on weed control and management is grouped into four categories: substitutive, preventive, complementary, and direct measures. Substitutive measures include land preparation and water management; preventive measures include use of clean seed, keeping levees and irrigation canals weed-free and keeping

tools and machinery clean; complementary practices include crop competition, fertiliser management and cropping system; and direct methods include hand pulling, rotary weeding, and herbicides.

CAB (WA 29-3967) A

paddy rice; herbicides

see also -

DATTA, S.K. DE. Weed control in rice in Southeast Asia: methods and trends. Philippine Weed Science Bulletin (1977), 4, 39-63

CAB (WA 28-2558)

DATTA, S.K. DE. Weed control and soil and crop management in rainfed rice at IRRI and other locations in tropical Asia. In: Rice in Africa. Proceedings of a conference held at Ibadan, 1977; edited by I.W. Buddenhagen and G.J. Persley, London, UK; Academic Press (1978), 201-211.

CAB (WA 29-45)

21004

NODA, K. Weed control in rice and other cereal crops. In: (Proceedings) BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 17 pp. [Rice Res. Div., Tohoku Agric. Exp. Sta., MAF, Omagari, Akita 014-01, Japan].

This paper describes present methods of weed control in paddy rice in Asia. Countries are broadly classified into three groups based on yield of rice per unit area, which is closely connected with the usage of modern weed control methods: Japan, Korea and Taiwan, and Southeast Asian countries. Paddy rice in Japan is predominantly transplanted by machine after land levelling and soil puddling. Intertillage with a rotary weeder, handweeding at the middle stages of growth and again after heading (especially for Echinochloa spp.), and pre- and post-emergence herbicide use are shown in a table of standard weed control measures. In Taiwan, virtually all rice is transplanted by hand. Weed control measures consist of soil preparation, water management, 2 or 3 weedings by hand or feet, hand pulling and chemicals. In Southeast Asian countries, most rice is transplanted and traditional methods of weed control are used. Traditional varieties are strong competitors with weeds and are still used despite low yields. Deep flooding controls weeds in the Mekong Delta. In water-seeded rice in Sri Lanka, a very dense stand is sown to suppress weed growth, followed by harrowing to reduce the stand to a proper density. In West Malaysia, repeated cutting with a type of scythe (Tajak) followed by flooding and soil puddling has been used to remove perennial weeds before planting. In Bangladesh, an implement locally known as 'Niranee' is used for hand pulling weeds.

Control of weeds in wheat and barley in lowland Japan and South Korea is briefly reviewed.

CAB (WA 28-2616) JAFC

paddy rice; Far East; Southeast Asia; Indian subcontinent; wheat; highland and temperate zone

21005

CHANG, W.L. Rice weed control in Taiwan. In: Proceedings of the 1st Asian-Pacific Weed Control Interchange, June 12-22, 1967, Univ. of Hawaii, Honolulu; East West Centre (1969), 73-76 [Chiayi Agricultural Experiment Station, TARI, Chaiayi, Taiwan].

Current weed control practices in paddy rice in Taiwan are reviewed. No herbicides are in use at present. Rotation of rice with upland crops and sequential cropping with vegetables (e.g., melons between the first and second rice crops), helps reduce aquatic weed numbers. Two or three ploughings with a water buffalo-drawn plough, harrowing and levelling precede seeding or transplanting. The nursery seedbed is prepared in strips of 1.2 metre width, with a 30 cm ditch between the two seedbeds, to facilitate weeding and roguing. Seedlings are transplanted in lines and weeding is done by hand pulling or with a hand-operated rotary cultivator. Farmers weed about 3-4 times in the first crop of the season and 2-3 times in the second crop. The labour requirement for hand-weeding the first and second crops is 400 and 200 man-hours/ha, respectively.

The first weeding and intertillage is done at about 15 days after transplanting (DAT) in the first crop and 10 DAT in the second crop, after which weeding is carried out once every 10 and 7 days in the first and second rice crops, respectively. Weeding takes about 100 man-hours per hectare each

time. Water is drained one day before weeding and a topdressing of fertliser is generally applied at the time of weeding. In Southern Taiwan, weeding may be done with the feet. Water is kept on the field at a depth of 3 cm for 20-30 days after transplanting.

CAB (WA 18-2070) JAFC

Far East; traditional systems; paddy rice

21006

KIM, D.S. An introduction to weed control in rice in Korea. In: Proceedings of the 2nd Asian-Pacific Weed Control Interchange (1969), 34-42 [Inst. Pl. Environment, Office Rural Dev., Suwon, S. Korea].

Rice is the staple food of Korea. A survey in 1965 found 65 species of weeds from 31 families in paddy fields in Southeast Korea. Echinochloa crus-galli is the worst weed and 5-125 plants/m^2 reduced rice yields by 12-34% compared with 8-13% for the same densities of Monochoria vaginalis; weeds reduced yields by 20% on average. Cultural control of weeds is described. Weeding time for 1 season is estimated at about 300 man-hours/ha. Propanil at 2.5 kg/ha is recommended for the control of E. crus-galli in lowland seedbeds. TOK granular (nitrofen 7%) at 25-35 kg product/ha, applied within 1 week after transplanting, was equal to handweeding in effect and yield. The use of nitrofen could reduce weeding costs by US $23.5/ha. Recommendations include PCP (86% a.i.) at 8-10 kg/ha before planting; nitrofen granular (7% a.i.) 30 kg/ha after transplanting but before weed emergence followed, i.e. within 15-20 days after transplanting; by rotary weeding; or, within 25-30 days, by MCPA (less phytotoxic) in the north or 2,4-D in the south and with hand pulling of high populations of E. crus-galli. Eighteen common weeds of paddies are listed with their common names.

CAB (WA 20-537) WA

paddy rice; Far East; traditional systems; herbicides; economic analysis

21007

UNITED STATES DEPARTMENT OF AGRICULTURE; UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT. Rice in West Africa: A Study by USDA/USAID. Washington, DC (1968), 196 pp.

This report presents the findings of a study of the rice economy of 11 West African countries: Dahomey, The Gambia, Ghana, Ivory Coast, Liberia, Nigeria, Niger, Senegal, Sierra Leone, Togo and the Upper Volta. The importance of rice in the economy, the physical environment, production practices, tools and techniques, marketing, and suggestions for improvements are outlined for each country. A description of weed control practices, which varies in detail from country to country, is included in the section on production practices.

-- JAFC

West Africa; upland rice; paddy rice; traditional systems

22108

BURRILL, L.C. Weed control methods in rice. Paper presented at the West African Rice Development Administration Plant Protection Seminar, Monrovia/ Liberia, May 1973 [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

In much of Western Africa, rice production is at a primitive level. The slash and burn system is often used, commercial fertiliser is rare, and most of the rice is broadcast seeded. Under these conditions, nonherbicidal methods of weed control should be encouraged. Using transplanted rice, good water control, crop rotation, clean seed, row planting, and hand- or mechanical weeding should provide a dramatic increase in yield. Herbicides should be introduced to help solve problems.

IPPC A

West Africa; paddy rice; upland rice

21009

AKOBUNDU, I.O.; FAGADE, S.O. Weed problems in African rice lands. In: Rice in Africa. Proceedings of a conference held at...Ibadan, 1977; edited by I.W. Buddenhagen and G.J. Persley, London, UK; Academic Press (1978), 181-192 [Int. Inst. Trop. Agric., PMB 5320, Ibadan, Nigeria].

The weed problems of dryland, hydromorphic land and lowland rice are reviewed and weed species listed. Yield reductions caused by weeds are discussed, cultural and chemical control are described and the benefits of weed control are outlined. It is concluded that rice grain yields in Africa could be doubled by improved weed control, especially in lowland rice.

Handweeding is common in Africa. Two weedings are usual for dryland and three for hydromorphic areas. Weeds are allowed to grow until tall enough to be easily grasped. Rotary weeders, such as used in Asia, are presently not in use in Africa. The hoe is more efficient than handweeding, but requires line sowing. Rotation of rice with a crop such as a legume reduces infestation of subsequent rice crops. Closer spacing of rice increases its ability to compete with weeds. Careful levelling of the bed and maintenance of the water level at a depth of at least 10 cm while rice is at the seedling stage helps to control many annual weeds.

CAB (WA 29-43) WA/JAFC

West Africa; paddy rice; upland rice

21010

MOODY, K. Weed control in sequential cropping in rainfed lowland rice growing areas in tropical Asia. In: (Proceedings) BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 19 pp. [Int. Rice Res. Inst., Los Baños, Philippines].

Traditionally, in the rainfed rice growing areas of Asia, farmers have grown only one rice crop per year by transplanting late-maturing varieties after sufficient rain has fallen so that the soil can be puddled. By sowing at the start of the rains and using early-maturing varieties, the farmer can grow two rice crops per year where previously he grew only one, the second being harvested at approximately the same time as the single crop. He can, therefore, grow an upland crop to follow rice harvest, a practice some farmers have already adopted. The problems with regard to weeds and their control associated with such a change and ways in which these problems may be overcome are discussed. Unless weeds can be controlled, particularly in the first crop of rice, should it be dry seeded, the idea of increasing production in rainfed rice growing areas in Asia by growing more crops in sequence will have to be abandoned. A major research effort will be needed to ensure that such a thing does not happen.

The following methods should be examined to find suitable ways of controlling weeds in dry-seeded rice. Ploughing at the end of the rice crop followed by repeated cultivations, or production of a drought-tolerant crop in which weeds are controlled should stop annual weeds from seeding and desiccate perennial weeds. Dry seeding rice as soon after the rains start as possible should reduce weed growth. Row planting or hill planting to allow one-way or two-way mechanical cultivation should reduce the time taken for weed control. Suitable herbicides for dry-seeded rice have still not been found.

CAB (WA 28-2618) WA

paddy rice; sequential cropping; Southeast Asia; novel systems; planting techniques

21011

DATTA, S.K. DE; LACSINA, R.Q. Weed Control in flooded rice in tropical Asia. In: Proceedings, 11th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1972), Volume 2, 472-478 [Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

Experiments at the International Rice Research Institute, at other experiment stations and in farmers' fields in the Philippines showed that 2,4-D and MCPA were equally effective in controlling Echinochloa crus-galli and other annual weeds in irrigated or rainfed transplanted rice, without causing sustained toxicity to either indica or japonica rice varieties. These herbicides were less expen-

sive than handweeding. Other herbicides such as butachlor or benthiocarb with 2,4-D, which can control weeds before or after they emerge, are more expensive than 2,4-D or MCPA. Butachlor is providing an excellent alternative to handweeding in Taiwan and Korea.

WRO A

Southeast Asia; Far East; paddy rice; herbicides

21012

DATTA, S.K. DE. Weed Control in Rice in South and Southeast Asia. Extension Bulletin No. 156 (1980), Food and Fertilizer Technology Center, P.O. Box 22-149, Taipei City, Taiwan [Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

A summary of weed control practices used in the types of rice culture practised in monsoon Asia: transplanted rice, direct-seeded flooded rice, dry-seeded rainfed bunded rice, upland rice, and deep-water rice. Techniques discussed include land preparation, selection of cultivar, timing of weeding operations, herbicides and herbicide application. The economics of herbicide treatments are discussed. Current research on perennial weed control (in particular, control of Scirpus maritimus and Paspalum distichum in paddy rice, and of Cyperus rotundus in upland rice) is reviewed.

-- JAFC

Southeast Asia; Indian subcontinent; paddy rice; upland rice; deep-water rice; perennial problem weeds; land preparation; cultivar selection; timing; herbicides; economic analysis

21013

DATTA, S.K. DE; BARKER, R. Economic evaluation of modern weed control techniques in rice. In: Integrated Control of Weeds; ed. by J.D. Fryer and S. Matsunaka, Tokyo, Japan; University of Tokyo Press (1977), 205-228 ISBN-0-86008-179-6 [IRRI, Los Baños, Laguna, Philippines].

In the Asian tropics, most rice farms are weeded by hand or with rotary weeders. Despite the rise in chemical costs, herbicides such as 2,4-D, which can control most annual weeds in transplanted rice, can be used effectively in many areas at a cost of about US $5-8/ha. In East Asia, high wages and less available labour have brought about the almost complete substitution of herbicides for handweeding; in the Philippines some farmers combine herbicide use with other weed control measures, while in other parts of South and Southeast Asia where wage rates are low, such as Indonesia, Bangladesh and India, handweeding is still the major form of control. For direct-sown flooded rice, granular formulations of butachlor, thiobencarb and C-288 (piperophos + dimethametryn) are highly selective in controlling barnyardgrass (Echinochloa crus-galli) and other annuals under tropical conditions. These treatments cost US $20-22/ha.

CAB (WA 26-4154) A

Southeast Asia; Indian subcontinent; paddy rice; herbicides; economic analysis

21014

MOODY, K.; DATTA, S.K. DE. Economics of weed control in tropical and sub-tropical rice growing regions with emphasis on reduced tillage. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1981), Volume 3, 931-940 [Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

In irrigated transplanted rice fields in Asia, farmers generally do an adequate job of weed control. The weed control method used depends on the resources available to the farmer. Weeding labour in Laguna Province, Philippines almost tripled between 1965 and 1975 as a result of the introduction of modern cultivars and a high rate of fertiliser application. Between 1975 and 1978, weeding labour decreased due to an increase in the use of herbicides and increased efficiency of herbicide use. In addition, real agricultural wages increased and herbicide prices stabilised. Reduced tillage techniques have resulted in considerable savings in time, labour, water, power, and capital without yield loss under varying ecological conditions. However,

usage of such techniques may be limited to areas where perennial weeds are absent. Acceptance of reduced tillage systems in tropical Asia has been slow, but they are expected to become more acceptable in the future with changing economic and social conditions.

WRO A

Southeast Asia; Indian subcontinent; Far East; paddy rice; minimum tillage; herbicides; economic analysis; land preparation

2.2 TOOLS AND TECHNIQUES

2.21 Weed control techniques - general

see also no. 42209 (Eupatorium as a green manure in paddy rice)

22101

DENIZE, J.R. New production techniques and chemical aids. In: Proceedings Report, Conference 'Mechanisation and the world's rice,' Leamington Spa, UK (Sept. 1966), 79-81 [Plant Protection Ltd., Fernhurst, Haslemere, Surrey, UK].

Paraquat (Gramoxone)--the minimal cultivation of rice. In Japan, out of a total of 1600 man-hours/ha spent in 1960 on rice production in Mie Prefecture, 420 were devoted to soil preparation; direct drilling into stubble could reduce labour costs for seedbed preparation by up to 50%. Paraquat has reduced the number of rotary cultivations needed to produce a dry seedbed from 3-4 to 1 and can also reduce the number required for a puddled soil. For direct drilling into paraquat-treated stubble, the Japanese have produced a hand-operated seeder which punches out plugs of soil and simultaneously sows seed in the holes. Malaya, the Philippines and Ceylon have also shown interest in minimal cultivation techniques. In Malaya, paraquat desiccation of weeds could reduce the time for seedbed preparation from the 5 weeks taken by slashing weeds, flooding and leaving to rot, to as little as 5 days. This technique, however, is only likely to be of value on montmorillonite type soils which expand on wetting. The wetter districts of Ceylon are subject to infestation by Salvinia auriculata. Here, the normal practice of raking into heaps and covering with soil is wasteful of space. S. auriculata is readily desiccated by paraquat at 600 g/ha and can then be trodden into the ground with buffaloes and the soil levelled and planted normally.

CAB (WA 17-52) WA

paddy rice; minimum tillage; herbicides; novel systems

22102

COUEY, M. [Research on rice in the Senegal river region]. Agronomie Tropicale, (1966), 21(1):19-37. [Fr, en, es] [Richard-Toll Development Scheme, Senegal].

Weed control techniques include the following:

(a) Ploughing rice fields, irrigating to induce germination of weed seeds and cultivating to kill the seedlings. Irrigation should be in the hot season at the end of February or beginning of March. Repeating the operations 2-3 times destroys most seeds in the top 10 cm of soil.

(b) Growing an early variety of rice, such as Sintiane Diofior, which is sown during April/May and can be harvested in mid-October, before the flowering or ripening of wild rices such as Oryza breviligulata, O. staptii and O. barthii. Two harvests of Sintiane Diofior, followed by irrigation, are recommended before another variety is sown.

(c) Growing a longer-season variety such as Paugern (yields up to 29 quintaux/ha) which is sown in May and can be harvested at the end of October. Its early rapid growth smothers weeds and gives results similar to those obtained with Sintiane Diofior except that larger areas can be treated. As for Sintiane Diofior, two harvests are recommended, followed by irrigation.

(d) Use of herbicides.

CAB (WA 15-1446) WA

West Africa; paddy rice; novel systems; herbicides; annual problem weeds; land preparation

22103

ATIENZA, F.M.; KUNKEL, D.E. Determining the economic family size farm for land reform areas. Journal of Agricultural Economics and Development (1974), 4(2): 107-129.

On the basis of mathematical models, this study attempts to determine the economic size of farm that can be operated with the use of family labour in irrigated lowland rice areas. It includes tables giving the cost and labour requirements of a number of methods of land preparation and weed control. Post-emergence weeding can be carried out with hand tools ('dulos') or a push-type weeder.

-- JAFC

paddy rice Southeast Asia; land preparation; inter-row cultivation; economic analysis

2.22 Techniques for land preparation and planting

22201

MOOMAW, J.C.; CURFS, H.P.F. Some general and particular aspects of rice and soil tillage. In: Meeting of Experts on the Mechanization of Rice Production and Processing, Paramaribo, Surinam, 1971 (1972), Food and Agriculture Organisation of the United Nations; 55-60 [IITA, PMB 5320, Ibadan, Nigeria].

Techniques of wet and dry tillage of rice soils are briefly reviewed from the point of view of crop production and soil management. The paper contains a comprehensive table of time and labour requirements (man-hours and animal-hours per hectare) for 54 different soil tillage operations with a wide range of hand implements, animal-drawn implements and machines, including the reference to the paper from which each figure came.

ITDG JAFC

paddy rice; land preparation; hand tools; animal-drawn implements; motor-powered implements

22202

DATTA, S.K. DE; MORRIS, R.A.; BARKER, R. Land preparation and crop establishment for rainfed lowland rice. IRRI Research Paper Series (1978), No. 22, 24 pp. [Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

New rice technology - short duration varieties, herbicides, and tillage machinery with higher horsepower - may make new systems of land preparation and crop establishment economically feasible. To identify conditions for adoption of alternative systems and to determine where further research is necessary, the characteristics of the traditional rainfed rice land preparation transplanting system and its alternatives are reviewed.

The major advantages of wetland tillage are reduction of draught requirements, improved weed control, ease of transplanting, enhancement of soil fertility, and reduction of percolation losses. The major disadvantages of wetland tillage are increased late-season drought risk, high transplanting labour requirements and power unit size limitations. Once the soil has been puddled, the method of crop establishment is restricted to transplanting or direct seeding of pregerminated seeds. Rainfed areas suitable for direct seeding are limited by drainage control. Weed intensity is an important consideration in determining whether rice should be transplanted or direct seeded.

Forms of dryland tillage for rice have been practiced in limited but suitable environments. The major advantages of dryland tillage are early crop growth that can be obtained from early rainfall, elimination of labour for seedbed preparation and transplanting, adequate trafficability for large power units, maintenance of soil structure for upland crops following rice (or increased time for a second rice crop), and reduction of many insect and disease pressures. The major disadvantages are high draught requirements, comparatively exacting early weed control requirements, comparatively high fertiliser losses, and exposure to soil-inhabiting insects and blast disease.

As with wetland tillage, possible methods of crop establishment are restricted once soil has been prepared in the dry state. Common establishment methods are broadcasting, drilling, and dibbling. The different establishment methods produce similar grain yields provided weeds can be controlled. The choice of a weed control technique compatible to establishment method is critical.

CAB (WA 29-42) A

paddy rice; Southeast Asia; land preparation; planting techniques

22203

INSTITUT DE RECHERCHES AGRONOMIQUES ET DES CULTURES VIVIERES. [Rice. Transplanting or direct sowing?] Le riz--repiquage ou semis direct? Cahiers d'agriculture pratique des Pays Chauds (1965), (2):67-72 [Fr] [IRAT, France].

P. 70-72. Weed control. It is more difficult with direct sowing. One method is to sow in a 10-15 cm depth of water. Most weeds are killed after 8-10 days while rice survives. The water level is then lowered to enable the rice to make rapid growth and the initial depth of water is not restored until some days later. With herbicides, it is possible to control all the weeds, but they are expensive (under African conditions), as are the implements needed for their application.

CAB (WA 30-2988) WA

paddy rice; West Africa; planting techniques; water management

22204

MITTRA, M.K. Paraquat as an aid to paddy cultivation. In: Proceedings, 9th British Weed Control Conference, London, UK, British Crop Protection Council (1968), 668-674 [Plant Protection Ltd., Haslemere, Surrey, UK].

In trials established in Ceylon in August 1966, traditional methods of land preparation, consisting of 2 to 3 cultivations and taking up to 30 days to complete, were compared with minimum tillage techniques taking 10 days, in which weeds were killed with paraquat at 1.12 kg/ha followed by one cultivation. During the next 3 seasons, the yields following minimum tillage were similar to those from normally cultivated plots, but were lower if paraquat was omitted. Limited trials suggest that the method, timing and level of nitrogen application recommended for normal cultivation are also suitable for minimum tillage.

Using minimum cultivation, the time and water required for land preparation is reduced, more efficient use can be made of labour, animals and machinery, and the timing of land preparation is more flexible. In continuous cropping trials in which sowing followed harvest in the shortest time possible, the use of minimum tillage increased grain production over normal cultivation from 13 to 17 kg/ha/day in the Wet Zone and from 18 to 22 kg/ha/day in the Dry Zone.

CAB (WA 18-1063) A/WA

paddy rice; Indian subcontinent; land preparation; minimum tillage; novel systems; herbicides

22205

SETH, A.K.; KHAW, C.H.; FUA, J.M. Minimal and zero tillage techniques and post-planting weed control in rice. In: Proceedings of the 3rd Asian-Pacific Weed Science Society Conference, 1971 (1973), Kuala Lumpur, Vol. 1, 188-200 [Plant Protection Ltd., Kuala Lumpur, Malaysia].

Trials comparing conventional cultivation techniques in wet paddy culture with minimal and zero tillage techniques using paraquat for precrop planting weed control are described. Good crop establishment and growth were achieved with minimal and zero tillage and yields were similar to those obtained with conventional tillage. In the traditional cultivations, weeds were first slashed with a 'tajak' (scythe-like tool) followed by a 2-3 week period of flooding to facilitate decomposition, then by a second slashing to control regenerating weeds, followed by incorporation of the dead vegetation into the soil. This usually required 1 or 2 rounds of harrowing, followed by levelling and transplanting. Total time taken from the start of cultivation to planting was 4 to 5 weeks.

CAB (WA 21-1751) JAFC

paddy rice; Southeast Asia; traditional systems; land preparation; minimum tillage

22206

PANDE, H.K.; BHAN, V.M. Effect of varying degree of soil manipulation on yield of upland paddy (Oryza sativa) and on associated weeds. Canadian Journal of Plant Science (1964), 44(4):376-380 [Dept. Agric. Engng., Tech. Inst., Kharagpur, India].

Trials were conducted in 1961 and 1962 to determine the minimum level of soil manipulation required for adequate weed control in upland paddy. The main weeds present were Echinochloa crus-galli, Panicum capillare and P. sanguinale. Cyperus rotundus and C. iria appeared approximately 3 weeks after sowing. Removal of topsoil with a Khurpi (a hand tool, consisting of a blade 4-6 in. long and 2-3 in. wide attached to a wooden handle) and dibbling the seed was considerably less effective against weeds than plough planting with a country plough (consisting of a bar-point share attached to a wedge-shaped wooden shoe, which tills the soil with practically no inversion) or a mouldboard plough.

Both treatments resulted in lower yields than those obtained by using the standard cultivation technique of ploughing 4 times with a country plough and harrowing before sowing. Ploughing once with a mouldboard plough and harrowing once with a disc harrow before sowing resulted in yields similar to those obtained by using the standard cultivation treatment. It was concluded that ploughing with a mouldboard rather than a country plough resulted in better control of weeds, and that ploughing once with a mouldboard plough, followed by harrowing, was the minimum cultivation necessary for efficient production of upland paddy.

CAB (WA 13-1610) WA

paddy rice; Indian subcontinent; land preparation; hand tools; animal-drawn implements

2.23 Techniques for weed control in the crop

22301

INTERNATIONAL RICE RESEARCH INSTITUTE. The economics of cultural weed control. Report, International Rice Research Institute (1967), 246-254. [Int. Rice Res. Inst., Los Baños, Laguna, Philippines].

The optimum time of weeding in relation to yield, prices and labour costs was determined at 16 days after transplanting IR-8 rice in wet and dry seasons and 7-14 days after transplanting H-4 rice in the dry season (after 21-28 days in the wet season due to lodging). Regression curves of weed weights 70 days after transplanting against yields indicated that IR-8 rice was more responsive to better land preparation and more competitive with weeds than BPI-76-1 rice. The minimum level of land preparation consistent with no reduction in yield was determined as 3 passes of a carabao(water buffalo)-drawn harrow or 1 pass of a tractor-drawn harrow; the same ratio held for weed removal. Fewer weeds survived in the wet than in the dry season. Regression lines of the dry weights of weeds against labour time showed that there was little difference in labour requirement for weeding at different stages of the crop growth when land preparation was good. Land preparation and weeding appeared to substitute for each other after 2-5 passes of the tractor-drawn harrow; the time required for weeding varied inversely as the time spent on land preparation. The removal of the 0.732 t weed d.m./ha remaining 14 days after transplanting required 415 man-hours costing $0.11/h. The optimum number of harrowings was reached when the saving in the cost of handweeding was as low as the cost of 1 additional tractor harrowing ($4.36); at 14 days after transplanting this occurred with 3 passes of the harrow and at 28 days after transplanting with 4-5 passes of the harrow in the dry season.

CAB (WA 23-1899) WA

paddy rice; Southeast Asia; economic analysis; land preparation; timing

22302

INTERNATIONAL RICE RESEARCH INSTITUTE. Economics of mechanization. In: IRRI annual report for 1971 (1972), 154-156 [Los Baños, Laguna, Philippines].

The use of granular herbicides was the least expensive of the 4 alternative methods of weed control studied, over the whole range of farm sizes. Among the other methods, handweeding (P75/h) was cheapest for areas of < 0.1 ha,

a manual rotary weeder was cheapest for areas of 0.1-6 ha and a powered rotary weeder for areas > 6 ha. Most farmers in Laguna Province use a combination of hand, manual rotary and chemical weeding.

CAB (WA 22-2217) WA

paddy rice; economic analysis; manual implements; motor-powered implements; herbicides; herbicide application (granules)

2.24 Hand tools and manually-operated implements

see also no. 22302

22401

INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR. [Weeding rice with a rotary hoe]. Cahiers d'agriculture pratique des pays chauds (1965), (2): 109-112. [Fr] [Lake Alaotra Res. Sta., Madagascar].

Although many nonaquatic weeds are controlled by the flooding of rice paddies, weed growth may become important during the period between ploughing and transplanting or direct sowing. Trials at Lake Alaotra showed that hand hoeing (with Japanese or Formosan rotary hoes) was not as satisfactory as handweeding or the use of herbicides, but that it was rapid, simple and inexpensive.

A hand-operated rotary hoe has the advantage that it (i) destroys weeds and buries them, (ii) can be used by unskilled labour, (iii) has a good physical action on the soil, (iv) makes an excellent seedbed for nurseries and (v) is cheap and robust. Its disadvantages are that (i) it can only be used where rice is sown or transplanted in lines (minimum spacing of 25 cm), (ii) it must be used in a 5-10 cm depth of water, (iii) it must be used at the correct stage of growth of weeds (maximum height 15 cm) and (iv) there is no efficient depth control.

A description is given of a modified rotary hoe suitable for Malagasy conditions.

CAB (WA 15-1447) WA

paddy rice; East Africa; manual implements; inter-row cultivation

22402

YADAV, B.G. Design, development and field evaluation of a hand rake hoe weeder. In: Program and Abstracts of Papers, Weed Science Conference and Workshop in India (1977), Paper No. 186, 121 [Dep. Farm Mach. Power, Orissa Univ. Agric. Tech., Bhubaneswar, India].

A rake hoe was designed for removing the weeds (uprooting them while they are still very small) without smothering the small paddy plants with soil. The hoe works quite satisfactorily in the field and, on an average, replaces 8-10 khurpi-man-days. (Khurpi = local short-handled weeding hoe or fork.) Its construction is simple. It is being prepared by the village artisans in Orissa and costs only Rs 6/ unit.

CAB (WA 28-1121) WA

paddy rice; Indian subcontinent; manual implements; inter-row cultivation

22403

PRADHAN, S.N. A more efficient paddy hoe. Indian Farming (Nov. 1970), 15-16, 21. [Central Rice Res. Inst., Cuttack, Orissa, India].

A paddy hoe developed at the Central Rice Research Institute in Cuttack is described. It consists of an anterior wheel, a sweep-type shovel with a razor-sharp shank to cut through the soil, and a posterior handle. The operator walks behind the weeder and pushes it forward in the inter-row. It is claimed that it is 20 percent more efficient per man-hour than the Japanese-type rotary weeder under wet field conditions. The weeder costs about Rs 25 and can be made and repaired by local artisans.

ITDG JAFC

paddy rice; Indian subcontinent; manual implements; inter-row cultivations

22404

PRADHAN, S.N. Combined blade and rake-type paddy weeder both for dry and wet fields. Indian Farming (November 1968), 33, 35, 36 [Central Rice Research Inst., Cuttack, Orissa, India].

A paddy weeder which can operate efficiently in both wet and dry fields is described. It consists of one double-edge blade, one rake and a rotating drum (roller) attached to a sheet-iron frame, in different positions depending on whether the weeder is to be used in wet or dry conditions. The operator walks behind the weeder and pushes it forward in the inter-row. Man-hour and cost requirements are tabulated for this weeder and the Japanese-type rotary weeder under wet and dry field conditions. This weeder was up to 40% more efficient than the Japanese-type weeder under wet conditions and can be used in dry conditions where the Japanese-type weeder cannot be used.

ITDG JAFC

paddy rice; semi-arid tropics; Indian subcontinent; jute; manual implements; inter-row cultivation

2.25 Animal-drawn and motor-powered implements

22501

HERBLOT, G. [Control of weeds by mechanical means in certain annual tropical crops, particularly in the case of rice.] (Paper in) 26th International Symposium on Crop Protection, Part I. Mededelingen Fakulteit van de Landbouwwetenschappen, Gent (1974), 39(2):377-399 [Fr] [C.E.R.M.A.T., Parc du Tourvoie, 93160 Antony, France].

A review is given of the role of cultural control techniques in improving crop yields in French-speaking Africa. Mechanisation of weeding, through the introduction of animal traction or tractors, and the implements used (harrows, rotary hoes, rolling cultivators) are described for upland and paddy rice.

CAB (WA 24-1659) WA

paddy rice; upland rice; West Africa; animal-drawn implements; motor-powered implements

22502

ZERBO, D. [Description of a weeding machine for rice.] Note sur la mise au point d'une sarcleuse à riz. In 3e Symposium sur le Désherbage des Cultures Tropicales, Dakar, 1978, 8, Av. du Président Wilson, 75116 Paris France. COLUMA. (1978) Vol. II, 522-526 [Fr, en] [Div. du Machinisme Agricole, B.P. 155, Bamako, Mali].

The S.E.M.C.M.A. apparatus for weeding in rice is described and illustrated. It consists of a steel frame on two wheels and is fitted with 3 A-blades. It is pulled by animals and has two steering handles. It penetrates the soil to a depth of 7 cm, has a working width of 20 cm per blade and a working speed of 70 cm/second. It should be used on weeds of a moderate height only and use on muddy soil should be avoided.

CAB (WA 28-3837) WA

paddy rice; West Africa; animal-drawn implements; inter-row cultivation

22503

TARCHETTI, A. The control of weeds in rice fields [in Italy] by rolling. International Review of Scientific and Practical Agriculture (1918), 9(10):1192-1193.

A technique of 'rolling' weeds is described in detail. The corrugated roller with wooden laths of iron bars can be pulled by one or two horses. Rolling is especially successful in first-year rice fields and in those with numerous sedges; it is not recommended for grass weeds.

ITDG JAFC

paddy rice; Eurpoe; animal-drawn implements

2.26 Herbicides and herbicide application

22601

AKOBUNDU, I.O. Weed control in direct-seeded lowland rice under poor water management conditions. In: Proceedings of the 7th Meeting of the Ghana Weed Science Committee (1978), 61-65 [Int. Inst. Tropical Agric., PMB 5320, Ibadan, Nigeria].

Herbicides were evaluated for weed control and for their effects on crop yield in direct-seeded lowland rice under poor water management conditions characteristic of the conditions in which lowland rice is grown by most farmers in Nigeria, where land preparation is accomplished with local hoes.

Molinate and thiobencarb did not give good weed control under these water management conditions. Best control of sedges and broadleaved weeds was obtained by a mixture of cyperquat at 2 kg/ha + 2,4-D at 0.5 kg/ha applied post-em., but grain yields were reduced in comparison to the weed-free check. The highest yields of rice, comparable to those from the weed-free check and significantly greater than yields after 2 handweedings, were obtained by fluorodifen at 1.5 kg/ha + propanil at 2 kg/ha applied post-em., bentazone at 2 kg/ha applied post-em., and bifenox at 2 kg/ha applied pre-em.

Broadcast application of 2,4-D granules at 0.75 kg/ha gave yields comparable to those from 2 handweedings at 14 and 35 days after emergence. The use of 2,4-D granules is appealing to small farmers as no special equipment or new skills are needed to apply this formulation.

CAB (WA 29-3971) WA/JAFC

paddy rice; West Africa; herbicides; water management; herbicide application (granules)

22602

DATTA, S.K. DE; LACSINA, R.Q.; AHMAD, CH. M. Water management for granular herbicides in transplanted rice. International Rice Commission Newsletter (1970), 19(3):1-10 [IRRI, Los Baños, Laguna, Philippines].

In monsoon Asia, most rice is grown in fields where precise water control cannot be achieved. The use of water management in weed control in a number of countries is briefly reviewed, and a number of useful references given. A water depth of 15 cm has been found necessary to give good suppression of grasses and sedges. In areas in Taiwan where rotational irrigation is practiced, infestations of weeds are heavy because fields are not continuously flooded during the early growth of the rice crop. In Japan, weeds are controlled in the following programme: thorough land preparation before transplanting the rice seedlings, precise flooding to 3-5 cm depth, 2-3 mechanical weedings, and one or two handweedings of barnyardgrass (Echinochloa spp.). Liquid herbicides, which require the field to be drained to provide effective weed control, are unacceptable to most Asian rice farmers because of the uncertainty of rainfall amount and distribution. Granular herbicides are easy to apply and can be broadcast directly onto water. In this experiment, adequate weed control was obtained by flooding the rice to a depth of 5 cm for a minimum of 10 days after application of granular TCE-styrene in combination with the isopropyl ester of 2,4-D, or the granular formulation of EPTC in combination with MCPA.

CAB (WA 21-610) WA/JAFC

paddy rice; Far East; Southeast Asia; herbicides; herbicide application (granules); water management

22603

DICKINSON, L.; CARPENTER, A.J. Home-made granular formulations for applying chemicals to irrigated rice. PANS (1977), 23(2):234-235 [Central Agric. Exp. Sta., Suakoko, Liberia].

Spraying equipment can be costly and unwieldy for the small farmer in developing countries; granular formulations are often more practical, but can be expensive to buy. This paper describes the use of MCPA, 2,4-D and lindane in homemade granular formulations in irrigated rice in Liberia using dry sand and urea or ammonium sulphate as the carrier.

WRO A

paddy rice; West Africa; herbicide application (granules)

see also no. 12210

22604

GOSNEY, J. ULV spraying [of Ronstar 2D = oxadiazon + 2,4-D] from the bottle [in Thailand rice]. International Agricultural Development (1980), 2 (Nov/Dec), 26.

A bottle of Ronstar 2D (oxadiazon + 2,4-D) is converted to an ULV sprayer by cutting off flush the 3 nipples which poke through the cap; the farmer in Thailand walks

through the paddy rice field after transplanting, shaking the bottle alternately to the right and left every 5 paces. The herbicide is so formulated that when a drop hits the water (< 100 mm deep) it spreads rapidly outwards, the solvent evaporates and the active ingredients sink and form a herbicidal layer on the soil surface. About 4-5 litres/ha are used costing £15/ha.

CAB (WA 30-3373) WA

paddy rice; herbicide application (low volume)

2.27 Biological control

Herbivorous fish

22701

YUDIN, V.L. [Grass carp in a rice-fish rotation]. In: Nikol'skii, G.V., (ed.): Novye Issled Covaniya po Ekologii i Razvedeniyu Rastitel'noyadnyk Ryb [New investigations in the ecology and breeding of herbivorous fish], Nauka, Moskva (1968), 143-146 [Ru] [Inst. Zool. Parazitol. Akad. Nauk Uzbek. SSR, USSR].

Trials in the use of Ctenopharyngodon idella to control weeds in rice were carried out in paddies under a water fallow. Yearlings failed to control Phragmites communis and Echinochloa spp. in 1964 and so 2-year-old C. idella and Cyprinus carpio were stocked in 1965. The soil was ploughed deeply in spring and flooded with 5-10 cm of water which produced a dense growth of Echinochloa spp. and Cyperus spp. in mid-May. On 20 May, the water depth was increased to 25-40 cm before stocking with fish. Grass carp were stocked at 23 kg/ha; 2-year-old grass carp increased their weight from 305 g to 1985 g by autumn. Echinochloa spp., Scirpus spp., algae, Potamogeton spp. and foliage of P. communis were destroyed. Grass carp prevented the emergence of weeds above the water surface whereas paddies stocked with C. carpio only were overgrown.

CAB (WA 20-198) WA

herbivorous fish; paddy rice; USSR; fallow; aquatic weeds

22702

BATENKO, A.I.; SOROKHINA, Z.F. [Fish rearing as a method of controlling weeds in rice paddies]. Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Prudovogo Rybnogo Khozyaĭstra (1969), 16, 204-206 [Ru, en].

Infestations of weeds, mainly Echinochloa spp., progressively reduced yields of a monoculture of rice in the Krasnodar district from 4.6 t in 1953 to 1.3 t/ha in 1956; crop rotation is normally used to control weeds. A rotation consisting of 2-years rice followed by a 1-year crop of mixed fish was proposed; common carp (Cyprinus carpio) feed on weed seeds and rice pests, grass carp (Ctenopharyngodon idella) on macrophytes, and silver carp (Hypophthalmichthys molitrix) and bighead (Aristichthys nobilis) on plankton. In 1964-65, trials were carried out in rearing fish on rice fields under a water fallow in the Karakalpakskaya ASSR; the main weeds were Echinochloa crus-galli and E. oryzicola. Fish reduced large-seeded weed populations from 78-100 millions to 11-15 millions/ha or by about 85%. Sheep manure, used to fertilise paddies, contained 9000 seeds (20% viable) of Echinochloa macrocarpa/100 g but the seeds lost viability 45 days after the manure was submerged in the paddy. Rearing fish on paddies for 2 years running reduced weed infestation by 96%. In 1965, weed populations per ha were 76 millions in rice fields, 3.4 millions in lucerne, 1.2 millions in melon crops and 20 millions in a reservoir without fish.

CAB (WA 20-1176) WA

herbivorous fish; paddy rice; USSR; fallow; aquatic weeds

22703

CHIZHOV, N.I.; ANOSHIN, A.I. [Fish culture on rice fields under water fallow]. Trudy vsesoyuznogo nauchno-issledovatel'skogo Instituta prudovogo rybnogo Khozyaistra (1969), 16, 187-193 [Ru, en].

In June 1965, rice paddies under water fallow in the Karakalpakskaya ASSR were stocked with common carp (Cyprinus carpio) averaging 20 g by weight, grass carp (Ctenopharyngodon idella) averaging 90 g and bighead (Aristichthys nobilis) averaging 80 g; artificial feeds were supplied. The best stocking rates giving the highest fish production (1.2 t/ha)

were grass carp 200, common carp 600 and bighead 400/ha. Grass carp at stocking rates of 200-300/ha completely cleared paddies of vegetation including common reed (Phragmites communis) and clubrush (Scirpus sp.). In fish polycultures in Central Asia, the best stocking rate for both 2-year-old common carp and bighead was 500-600/ha and for grass carp 200-300/ha. Large-scale field trials showed that 75-85% of fish perished in shallow water less than 35 cm deep compared with 3-5% at a water depth of 50 cm.

CAB (WA 20-1177) WA

herbivorous fish; paddy rice; USSR; fallow; aquatic weeds

22704

CHIZHOV, N.I.; DEM'YANENKO, V.F. [Fish farming rice paddies under water fallow in order to improve them]. In: Acclimatization of herbivorous fish in the reservoirs of the USSR, edited by M.F. Yaroshenko. [Part of] Proceedings of the 7th All-Union Conference on the Acclimatization of Herbivorous Fish, Kishinev, 1972, Kishinev, Moldavian SSR, Shtiintsa, (1972) 136-139 [Ru] [Vses. n-i Inst. prud. ryb. Khoz., Moscow Zh-33, USSR].

In 1967-69, 9 paddies under a water fallow were stocked with 1-year-old common carp (Cyprinus carpio), 2-year-old silver carp (Hypophthalmichthys molitrix) and 2- and 3-year-old grass carp (Ctenopharyngodon idella). Common carp consumed 30-87% of weed seeds on the soil surface and increased rice production by 0.3-0.6 t/ha. Two-year-old grass carp stocked at 50-80 fish/ha and 3-year-olds at 15-20 fish/ha completely controlled all weeds in the paddies, of which the chief were weed millets (Echinochloa spp.), clubrushes (Scirpus spp.), rush (Juncus sp.), naiad (Najas sp.), bladderwort (Utricularia sp.), waterwort (Elatine sp.) and stoneworts (Chara spp.). As the plants were used up, the fish began to feed on detritus. Two-year-old silver carp preferred phytoplankton (Protococcaceae, Volvocaceae, Euglenophycaceae and diatoms), but also consumed zooplankton, detritus, sand and soil; the optimum stocking rate was determined to be 600-700 fish/ha. Fish production ranged from 0.74 to 0.95 t/ha; the addition of herbivorous fish increased production by 40-44%.

CAB (WA 23-1299) WA

herbivorous fish; paddy rice; USSR; fallow; aquatic weeds

22705

TSUCHIYA, M. Control of aquatic weeds by grass carp (Ctenopharyngodon idellus Val.). JARQ (Japan Agricultural Research Quarterly) (1979), 13(3):200-203 [Saitama Pref. Fish. Exp. Sta., 1060 Kitakchama Kazoshi, Saitama-ken, Japan 347].

Grass carp (sogyo in Japanese) was introduced to Japan in World War II, but reproduces naturally only in the Tone River System. Elsewhere, spawning is artificially induced by hormone injection. An experiment at Ueda in a heavily infested reservoir showed that 100 fish averaging 200 g in weight, or 50 fish of 750 g, or 30 fish of 2 kg, were required/ha for weed control. Weed control by grass carp is widely practised in fish ponds, castle moats, park lakes and factory reservoirs. The culture of common carp (Cyprinus carpio) and Tilapia mossambica in paddy fields is widely practised in Southeast Asia. Stocking 30 g grass carp at 1-6/10 m^2 has completely controlled weeds in a paddy field. Floating weeds disappeared after 1-1½ months, followed by submerged species. The grass carp has a preference for cereals and so should not be stocked until rice seedlings are well established; complete submergence of the rice seedlings should be avoided. Grass carp weighing 0.5-2 kg grazed areas of 4-30 m^2 in fallow paddies and controlled Typha latifolia, Isachne globosa and Phragmites communis (= P. australis). Weed infestation is a great problem in the eutrophic waters of irrigation canals; stocking grass carp at 20-50 g fish/m^2 was effective especially with release at about the time of weed emergence. There was little difference in weeding ability between fishes in the 0.3 to 1 kg weight classes. Grass carp cost only half as much as other methods of weeding cereals.

CAB (WA 29-3273) WA

herbivorous fish; paddy rice; Far East; fallow; aquatic weeds

22706

INDIAN FARMING. Use grass carp for weed control. Indian Farming (1971), 21(5): 45-47 [Central Inland Fish Res. Sub-Stn. Cuttack, Orissa].

Grass carp 10 cm long (weighing 15 g) are stocked at 1000-2000 fish/ha (according to weed density) for the control of the floating weeds Wolffia, Lemna, Spirodela and Azolla spp. Fish 20-30 cm long (100-200 g) are stocked at 200-1000/ha to control the submerged weeds Hydrilla, Najas, Ceratophyllum, Potamogeton, Utricularia and Myriophyllum spp.; some control is also afforded of Ottelia, Nechomandra, Vallisneria, Trapa, Limnophila and Salvinia spp. Induced breeding and rearing are described.

CAB (WA 21-3015) WA

herbivorous fish; Indian subcontinent; aquatic weeds

22707

SOEWARDI, K.; NURDJANA, M.L.; LELANA, I.J.B. Some ecological impacts of the introduction of grass carp (Ctenopharyngodon idella Val.) for aquatic weed control. In: Proceedings of the 6th Asian-Pacific Weed Science Society Conference, Jakarta, Indonesia, 1977 (1979), Vol. 2, 451-458 [BIOTROP, Bogor, Indonesia].

The faeces of grass carp (Ctenopharyngodon idella) indirectly cause deterioration of water quality, such as a decrease in dissolved oxygen. A mixed culture in equal weight of grass carp and kissing gourami (Helostoma temmincki) reduced the deterioration of water quality. When the plankton feeder constituted only 30% of the total fish population, the deterioration of water quality still occurred. A mixed culture with common carp (Cyprinus carpio) did not reduce the deterioration of water quality. Another ecological implication of the use of grass carp for biological control of aquatic weeds is its preference for the rice plants. The presence of hydrilla (Hydrilla verticillata) significantly reduced the consumption of rice by grass carp, while the presence of salvinia (Salvinia cucullata) and waterhyacinth (Eichhornia crassipes) did not decrease the damage to rice.

CAB (WA 29-3699) A

herbivorous fish; paddy rice; Southeast Asia; aquatic weeds

22708

MORÃES, S. DE. [Fish culture and biological control in rice fields]. A piscicultura e o controle biológico nos arrozais. Lavoura Arrozeira (1976), 29 (294):17-18 [Pt].

Weeds in irrigated rice fields can be controlled by herbivorous fish such as Tilapia rendalli, T. zilli or Puntius javanicus, and algae, by T. mossambica. All these fish are well adapted to the Brazilian environment.

CAB (FA 39-697) FA

herbivorous fish; paddy rice; Brazil; aquatic weeds

22709

HAUSER, W.J.; LEGNER, E.F.; MEDVED, R.A.; PLATT, S. Tilapia - a management tool. Fisheries (1976), 1(6):24 [Div. Biol. Control, Univ. of California, Riverside, CA, USA].

Tilapia are cultured in the southern states for sport and commercial fishing, and in Southern California, T. mossambica and T. zillii are used for the control of aquatic weeds and noxious insects in various habitats, including irrigation canals, recreational lakes, ornamental ponds and sewage treatment lagoons. The most extensive application has been the use of T. zillii for weed control in irrigation canals and drainage ditches. In some cases, stocking rates of 75 mm fish of 2500/ha were effective whereas, in others, integrated biological and mechanical control was needed. The use of T. zillii is economically feasible and saves energy and herbicides. Two disadvantages are its dislike of low winter temperatures, necessitating year-round culturing, and its dislike of Myriophyllum spicatum; it prefers Potamogeton pectinatus, Najas guadalupensis and Chara sp. The mixing of T. mossambica with T. zillii broadened

the spectrum of weeds controlled; a stocking rate of 1450 fish/ha gave better weed control than herbicides. Stocked in paddies after rice emergence, Tilapia will control emerging weeds and insects, converting them to fertiliser. At rice harvest, Tilapia could provide extra protein or be ploughed in as a fertiliser. About 160 kg T. mossambica/ha was produced in small rice ponds in 3 months in 1975, a 9-fold increase in biomass over the amount stocked, and no supplemental feeds were added.

CAB (WA 27-3687) WA

herbivorous fish; paddy rice; North America; aquatic weeds

22710

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS. Fish in rice-fields. International Rice Commission Newsletter, June 1961.

In a 3.2 ha rice field into which milk fish (Chanos chanos) had been introduced, growth and maturing of rice were more rapid, and tillering was greater, than in an adjoining field in which no fish were used. Fish were helpful in controlling algae and other weeds. Rice yield was estimated to be higher from the field with fish than from the field without.

CAB (FCA 15-1186) FCA

herbivorous fish; paddy rice; Southeast Asia; aquatic weeds

22710A

Coche, A.G. Fish culture in rice fields. A world-wide synthesis. Hydrobiologia (1967), 30(1), 1-44 [FAO Dept. of Fisheries, Fishery Resources and Exploitation Division, Inland Fishery Branch, Rome].

Fish culture in rice fields has been known for centuries in Asia, and the practice is increasing in Africa and the USA. Under proper conditions, fish can greatly contribute to the control of algae and weeds, snails (bilharzia vectors) and mosquitos (malaria vectors). There are two main types of culture: in the captural system, wild fish are admitted in the fields with the irrigation water. In cultural systems, chosen fish species are deliberately stocked and raised together with the rice (rizipisciculture) or in rotation with rice. This paper reviews economic and technical aspects of fish culture in rice fields under the following headings: The rice fields as fish environment; Main fish cropped in rice fields, Biological control in rice fields [of weeds and pests]; Socioeconomic importance; Critical analysis of fish culture; Problems, research and future; Worldwide survey [of culture techniques]. The main fish species discussed are Cyprinus carpio (common carp) and Tilapia mossambica, with additional notes on Carassius auratus, Catla catla, Chanos chanos, Cirrhina mrigala, Clarias batrachus, Ictalurus punctatus, Ictiobus cyprinellus, Labeo rohita, Ophinocephalus striatus, Puntius javanicus, Tinca tinca, and Trichogaster pectoralis.

ITDG JAFC

paddy rice; herbivorous fish; aquatic weeds

see also Vincke, M.M.J. [Situation as regards rice paddy aquaculture and its future role]. Situation et role futur de l'aquiculture en rizières. Paper presented at an FAO Technical Conference on Aquaculture, Kyoto, Japan, 1976. FIR: AQ/Conf/76/R.35.

Other organisms

22711

YEO, R.R.; FISHER, T.W. Progress and potential for biological weed control with fish, pathogens, competitive plants and snails. [Paper presented at] 1st FAO International Conference on Weed Control, University California, Davis (1970), WC/70:WP/37, 15 [USDA, Univ. California, Davis, CA, USA].

Although this paper is concerned with aquatic weed control in the USA, some of the information in it may be useful elsewhere. The preferences of 8 species of fish for 35 aquatic plant species and effective stocking rates and times to effect weed control are tabulated. Effective stocking rates cited for grass carp about 30 cm long vary from 49-99 to 1693 fish/ha to effect control in 2-3 months.

The Caribbean snail (Marisa cornuarietis) can be expected to thrive only in tropical or subtropical fresh waters. Maximum feeding and reproduction occur at water temperatures of 21 to 32°C; it feeds

readily on submersed rice seedlings, but not on emerged rice. At 26.5°C the eggs hatch in 10-12 days. Egg production begins 4½-5½ months later. The snail is unisexual; oviposition is not contingent on fertilisation, but unfertilized eggs do not produce embryos. It is selectively polyphagous and seems to prefer broadleaved or floating plants, is highly sensitive to molluscicides, but can protect itself from certain herbicides, does not act as a host to the common and animal trematodes, and has no specific enemy. In small impoundments, a single release, plus the progeny produced by the single inoculum, can control certain aquatic plants in < 2 years.

CAB (WA 20-2692) WA

biological control; aquatic weeds; herbivorous fish; paddy rice

22712

MATSUNAKA, S. Tadpole shrimp: a biological tool of weed control in transplanted rice fields. In: Proceedings of the 5th Asian-Pacific Weed Science Society Conference, Tokyo, Oct. 5-11, 1975 (1976), Asian-Pacific Weed Science Society, 439-443.

Three species of tadpole shrimp, Triops longicaudatus, T. granaris, and T. cancriformis, can be found in Japan. They can be used for weeding in fields of transplanted rice. Their leg-like organs agitate the soil and, at the same time, mechanically damage newly emerged weeds. They feed on the soft parts of weeds. 20-30 tadpole shrimps per square metre give good control of weeds.

A survey of their distribution in Japan found tadpole shrimps only in well-drained or semi-ill-drained paddy soils. In some districts, many farmers are already aware of their usefulness and endeavour to keep them in the fields. They are, however, susceptible to insecticides and some herbicides. A technique for the mass production of eggs is needed.

CAB (WA 26-2260) A

tadpole shrimp; paddy rice; Far East; aquatic weeds

22713

MATSUNAKA, S. Further research on tadpole shrimps for biological weeding. In: Proceedings of the 6th Asian-Pacific Weed Science Society Conference, Jakarta, Indonesia, 1977 (1979), Volume 2, 447-450 [Nat. Inst. Agric. Scis., Konosu, Saitama 365, Japan].

The effect of tadpole shrimps (Triops spp.) on rice seedlings, especially young seedlings at the 2.5-leaf stage and suitable for mechanical transplanting, was investigated. The results showed that there was no damage to young seedlings by tadpole shrimps, even in the case of irregular and rough transplanting operations. Introduction of egg-containing soil into paddy fields, which had been flooded, did not result in the occurrence of tadpole shrimps. The effect of the flooding date before the introduction of tadpole shrimps was tested using experimental concrete pots. Although the pots were flooded 3, 6, and 9 days before the introduction of eggs, no tadpole shrimps could be observed. Only when the eggs were introduced at the same time as flooding were a moderate number of tadpole shrimps observed. It appears that the natural enemies, which had hatched prior to the tadpole shrimps, took their toll when the introduction of the eggs was delayed. Actual labour of weeding was estimated in paddy fields where a number of tadpole shrimps occurred and no pesticide was used. Total weeding labour, 20 h/ha (for a single handweeding carried out at 40 days after transplanting, all previous weeding being left to the tadpole shrimp), was significantly less than the average of 100 h/ha for present weeding systems in Japan, including the use of herbicides.

CAB (WA 29-2943) WA

tadpole shrimp; paddy rice; aquatic weeds; Far East

22714

YONEKURA, M. Weeding efficacy of the tadpole shrimp (Triops spp.) in transplanted rice fields. In: Proceedings of the 7th Asian-Pacific Weed Science Society Conference, Sydney, Australia (1979), 237-240 [Kanagawa Pref. Agric. Res. Inst., Hiratsuka, Kanagawa, 259-12, Japan].

In order to study the efficacy of Triops spp. as an agent for biological control of weeds in transplanted rice fields, many eggs deposited in the soil were released in the plots at puddling time and the relations between their population and suppression of weed growth were examined. The results obtained are as follows: some metanauplii and young tadpole shrimps (Triops granarius, T. longicaudatus) were found on the 4th day after puddling, close to the time of weed emergence. The successful population density of tadpole shrimps for control of weeds was estimated at 50 or more/m^2. They did not damage the transplanted rice plants.

CAB (WA 29-3564) A

tadpole shrimp; paddy rice; aquatic weeds; Far East

22715

YONEKURA, M. [Biological control of weeds by tadpole shrimps in paddy field - weed efficacy of tadpole shrimps in transplanted rice fields]. Weed Research, Japan (1979), 24(2):64-68 [Ja, en] [Kanagawa Prefectural Agric. Res. Inst., Hiratsuka, Kanagawa, Japan].

Tadpole shrimp (Triops granarius and T. longicaudatus) eggs were released in experimental plots of transplanted rice at puddling time. The eggs hatched on the 4th day after puddling at almost the same time as weed emergence and the shrimps began to scratch the soil surface 6-7 days later. Weed populations decreased with the increase in shrimp populations. The effective population density of tadpole shrimps for weed control was estimated at 50/m^2; shrimps did not damage the transplanted rice.

CAB (WA 30-1102) WA

tadpole shrimp; paddy rice; Far East; aquatic weeds

see also TAKAHASHI, F. Triops species for the biological control of weeds in Japanese paddy fields. Entomophaga (France) (1977), 22(4):351-357.

22716

FONTENOT, H.A. Feathered weed control: wild ducks fight red rice. Rice Journal (New Orleans) (1973), 76(3):14.

Some rice farmers in southwest Louisiana flood their fields during the winter fallow season to encourage wild ducks to inhabit the fields and eat red rice and other weed seeds in the top zone of the soil. Wild ducks are thought not to spread seeds because most seeds are broken up and completely digested by the birds.

CAB (WA 23-735) JAFC

North America; paddy rice; fallow; biological control; annual problem weeds; weed seed source reduction

2.28 Utilisation of 'weeds'

22801

DATTA, S.C.; BANERJEE, A.K. Useful weeds of West Bengal rice fields. Economic Botany (1978), 32(3):297-310 [Dep. Bot., Univ. Calcutta, Calcutta 700019, India].

Out of 158 weed species collected from rice fields of Hoghly and Midnapore districts of West Bengal, 124 possess economic importance in one way or other. The various uses of these weeds may aid dealers in crude drugs, manufacturers of plant products, or persons interested in the beneficial aspects of plants.

CAB (WA 29-2704) A

Indian subcontinent; paddy rice; utilisation

2.3 CONTROL OF PROBLEM WEEDS

2.31 Perennial problem weeds

23101

VERGARA, B.S.; MOODY, K.; VISPERAS, R.M. Autecology of Scirpus maritimus L. (4). Suggested control under field conditions. Philippine Weed Science Bulletin (1977), 4, 7-12 [Int. Rice Res. Inst., Los Baños, Laguna, Philippines].

The shift to semi-dwarf rice varieties and continuous cropping has aided the spread of the perennial sedge S. maritimus. Control methods reviewed include handweeding, harrowing, competitive cropping with tall rice varieties and with longer duration varieties, ploughing 10-20 days after harvest, desiccation of the tubers, crop rotation and the use of herbicides. The best herbicides are fenoprop, oxadiazon and bentazone; they could be economical if the cost were spread over 2 or more crops.

CAB (WA 28-2309) WA

paddy rice; Southeast Asia; perennial problem weeds; herbicides

23102

DATTA, S.K. DE. Approaches in the control and management of perennial weeds in rice. In: Proceedings of the 6th Asian-Pacific Weed Science Society Conference, Indonesia, 1977, Volume 1, 204-225 [Dep. Agron., Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

Increased use of herbicides to control annual rice weeds in temperate East Asia has resulted in serious problems with perennial weeds. For tropical Asia, there is evidence that, given reliance on a single method of weed control, such as continuous use of the same or similar herbicides, perennial weeds could create a similar serious problem. Rice farmers must integrate all available and relevant technologies to reduce the losses of grain yield and quality caused by all weeds. As direct methods of perennial weed control, handweeding, the use of a push-type rotary weeder, mechanical weeding, and herbicides are alternatives from which rice growers can choose. For indirect methods of perennial weed control, appropriate land, water, soil and weed management practices should be developed. The use of a rice variety that competes better with perennial weeds, the transplant method of planting and suitable cropping systems could minimise further the buildup of difficult-to-control weeds, such as perennials. Various approaches should be followed to develop suitable management of perennial weeds in rice. An efficient perennial weed management system for rice should integrate preventative measures, crop rotation, soil and water management practices, tillage practices, use of competitive varieties and herbicides. Integrated weed control in the management of perennial weeds must be compatible with the management of annual weeds and other pests, such as insects and diseases and with other practices that help in increasing rice production. Furthermore, in developing suitable controls for perennial weeds in rice the farmer's resource capabilities must be considered.

CAB (WA 27-1755) WA

Southeast Asia; paddy rice; perennial problem weeds; upland rice; herbicides

see also no. 21012 for a brief review of more recent work

2.32 Annual problem weeds

see also nos. 22102, 24001

23201

RAI, B.K. The red rice problem in Guyana. PANS (1973), 19(4):557-559 [Central Agric. Sta., Mon Repos, Guyana].

High red rice incidence in Guyana paddy fields is encouraged by the use of season-bound rice varieties maturing in 140-150 days, while red rice matures earlier. Hurried dry-seedbed preparation, a result of the tractor shortage and the need for nearly simultaneous preparation of all fields, encourages red rice germination. The solution suggested is the cultivation of short duration (90-110 days) period-bound varieties, with short stature (70-90 cm) enabling the taller red rice (150 cm) to be rogued out, and with good seedling vigour enabling sowing in a wet seedbed; secondly, thorough seedbed preparation and the sowing of pregerminated seed or transplanted seedlings.

CAB (WA 23-2109) JAFC

paddy rice; northern South America; annual problem weeds; land preparation; cultivar selection; weed seed source reduction

23202

SONNIER, E.A. Red rice studies: water management experiment (a preliminary report). In: 71st Annual Progress Report, Rice Experiment Station, Crowley, Louisiana, USA, 1979 (1980), 101-112.

In a comparison of water management practices for red rice control, continuous flooding from the time of sowing to preharvest drainage resulted in the greatest reduction of red rice plants, from both April and May sowings, while drainage immediately after sowing followed by gradual reflooding as the crop took root provided the greatest suppression of red rice seed. Delayed flooding (until the rice plants were large enough to withstand full flooding) resulted in the highest number of rice seedlings and the lowest crop yield.

CAB (WA 30-845) WA

paddy rice; North America; annual problem weeds; water management

2.4 WEED CONTROL IN DEEP-WATER RICE

24001

VALLÉE, G. [Use of cultural techniques to control annual wild rice (O. barthii) in the Niger bend (Mali)]. Utilisation de techniques culturales dans la lutte contre le riz sauvage annuel (O. barthii) dans le Boucle du Niger (Mali). In: 3e Symposium sur le Désherbage des Cultures Tropicales, Dakar, 1978, 8, Av. du Président Wilson, 75116 Paris, France; COLUMA. (1978) Vol. 1, 304-311 [Fr, en].

The development of floating rice crops with controlled submersion in the Niger River sweep in Mali have been associated with a rapid spread of Oryza barthii. This is most effectively controlled by hand hoeing, together with various weed cutting and ploughing programmes, but labour shortage has led to the need for mechanised hoeing; a multi-cultivator to hoe after drilling with a 4-row seed drill has been developed. In the long term, increased technical knowledge on the part of local farmers will be essential if O. barthii is to be controlled.

The most effective methods of control are combinations of hand hoeing with the following tillage systems:

(1) Water weed cutting (1st year) followed by ploughing at the end of the season (2nd year)

(2) Ploughing at the beginning of the season followed by several cultivations at intervals of a few days

(3) Ploughing at the beginning of the season just before flooding (1st year) followed by late ploughing at the end of the season (2nd year)

CAB (WA 28-3914) WA/A

West Africa; deep-water rice; annual problem weeds; land preparation

24002

DATTA, S.K. DE; BANERJI, B. Recent developments in cultivation of deep-water rice. MACCO Agricultural Digest (1979), 4(1): 9-16 [Rice Res. Sta., Chinsurah, West Bengal, India].

Present cultural practices in deep-water rice in India are reviewed. Seeds are broadcast onto dry land at the beginning of the rainy season, or sown in nurseries and the seedlings transplanted. In the broadcast crop, usually 2-3 weedings are given with the Bidha (bullock-drawn, bamboo-tooth harrow) at intervals of 10-12 days when the rice is 15 to 20 cm tall, with supplementary handweeding. When the crop is 30 to 40 cm high, the field is ploughed crosswise with a light plough. Following this, handweeding, thinning and filling of gaps with transplanted seedlings are carried out. These operations are done in shallow water (20-25 cm depth). Generally, cultivators build barricades around their rice plots to protect them from water hyacinth. Floating filamentous algae are controlled by skimming with a tin or bucket or applying copper sulphate at 10-12 kg/ha.

CAB (WA 29-44) WA

Indian subcontinent; deep-water rice; land preparation

24003

CATLING, H.D.; THORNHILL, E.W.; ISLAM, Z. A boat-mounted spray boom for deepwater rice. Tropical Pest Management (1980), 26(1):56-60 [Deepwater Rice Pest Management Project, Bangladesh Rice Research Institute, Jaydebpur, Bangladesh].

A lightweight spray boom for applying pesticides in flooded rice was designed and built in Bangladesh for use with a local type of boat. The 5 m long boom is equipped with 4 Micron rotary atomisers powered by a 12-volt car battery and can spray a 4 m swath on one side of the boat. Two operators are required - one to propel the boat and another to supervise spraying. The equipment is described in detail, with photos and diagrams. The spray boom has been successfully used in Bangladesh for spraying insecticide in crop loss assessment experiments and is probably suitable for spraying herbicides.

CAB (WA 30-1267) A/JAFC

Indian subcontinent; deep-water rice; herbicide application equipment; herbicide application (low volume)

24004

GRIST, D.H. Rice. Longmans, London (1965), 4th ed., 548 pp., 734 ref.

Chapter XII Weeds, pp. 260-275, A review. Includes the information that, in East Pakistan, jute (Corchorus sp.) and Sesbania spp. are sometimes cultivated on river banks to exclude Eichhornia crassipes from beds of deep-water rice.

-- WA

paddy rice; herbicides; deep-water rice; Indian subcontinent; cover crops

3. HIGHLAND AND TEMPERATE ZONE

3.1 WEED CONTROL SYSTEMS (EXISTING AND INNOVATIVE)

31001

BENGTSSON, B. Cultivation practices and the weed, pest and disease situation in some parts of the Chilalo auraja. Mimeograph Publication, Chilalo Agricultural Development Unit (1968), pp. 62 + 9.

Information is given on the cultivation practices and weed status in the North and South Asella, Yehoma and Dighella areas of the Chilalo auraja (Ethiopia), based on field surveys and farmer interviews conducted during 1967. Notes are provided on the following frequently-occurring weeds: Snowdenia polystachya, Polygonum nepalense, Guizotia sp., Avena spp. (particularly A. strigosa), Galium spurium, Lolium temulentum, Galinsoga parviflora, Datura stramonium, Rumex bequaertii and R. abyssinicus. Other weeds of local importance include Phalaris paradoxa, Setaria acromelana, Cynodon dactylon, Digitaria scalarum, Cotula abyssinica, Lactuca capensis, Satureja pseudosimensis, Chenopodium album, Geranium sp. and Stellaria media. Under conditions characterised by poor seedbed preparation and broadcast sowing, hand pulling is the main method of weed control, but the significance of weed competition does not appear to be fully appreciated and weeding is seldom sufficiently intensive to exploit yield potentials, which would more than offset additional labour costs. At present, wheat, barley and teff (Eragrostis abyssinica) are seldom weeded, whereas maize and sorghum are ploughed once in a weeding/thinning operation and hand-weeded twice, and broad beans are generally weeded twice.

CAB (WA 20-5) WA

East Africa; traditional systems; wheat; local cereals; cereals; maize; sorghum; grain legumes

31002

ZAHIR, M.A.; GUPTA, V.K. Management of weed control: a behavioural analysis of farmers in Punjab. Pesticides (1979), 13(10):18-24 [Dep. Business Management, Punjab Agric. Univ., Ludhiana, India].

A survey of weed control practices was carried out among a total of 56 wheat-growing farmers in the Jullundar and Amritsar provinces of Punjab. Phalaris minor was a problem of wheat throughout the state, though wild oats (Avena sp.) and Chenopodium sp. were most pronounced in the wheat-potato rotations of Jullundar East. Only 12.5% of the farmers took no steps at all to control weeds, while of the remainder, 50% used combined cultural and chemical control measures. Tribunil (methabenzthiazuron) was the most frequently used herbicide (60%), followed by 2,4-D (40%) and Tok E-25 (nitrofen) (36%).

CAB (WA 30-1641) WA

Indian subcontinent; wheat; root and tuber crops; herbicides

3.2 TOOLS AND TECHNIQUES

32001

EVERAARTS, A.P. Tools used for weeding in highland horticulture in Java, Indonesia. In: Proceedings of the 6th Asian-Pacific Weed Science Society Conference, Jakarta, 1977 (1979), Vol. 2, 364-368 [Agron. Div., Horticultural Res. Inst., Pasarminggu, Jakarta, Indonesia].

A brief description of highland horticulture in Java, Indonesia is given. The tools being used for weed control are described and drawings of six weeding knives and hoes are included. It is suggested that lighter Dutch hoes replace traditional heavy weeding hoes.

CAB (WA 29-3095) JAFC

Southeast Asia; traditional systems; hand tools; vegetable crops

32002

GADE, D.W.; RIOS, R. Chaquitaclla. The native footplough and its persistence in central Andean agriculture. Tools and Tillage (1972), 2(1):3-15 [Univ. of Vermont, Dept. of Geography, Old Mill Building, Burlington, VT 05401, USA].

The chaquitaclla, taclla, or Andean footplough is a tillage implement indigenous to the Central Andes, consisting of a wooden shaft (1-1.5 m), a handle, a footrest bound to the shaft by leather thongs, and an iron share (about 7.5 cm wide, 23 cm long). It is used on poor mountain soils where the land is rested for an average of four years before each cropping cycle of 2-3 years. The scratch plough introduced by the Spaniards is not sufficiently strong to break the dense sod after the fallow period, and the wooden traction plough is unsuitable for small or rocky plots and steep slopes. The taclla therefore continues to be used in these situations and to combat kikuyu grass (Pennisetum clandestinum). Its use is somewhat similar to a spade, in that each clod is cut with the ploughshare and pried from the ground, but it is not equipped to raise, cradle and turn the sod, and this is done with sticks by other members of a ploughing team. Later, a wooden mallet or mattock is used to break up the clods before planting.

ITDG JAFC

Andean countries; hand tools; land preparation; shifting cultivation; perennial problem weeds

3.3 WEED CONTROL IN PARTICULAR CROPS

33001

ALKÄMPER, J.; MANIG, W. [Weed control in teff]. (Paper at Symposium Arbeitsgruppe Unkrautprobleme Warmer Klimate im Arbeitskreis Herbologie der DPG, Stuttgart-Hohenheim, 1972).

Berichte aus der Abteilung fur Herbologie an der Universität Hohenheim (1972), No. 3, 65-80 [De, en] [Tropeninst., Justus Liebig-Univ. Giessen, German Federal Republic].

Experience with weed control in teff (Eragrostis abyssinica) in Ethiopia is described and possibilities for the use of herbicides are examined. As a rule, fields are ploughed after harvesting the previous crop and left to dry out, while, in addition, burning-off is practised in many parts of the country. Between onset of the rains and sowing, plots are ploughed a further 4 or 5 times and the soil consolidated. After tillering, the crop is handweeded once or twice. Among the possibilities for chemical weed control, both MCPA and 2,4-D control broadleaved weeds, but with the former resulting in the higher yield increases. Cost analyses are provided of hand and chemical weed control operations and their profitability in terms of estimated yield increases. Handweeding at a labour cost of E$30-40/ha shows marginal profitability, but two weedings (rarely practised) can result in 94% yield increase and a satisfactory profit margin. MCPA, diuron and linuron appear economically justifiable.

CAB (WA 22-1261) WA

East Africa; local cereals; traditional systems; herbicides; economic analysis

4. HUMID TROPICS

4.1 WEED CONTROL SYSTEMS (EXISTING AND INNOVATIVE)

4.11 Manual-powered systems

41101

SURYATNA, E.S.; McINTOSH, J.L. Weed control in a shifting cultivation and permanent agriculture. In: (Proceedings), BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 14 pp. [Central Res. Inst. Agric., Bogor, Indonesia].

Shifting cultivation can only be appropriate if it is well managed and the land is put into a perennial crop-based system for the long term. Weeds will be no problem provided there is a good cropping pattern that permits continuous or partial cover of the land throughout the year. Irrespective of whether the aim is weed control or weed management, the objective should be the same: to reduce weed infestations to a level at which yield loss is prevented. Numerous methods of weed control are available which should be used in combination rather than separately.

Stabilising shifting cultivation can be based on two approaches that are agronomically productive and ecologically sound. In the first year of the indigenous perennial crop-based cropping system, the trees are cut and burned during the dry season, and rice is dibbled into the untilled soil between the stumps at the beginning of the rainy season. At the time the rice is sown, small trees are planted in a 2.5 m spacing arrangement, for shade and as living poles for pepper vines which are planted 3 months later. Two months after the rice, coffee is planted in a 2.5 m X 2.5 m spacing equidistant from the shade trees, and cassava is planted in the pepper rows about 80 cm from the pepper plants. A legume crop can be grown after the rice is harvested, and a food crop can be planted in the second year. Coffee is harvested from the fourth to sixteenth year, and rubber later dominates the system. After 20 years the plantation is broken open. Kudzu (Pueraria phaseoloides) can be planted between the trees to improve soil fertility from the third year.

In the food crop-based cropping system, continuous relay and intercropping of maize, upland rice, cassava and grain legumes is combined with early weed control and return of crop residues as a mulch for each succeeding crop. Perennial weeds are shaded out.

CAB (WA 28-2559) WA/JAFC

Southeast Asia; shifting cultivation; traditional systems; novel systems; sequential cropping; intercropping; mulching; cover crops; coffee; rubber; grain legumes; cassava; maize; upland rice; perennial problem weeds; perennial crops; planting techniques

see also no. 43104

41102

WELSH, N.S. JR. Control of weeds in swidden agriculture. In: Proceedings of the 7th Asian-Pacific Weed Science Society Conference, Sydney, Australia (1979), 409-412 [Australian Baptist Missionary Soc., Box 29, Chiang Mai, Thailand].

The tribes of Northern Thailand use swidden technology to grow their staple crop of upland rice and cash crops of soyabean, sesame, maize and opium poppy. Yields are low and chemical input minimal. The lifestyle and agriculture of tribes is described, because consideration of weed control is useless without knowing the overall system. Weeds are controlled by hand pulling or cutting, although recently some experimenting with herbicides has occurred. In a society where people and time are abundant, economic aspects of weed control require careful examination. Despite the problems of finance, packaging and illiteracy, herbicides may be a worthwhile innovation. However, there is a need to identify appropriate products, to evaluate the use of equipment, and to investigate the use of suboptimal herbicide rates combined with handweeding.

CAB (WA 29-3115) A

Southeast Asia; shifting cultivation; traditional systems; economic analysis

41103

MOHAN LAL, K.B. Eradication of Lantana, Eupatorium and other pests. Indian Forester (1960), 86(8):482-484 [Conservator of Forests, Assam, India].

In the Khasi and Jaintia Hills, the Khasi people have brought Lantana camara and Eupatorium odoratum under control by using them to enrich the soil. The branches are cut, laid over cultivated areas, allowed to dry, covered with sods which are allowed to dry, and then slowly burned. After light hoeing, potatoes and other vegetables are planted and cow dung added at the same time. Other crops such as maize or sweet potato are planted after harvesting the potatoes, and the area is then left uncultivated for 5 to 10 years.

CAB (WA 10-1257) FA

Indian subcontinent; shifting cultivation; traditional systems; perennial problem weeds; utilisation

41104

BERNSTEN, R.H.; HERDT, R.W. Towards an understanding of milpa agriculture: the Belize case. Journal of Developing Areas (1977), 11(3):373-392 [Dept. of Agric. Economics, Univ. of Illinois, Urbana-Champaign, IL, USA].

The paper describes the milpa indigenous agricultural system in Belize, and possible means of increasing its productivity. A detailed description is given of the crop production process including site selection, land clearing, seed selection and planting, intercropping, weeding and harvesting. Costs and labour inputs for each part of the production process are given. Measures to improve productivity should concentrate on the times of labour shortage at weeding and planting, possibly by introducing hand planters and granular herbicides.

CAB (WAERSA 20 -6894) JAFC

Central America; shifting cultivation; traditional systems; economic analysis; maize; Phaseolus; intercropping

41105

HAMMERTON, J.L. A role for herbicides in the transition from slash and burn farming. In: Abstracts of 1979 Meeting of the Weed Science Society of America (1979), 69 [Caribbean Agric. Res. Devel. Inst., Belize].

The 'milpero' or slash and burn farmer in Belize usually abandons his land ('milpa') after only 1 or 2 crop seasons. In the first place, this is because severe weed problems develop which would normally require much hand labour for cutting in order to plant further crops and, secondly, because a decline in soil fertility results from cropping, leaching and erosion. Experiments in Belize have shown that paraquat gives excellent desiccation of the dense stands of predominantly grass weeds commonly encountered after two cropping seasons, leading to an effective burn. Pre-em. atrazine gave good control of weeds in maize sown after burning, resulting in improved growth and yields. Fertiliser without pre-em. atrazine also gave substantial increases in yield, but at much greater cost. Similar results were obtained with dry beans where 3 inter-row weedings gave large yield increases. These findings are discussed in relation to extension methods among 'milperos' in seeking to encourage more settled farming practices.

CAB (WA 29-972) A

Central America; shifting cultivation; traditional systems; novel systems; economic analysis; social analysis; herbicides; maize; Phaseolus

41106

SORIA, J.; BAZAN, R.; PINCHINAT, A.M.; PAEZ, G.; MATEO, N.; MORENO, R.; FARGAS, J.; FORSYTHE, W. [Studies of agricultural production systems for the small farmer in the tropics]. Investigación sobre sistemas de producción agrícola para el pequeño agricultor del trópico. Turrialba (1975), 25(3):283-293 [Es, en] [Departamento de Cultivos y Suelos Tropicales, CATIE, Turrialba, Costa Rica].

In field trials at Turrialba to test different systems of production suited to small farmers, various spatial and chronological patterns of monoculture, intercropping and crop rotation of bean, maize, cassava and sweet potato, with varying fertiliser rates, were investigated. The majority of multiple-cropping systems were

more efficient than their corresponding monocultures, both in yield and biomass production. Some of the outstanding systems were: a rotation of beans and maize followed by maize; in intercropping of beans and maize followed by maize; beans and cassava followed by maize; beans intercropped with cassava followed by sweet potato. Multiple-cropping systems were more efficient than monoculture in reducing weed biomass and in permitting a broader and more uniform distribution of hand labour throughout the year.

CAB (FCA 31-873) FCA

Central America; intercropping; crop rotation; sequential cropping; Phaseolus; maize; cassava; sweet potato

41107

ZEHRER, W. Initiation into the weed control problems in Togo. In: Proceedings of a Symposium held at Münster on Plant Protection, 7-18 August, 1978. Dag-Hammarskjöld-Weg 1, D-6236 Eschborn 1, German Federal Republic; Gesellschaft für Technische Zusammenarbeit mbH. (1978), 10 pp. [Lomé-Cacareli, Togo].

Details are given of some aspects of the weed flora and cropping of Togo, cultural methods of weed control employed, some preliminary trial work with herbicides, and the administration of the Crop Protection Service.

Crop production in Togo is mainly based on shifting cultivation. The ground is prepared with a hoe after burning and cutting the trees and shrubs at the beginning of the rainy season. Grasses, especially Imperata cylindrica, rapidly invade and the small-holder is forced to abandon the plot after 3-4 years.

CAB (WA 28-2563) WA/JAFC

West Africa; shifting cultivation; traditional systems

4.12 Animal draught systems

41201

FISHER, H.H.; SABIO, E.A.; PASTORES, R.M. Weed control systems for upland rice in the Philippines. (Abstract of paper presented at the 77th Annual Meeting of the American Society for Horticultural Science, Fort Collins, Colorado, July-August 1980). HortScience (1980), 15(3, Section 2):413 [Int. Inst. Rural Reconstruction, Silang, Cavite, Philippines].

A cropping system using the new, highly competitive C-22 upland rice sown in rows 30 cm apart was tested by Filipino upland farmers. Treatments were as follows: 2 handweedings; the application of butachlor at 2 or 1.33 kg/ha each followed by 1 handweeding; a modification of the farmer's normal practice of 2 draught cultivations followed by 1 handweeding; and no weed control. Rice yields from the improved systems ranged from 1.7 to 4.3 t/ha depending on weed density and soil moisture. Rice yields with no weed control were depressed about 51%. Net revenues ranged from P 2145 to P 4795 using the improved systems, compared with P 2632 using the farmer's traditional practice. Adoption of economic alternatives to the traditional practice would depend on the availability of cash, labour and/or spraying equipment.

CAB (WA 30-1667) WA

Southeast Asia; novel systems; upland rice; economic analysis; herbicides

41202

FISHER, H.H.; NIELSEN, K.C. Alternative Weed Control Methods for Upland Rice in Cavite, Philippines. Paper presented at the 1981 Meeting of the Weed Science Society of America, Las Vegas, Nevada, 1981 [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

Poor weed control, often resulting from untimely and ineffective handweeding, is the second most important obstacle to increased upland rice production, after inadequate soil moisture. There is evidence that hired handweeding labour is becoming more difficult to obtain in many developing nations. In Cavite, the cost of handweeding has risen from P 5 to P 15/man-day since 1975, while rice selling

price has only increased from ₱ 1.10 to P 1.30/kg in the same period. Between 1978 and 1979, labour and input costs rose about 25%; rice selling price 17%. To maintain present living standards, the farmer must produce more rice per field. The new, high-yielding C-22 variety, developed for the upland, is farmer-tested and gaining acceptance. In Balubad, Cavite, in 1977, 41 growers increased yields from 1437 (traditional practices) to 3133 kg/ha (C-22 improved). C-22 is yield unstable however, being prone to moisture stress. But it competes well with weeds, even at the wider 30 cm spacing, allowing animal draught cultivation with a small mouldboard plough and easier handweeding. Balubad farmers who adopted C-22 have switched from two handweedings to two cultivations or pre-emergence butachlor; each followed by a handweeding. Experiments were conducted on farmers' fields in the 1978 (87 weeds/m^2, optimum moisture) and 1979 (436 weeds/m^2, late-season moisture stress) wet seasons. There were few differences among 1978 yields, net returns or weeding times. However, there were marked differences in these under the stress conditions of 1979. Two cultivations slightly delayed handweeding time beyond the first handweeding 'peak' (where rice, corn and sugarcane weeding coincide), required no herbicide or sprayer, utilised available implements and saved 175 man-hours/ha. Butachlor at 1.33 kg/ha produced at least 410 kg/ha more grain and consequently higher net return, delayed handweeding well past the 'peak' (labour more obtainable), saved 456 man-hours/ha and controlled weeds early when cultivations and handweeding were less effective.

IPPC A

Southeast Asia; upland rice; novel systems; herbicides; economic analysis

41203

SABIO, E.A.; FISHER, N.E.; PASTORES, R.M. Results from Retesting a Production Technology Package Based on C-22 Upland Rice in Cavite. Paper presented at the 11th Annual Conference of the Pest Control Council of the Philippines, April 23-26, 1980, Cebu City, Philippines. [Rice and Feed Grains, Internat. Inst. of Rural Reconstruction (IIRR), Silano, Cavite, Philippines].

Two weed control systems experiments on upland rice variety C-22 were conducted on farmers' fields on Taqaytay loam soil in Cavite Province during the 1979 wet season. The purpose of the experiments was to retest a package of C-22 production practices developed in 1978, both from the agronomic and economic standpoints.

At the Lalaan site, late season soil moisture stress and heavy weed populations resulted in lower yields in 1978. Butachlor at 1.33 and 2.00 kg a.i./ha followed by one handweeding each provided the same yield. These treatments yielded more than two handweedings, which, in turn, yielded more than modified farmer's practice of two draught cultivations followed by one handweeding. The weedy check yielded the least. Uncontrolled weeds reduced rice yields 91% compared to two handweedings.

At Palapala, severe moisture stress during the middle part of the crop cycle drastically reduced yields compared to the same location in 1978. Yields from farmer's practice or two handweedings, or butachlor (either rate) followed by one handweeding were equal. Weedy check yields were reduced 84% compared to average yields of plots having weed control.

There were no differences in yield when any weed control treatment was compared between 50 and 75 kg/ha seeding rates at either site.

Based on Lalaan results (less influenced by drought than Palapala results), possible net returns for 11 improved weed control methods were calculated, assuming herbicides would be applied by the farmer and handweedings and cultivations would be performed by the farmer or by hired labour. The four highest net revenues (butachlor plus one handweeding) would range from ₱3,024 to 2,497. Three other high net revenues (₱2,496 to 2,145) would be obtained if the farmer were able to handweed twice or cultivate and handweed, provided that handweeding would be carried out mostly with family labour.

In comparison, traditional upland rice handweeded twice by the farmer under Lalaan drought and weed conditions and yielding 2.0 t/ha (twice the national upland rice average) would realise a net revenue of ₱2,600 to 2,225.

Under the 1979 Lalaan wet season constraints, improved practices appear to be little better than traditional practices in increasing farmer income. Further research is necessary to fully assess C-22 yield potential.

The production package, as tested, appears to offer the upland rice farmer several weed control choices depending on available cash, cultivation implements, weeding labour, knapsack sprayers and off-farm employment.

IPPC A

Southeast Asia; upland rice; novel systems; herbicides; economic analysis

4.13 Minimum tillage systems

see also no. 42201

41301

ROCKWOOD, W.G.; LAL, R. Mulch tillage: a technique for soil and water conservation in the tropics. Span (1974), 17(2): 77-79 [En, fr, es, de] [International Institute of Tropical Agriculture, Ibdan, Nigeria].

Systems of mulch tillage (zero tillage) cropping on tropical soils are discussed. In plot trials, yields of maize, cowpeas and pigeon peas were similar for mulch tillage and ploughed treatments, except during periods of drought stress when yields of maize and cowpeas were 50 and 25% higher with mulch tillage. Yields for soyabeans were lower with mulch tillage than for ploughed treatments.

CAB (CAB Annotated Bibliography no. 25-162) CAB

minimum tillage; West Africa; mulching; novel systems; maize; Vigna; Cajanus; soyabean

41302

LAL, R. Role of mulching techniques in tropical soil and water management. Technical Bulletin, International Institute of Tropical Agriculture (1975), No. 1, 38 pp. [International Institute of Tropical Agriculture, Ibadan, Nigeria].

Surface mulching with crop residue at the rate of 4 to 6 tons/ha decreases soil temperature and maintains favorable soil structure through enhanced biological activity. Continuous surface cover can be maintained by growing crops exclusively for use as a mulch, by live mulch from low-growing and least-competitive cover crops, or by the use of crop residue through rotation and tillage techniques. Mulch tillage, such as minimum tillage based on the zonal tillage concept of maintaining crop residue in the inter-row zone and simultaneously providing a good seedbed, meets most soil management requirements for many upland crops. Yields of maize, cowpeas, pigeon peas, soyabeans and sweet potatoes on mulch tillage plots equal yields from ploughed plots. At the same time, the soil erosion is minimal and soil structure is maintained by more intensive soil flora and fauna activity.

CAB (CAB Annotated Bibliography no. 25-121) CAB

Mulching; cover crops; maize; Cajanus; soyabean; sweet potato; West Africa; minimum tillage; novel systems

41303

WIJEWARDENE, R. Systems and energy in tropical smallholder farming. In: Proceedings of the Appropriate Tillage Workshop, IAR, Zaria, Nigeria, 1979 (1980), 73-86 [International Institute of Tropical Agriculture, Ibadan, Nigeria].

A no-till system of farming for the humid tropics is described. Weed growth is killed at the beginning of the season by low volume herbicide sprays and forms a mulch which minimises soil erosion and discourages further weed growth. Crop seeds are jab planted through the mulch. A table of labour needs for the no-till system and conventional tillage is presented. For descriptions of some sprayers and jab planters commercially available, see no. 41301.

CAB (AEA 5-4347) JAFC

novel systems; West Africa; minimum tillage; mulching; planting techniques; herbicide application equipment; herbicide application (low volume)

see also -

WIJEWARDENE, R. Systems and energy in tropical farming. Paper presented at the Winter Meeting of the American Society of Agricultural Engineers (ASAE), Chicago, Illinois, USA (1978), ASAE Paper 78-1511, 15 pp.

WIJEWARDENE, R. Weed control equipment for the smallholder in the tropics. In: Weeds and Their Control in the Humid and Subhumid Tropics (ed. I.O. Akobundu), Proceedings of a Conference held at the International Institute for Tropical Agriculture, Ibadan, Nigeria, 1978 (1980), 367-370.

WIJEWARDENE, R. Energy-conserving farming systems for the humid tropics. Agricultural Mechanization in Asia (1980), Spring, 48-53.

41304

GEEST INDUSTRIAL GROUP LTD. The Groom system. Inset (advertisement) between pages 54 and 55, World Crops (1980), 32(2):6 pp., 12 pl. [Geest Industrial Group Ltd., West Marsh Road, Spalding, Lincs. UK].

The 'Groom system' package aimed at small farmers in the humid tropics is described. Weed growth is killed at the beginning of the season by low volume herbicide sprays and forms a mulch which minimises soil erosion and discourages further weed growth. Crop seeds are jab planted through the mulch. The possible benefits of this system are: increased yields through reduced soil erosion and moisture loss, reduced labour per hectare giving the farmer time to cultivate a greater area, and reduced planting time after harvest enabling an additional crop to be grown in the same season. Equipment for spraying, transporting and jab planting is described in detail and illustrated.

-- JAFC

novel systems; minimum tillage; mulching; manual implements; motor-powered implements; herbicide application equipment; herbicide application (low volume); planting techniques

41305

SHENK, M.; LOCATELLI, E.; BURRILL, L.C.; McCARTY, T. Preplant vegetation control for minimum and zero tillage systems. In: 3e Symposium sur le Désherbage des Cultures Tropicales, Dakar, 1978, 8, Av. du Président Wilson, 75116 Paris, France; COLUMA (1978) Vol. II, 483-493 [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

Following a review of farming practices in Costa Rica, results are given of herbicide experiments in maize, beans and rice.

Small farmers in Costa Rica plant maize in January or February, and often a second crop is sown in August-September. Beans are sown in December, to be harvested before the heaviest rains. Rice is sown about March.

In maize, the weeds are first cut with a machete to less than 5 inches, requiring an average of 14 five-hour man-days per hectare in 'normally difficult' conditions, and 25 man-days in a stand of rank perennial weeds (such as Panicum maximum and Paspalum fasciculatum). The debris is left as mulch. A few farmers used chemicals after this cutting. Fields are weeded again, with machete, hoe or herbicides (2,4-D alone or in a mixture), within a month after planting, and weeds are cut again with a machete when the stalks are doubled about a month before harvest. Beans were planted in a 'covered beans' system: pathways were cut through the weeds and the seeds broadcast, then the weeds were cut with a machete to ground level. Only spot weeding was done before harvest, with the exception of one farmer who hoed the field once. Rice is sown with a sharp stick; herbicides are used for weed control. 'Improved systems' suggested for weed control consist of treatment with paraquat or glyphosate prior to planting in developed vegetation, planting in the mulch of cut plants, and later handweeding or directed spraying with paraquat.

CAB (WA 28-3442) JAFC

Central America; traditional systems; novel systems; minimum tillage; mulching; maize; Phaseolus; upland rice; planting techniques; perennial problem weeds; herbicides; slashing

41306

SHENK, M.; LOCATELLI, E.; BURITY, H.; ZAFFARONI, E. [Response of beans (Phaseolus vulgaris L.) to different systems of vegetation management]. Respuesta de frijol (Phaseolus vulgaris L.) a diferentes manejos de la vegetacion. Paper presented at the 25th Annual Meeting of the Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (PCCMCA), Tegucigalpa, Honduras, Mar. 1979, 8 pp. [Es, es] [Int. Plant Prot. Center / CATIE, Turrialba, Costa Rica].

Various systems of vegetation management based on zero tillage are compared with conventional tillage systems. Zero tillage systems gave adequate weed control and gave yields which were agronomically and economically superior to those obtained with conventional tillage.

Application of glyphosate to the regrowth 24 days after having cut the vegetation gave yields of 1384 kg/ha. Conventional tillage gave yields of 1169 kg/ha and the traditional 'covered beans' gave 77 kg/ha. The 'covered beans' system consists of simply broadcasting bean seeds over the weedy plot of land and, immediately after, hand slashing weed growth to cover the seeds.

It was also shown that it is possible to significantly increase bean yields in the 'covered beans' system by simply sowing beans with a planting stick (espeque or chuzo) in place of broadcasting. This improvement made possible an increase in yield of 470 kg/ha.

-- A

Central America; traditional systems; novel systems; minimum tillage; mulching; Phaseolus; planting techniques; herbicides; perennial problem weeds; slashing

41307

SHENK, M.; SAUNDERS, J.; CARBALLO, M.; CRAWFORD, E. Interaction between insects and soil-weed management in a tropical maize production system. Paper presented at the 1981 Annual Meeting of the Weed Science Society of America, Las Vegas, Nevada, USA, Feb. 1981 [Int. Plant Prot. Center, Oregon State University, Corvallis, OR 97331, USA].

Maize yields in no-till systems were equal to or greater than those from ploughed plots in experiments conducted in Costa Rica over a four-year period. Soil-inhabiting insects reduced production up to 40% in ploughed plots and up to 20% in no-till plots. Foliar feeding by Diabrotica balteata and Spodoptera frugiperda was significantly less in no-till systems. Of the no-till systems, a preplant application of glyphosate, paraquat preplant followed by a directed postplant application, and pre-plant weeding with a cutlass followed by directed postemergence paraquat application all adequately controlled weeds. Treatments with taller weed residues had less S. frugiperda attack than those with mulch flat on the soil surface.

-- A

Central America; maize; novel systems; minimum tillage; herbicides; slashing; mulching

4.2 TOOLS AND TECHNIQUES

4.21 Herbicides

42101

AHMAD FAIZ BIN MD. ALIF. Use of herbicides in small scale plantations in Southeast Asia. In: (Proceedings), BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 10 pp. [Rubber Res. Inst. Malaysia, Kuala Lumpur, Malaysia].

Interest in herbicide use is still quite recent in small-scale plantations in Southeast Asia. Not many planters are inclined to adopt such practices in view of the cost of the herbicides and the cheapness of manual labour. In some small-scale plantations, farmers should be encouraged to adopt herbicide use where this is economically justified. Efficient extension services should be provided to disseminate information to small-scale planters. The paper includes a survey of the chemical methods available for controlling weeds in long-, medium- and short-term crops, with indication of some pitfalls.

CAB (WA 28-2703) WA

perennial crops; Southeast Asia; herbicides

42201

AKOBUNDU, I.O. Live mulch: a new approach to weed control and crop production in the tropics. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1980), 377-382 [Int. Inst. Trop. Agric., Ibadan, Nigeria].

Live mulch is a crop production technique in which a food crop is planted directly in a living cover of an established cover crop without tillage or destruction of the fallow vegetation. The effect of several established legume covers on weed competition, fertiliser requirement and yield of maize was studied in the field at the International Institute of Tropical Agriculture. Weed infestation was heaviest in unweeded conventionally tilled and no-tillage plots, but very low in unweeded Centrosema pubescens and Psophocarpus palustris plots. Consequently, maize yield was reduced in all ground covers where weed infestation was heavy, but not in the covers that effectively suppressed weeds. Maize yield was significantly higher in the live mulch plots that received no fertiliser than in similarly treated conventionally tilled and no-tillage plots. When 60 kg/ha each of N, P_2O_5 and K_2O was applied to all ground covers, maize yield in the live mulch plots was either equal to or better than in the conventionally tilled and no-tillage plots.

CAB (WA 30-1655) A

cover crops; minimum tillage; maize; West Africa; novel systems

42202

OLADOKUN, M.A.O. An assessment of cultural weed control methods in Coffea canephora (var. Quillou). In: Weeds and Their Control in the Humid and Subhumid Tropics (ed. I.O. Akobundu), Proceedings of a conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 1978 (1980), 362-365 [Cocoa Res. Inst. of Nigeria, PMB 5244, Ibadan, Nigeria].

Four legume cover crops (Calopogonium mucunoides, Centrosperma pubescens, Pueraria phaseoloides and Vigna unguiculata) and two types of organic mulch (grass mulch and banana/plantain leaf mulch) were compared with slashing as weed control measures for postnursery establishment of coffee seedlings (Coffea canephora var. Quillou) in the field. Weed species distribution was identical in plots seeded with P. phaseoloides or mulched with banana/plantain leaves. The latter was more effective in suppressing weed growth. The least effective in suppressing weeds was Calapogonium mucunoides.

CAB (WA 1981) A

West Africa; mulching; imported mulches; cover crops; coffee

42203

BOUHARMONT, P. [The use of cover plants and mulching in arabica coffee crops in Cameroon]. L'utilisation des plantes de couverture et du paillage dans la culture du caféier arabica au Cameroun. Café, Cacao, Thé (1979), 23(2):75-102 [Fr, en].

Trials were conducted at several sites in Cameroon to study the following aspects of cover crops and mulching in coffee; costs, effects on soil chemistry and availability of water, mineral nutrition of coffee bushes, and yields. In arabica, unlike robusta coffee, the use of creeping cover plants did not significantly increase yields and had certain disadvantages; Stylosanthes offered little resistance to infesting grasses, Mimosa increased the fire risk and, in general, there was competition for water; the costs of cutting and mulching were another drawback. Flemingia has given variable results as a cover crop, depending on environmental conditions; it is suggested that experiments with this species be extended from low to medium and high altitudes.

CAB (WA 30-588) WA

West Africa; coffee; mulching; imported mulches; cover crops

42204

TEMPLER, J.C. Guatemala grass for mulch on proposed tea planting sites. Tea in East Africa (1973), 13(1):12-14 [Tea Res. Inst. E. Africa, Uganda Res. Stn., Rwebitaba].

Guatemala grass (Tripsacum laxum) was planted in 1970 and 1971 and, at the ages of 18 or 19 months, was cut to form a mulch; tea was planted into the mulches in 1972. The planting of 30 cm long-rooted grass stems at a spacing of 1.2 X 1.2 m into clean soil is recommended early in the rainy season; P should be applied to planting holes at 50 kg P_2O_5/ha. At least one wheel hoeing is needed, but after canopy close, the grass may keep itself entirely weed-free. NPK 25-5-5 fertiliser should be applied at 400 kg/ha just before canopy close. After 1 year (preferably) of growth, the grass should be cut at or just below ground level to discourage regrowth, and the stems laid along the contour so as to cover the ground completely. The few weeds that may grow can easily be removed by hand. Regrowth of the grass from stools is easily checked by hoeing, scuffling by feet, or by spraying with Gramoxone [paraquat] (with protection for tea plants). Regrowth from nodes can be checked by turning the stems over.

CAB (WA 30-3530) WA

tea; cover crops; slashing; mulching; East Africa

42205

WATSON, G.A. Cover crops in Malayan rubber plantations. World Crops (1963), 15(2):48-52 [Rubb. Res. Inst., Kuala Lumpur, Malaysia].

Various types of cover crops for rubber are briefly discussed, with particular emphasis on leguminous covers. Species discussed include Pueraria phaseoloides, Calopogonium mucunoides, Centrosperma pubescens, Flemingia congesta, Stylosanthes gracilis and Calopogonium caeruleum.

CAB (WA 12-738) JAFC

Southeast Asia; rubber; cover crops

42206

WYCHERLEY, P.R.; CHANDAPILLAI, M.M. Effects of cover plants. Journal of the Rubber Research Institute of Malaya (1969), 21(2):140-157. [Rubber Res. Inst. Malaya, Kuala Lumpur].

Three trials at the Experiment Station and three in West Malaysia and a cover management trial are described. Species evaluated as cover plants included Eupatorium odoratum and Mikania cordata; their depressive effects on rubber growth can be largely relieved by control measures to reduce their quantity. The depressing effects of M. cordata on tree growth were attributed to inhibitory exudates which may act directly on the trees or indirectly by suppression of soil nitrification; M. cordata can be controlled by spraying with 2,4-D. Good tree growth resulted from periodic slashing and spraying of natural weed covers. The most effective leguminous cover plants are given as Calopogonium caeruleum, Centrosema pubescens, Desmodium ovalifolium, Moghania macrophylla and Pueraria phaseoloides.

CAB (WA 20-2139) WA

Southeast Asia; rubber; cover crops

42207

SCHINDLER, A.J.; FRASER, R.R. Cover crops, mulch or clean weeding for coffee (Coffea arabica) in the highlands of New Guinea. Papua and New Guinea Agricultural Journal (1964), 17(1):39-47 [Highlands Agric. Exp. Stn., Aiyura].

In two trials in New Guinea, treatments used were: (a) cover crop of Vigna oligosperma, (b) cover crop of Indigofera endecaphylla, (c) mulch of elephant grass (Pennisetum purpureum), (d) clean weeding (weeds hoed just below ground level), and (e) slash weeding (weeds cut just above ground level). Best yields were given by the mulch treatment and these were significantly higher than for any other treatment, especially during the fourth year of the trials. Next best yields were given by the clean-weeding treatment, though, by the fourth year, yields following this treatment were only slightly higher those where the V. oligosperma cover crop was used. Lowest yields resulted from the I. endecaphylla cover crop, which competed severely with the coffee. V. oligosperma was unsatisfactory as a cover crop because of its lack of ability to compete with weeds. Slash weeding encouraged the growth of grasses, was tedious and did not kill the weeds effectively. Where weeding was practised, it was concluded that this should completely

destroy the weeds, rather than merely remove the tops; in the long run, the former was the least costly.

CAB (WA 15-127) WA

Australasia; coffee; slashing; mulching; imported mulches; cover crops

42208

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. Cassava Program 1979 Annual Report. CIAT, Cali, Colombia (1980), 93 pp.

Pp. 55-56. Cultural weed control: mulching and green covers. In trials at two locations, comparing the effects of different mulches on weed weight/ha, soil temperature, and root yield of cassava, the highest yields were obtained with a maize straw mulch, which provided good weed control and a lasting soil cover. Puntero grass (Hyparrhenia rufa), sugarcane leaves and Stylosanthes straw also formed good, persistent mulches. Plantain leaves, kudzu straw and cassava leaves decomposed rapidly, leaving the soil exposed.

In another trial, green covers established with Desmodium heterophyllum and with intercropped beans (Phaseolus vulgaris) gave similar weed control to that achieved with continuous manual weeding. The high seed cost of both legumes was offset by the value of the bean crop and the long-lasting cover, erosion control, N fixation and forage material from D. heterophyllum.

WRO JAFC

northern South America; cassava; Phaseolus; mulching; imported mulches; intercropping; cover crops

42209

LITZENBERGER, S.C.; HO TONG LIP. Utilising Eupatorium odoratum L. to improve crop yields in Cambodia. Agronomy Journal (1961), 53(5):321-324 [Agron. Div., Cambodian Direction of Agric., Ministry of Agric., Phnom Penh, Kampuchea].

In trials carried out in 1958-1960, 20 tons/ha Eupatorium odoratum used as a green manure on paddy rice produced significantly higher grain yields (2.5 tons/ha) than the use of farmyard manure at 5 tons/ha (yield 1.5 tons/ha) or the use of chemical fertilisers. The presence of E. odoratum eliminated damage due to land crabs, but also killed fish. In black pepper, an annual mulch of 45 tons/ha of green E. odoratum effectively controlled the prevalent destructive yellow disease and root rot of pepper in Cambodia. Other mulches are ineffective and it is thought that the effect of E. odoratum is due to its nematicidal properties, which are currently under investigation.

In a preliminary trial, the use of 45 tons/ha E. odoratum incorporated into the soil before ploughing gave a significantly higher yield of sole-crop cassava roots (22 tons/ha) than the use of farmyard manure at 20 tons/ha (yield 14 tons/ha) and gave more than double the yield of unfertilised cassava (10 tons/ha).

WRO JAFC

Southeast Asia; paddy rice; cassava; perennial crops; perennial problem weeds; utilisation; mulching; imported mulches

42210

SALGADO, M.L.M. Tephrosia purpurea (Pila) for the control of Eupatorium and as a green manure on coconut estates. Ceylon Coconut Planters' Review (1972), 6(4): 160-174 [Agric. Consultant, 49 Lady Catherine Housing Estate, Borupana Road, Ratmalana].

Eupatorium odoratum has become established in coconut estates in most districts of Ceylon and its control is both expensive and time-consuming. Slashing and mowing were useless and the plants reacted as they might to pruning. Removing with a tine cultivator, followed by hand digging and cover cropping, is effective and economical, but the establishment of T. purpurea has been found to be the cheapest and most effective control method. On an estate in the Chilaw District in 1969, T. purpurea almost eradicated E. odoratum

and smothered almost all other weeds except Mimosa pudica. Cattle and goats do not graze T. purpurea and might be used to control M. pudica.

CAB (WA 22-1690) WA

Indian subcontinent; coconut; perennial problem weeds; cover crops; grazing

4.3 CONTROL OF PROBLEM WEEDS

see also nos. 42209, 42210

43101

SALGADO, M.L.M. Weeds on coconut lands and their control. Ceylon Coconut Planters' Review (1961), 1(3):16-27 [Coconut Res. Inst., Lunuwila, Sri Lanka].

Includes an account of the appearance and control of Imperata cylindrica in coconut plantations. Satisfactory control is given by frequent harrowing, grazing with penned cattle, with or without previous burning, growing a cover crop such as Pueraria javanica or Tephrosia candida, which is mulched between the coconut rows, or growing the recently introduced weed, Euphorbia geniculata, as a smother crop.

CAB (WA 11-1053) WA

Indian subcontinent; perennial problem weeds; coconut; cover crops; grazing; inter-row cultivation

43102

COCONUT RESEARCH INSTITUTE OF CEYLON. Control of illuk. Leaflet, Coconut Research Institute of Ceylon, 28 (Revised ed., 1966), 4 pp.

The growing of catch and cover crops such as cowpea (Vigna unguiculata) and green gram (Vigna sp.) in young plantations will prevent the establishment of illuk (Imperata sp.); in older plantations, soil cultivations and grazing with buffalo are recommended. No recommendations for herbicidal control are at present available.

CAB (WA 17-2736) WA

Indian subcontinent; coconut; cover crops; grazing; perennial problem weeds; intercropping

43103

VAYSSIÈRE, P. [Weeds in Indo-Malaya]. Journal d'agriculture tropicale et botanique appliquée (1957), 4(9/10):392, 401 [Fr] [J. d'Agric. 57, rue Cuvier, Paris, France].

The importance, distribution and control (mainly now-outdated chemical treatment) of Imperata cylindrica are discussed. Competitive cover crops include Vitex pubescens, Albizzia moluccans, Centrosperma pubescens and Dolichos hosei in Malaysia, Tephrosia candida in Nigeria, Crotalaria striata and C. utilis in Ghana, Pueraria thunbergiana in Kenya, and Crotalaria juncea in India. In Madagascar, I. cylindrica was completely eliminated by one ploughing in the dry season and one ploughing in the rains, followed by planting a strong-growing variety of cassava which was kept weeded until it covered the ground. In Indo-China, in areas where annual bush fires are practised, broadcast sowing of Mimosa invisa at 20-40 kg/ha before burning (which favours germination of the Mimosa) has given good control of I. cylindrica.

CAB (WA 7-1729) WA/JAFC

Southeast Asia; perennial problem weeds; cover crops; cassava; perennial crops

43104

SURYATNA, E.S.; McINTOSH, J.L. Food crops production and control of Imperata cylindrica on small farms. Paper presented at the Workshop on Alang-alang (Imperata cylindrica), Bogor, Indonesia, July 28-29, 1976, BIOTROP Special Publication No. 5 (1980), 23 pp. [Agronomy Division, Central Res. Inst. for Agric., Jl. Merdeka 99, Bogor, Indonesia].

The control of Imperata cylindrica is discussed with references to the two cropping systems described in no. 41101. Both systems appear to perform well without any insurmountable problems with I. cylindrica. Initial levels of viable alang-alang plants are low in newly-cleared forest, adequate levels of soil fertility help food crops compete vigorously to shade out alang-alang, and simple handweeding on a regular basis prevents weed infestation.

WRO JAFC

Southeast Asia; shifting cultivation; intercropping; mulching; cover crops; sequential cropping; traditional systems; novel systems; perennial crops; perennial problem weeds; coffee; rubber; grain legumes; cassava; maize; upland rice; planting techniques

43105

SOERJANI, M. Alang-alang, Imperata cylindrica (L.) Beauv. (1812). Pattern of growth as related to its problem of control. (Ph.D. Thesis, Gadjah Mada Univ., Jogjakarta, 1970). In: BIOTROP Bulletin (1970), 1, 88 [En, in] [Reg. Cent. Trop. Biol. (BIOTROP), c/o Natn. Biol. Inst., P.O. Box 17, Bogor, Indonesia].

Research on the distribution, economic importance, control methods and biology of I. cylindrica is reviewed. Shading under a canopy of rubber trees severely retarded growth, but flooding only checked growth. Regular slashing did not eradicate alang-alang, but increased the incidence of 'onion disease' caused by the gall-forming insect Orseoliella javanica (Cecidomydae); the latter shows potential as a biological control agent, but was heavily parasitised by an unidentified Chalcid wasp.

Ground covers and flooding are also recommended as control measures.

CAB (WA 21-866) A

Southeast Asia; perennial problem weeds; cover crops; rubber; slashing; water management; herbicides

4.4 WEED CONTROL IN PARTICULAR CROPS

4.41 Root and tuber crops

44101

ONOCHIE, B.E. Critical periods for weed control in cassava in Nigeria. PANS (1975), 21(1):54-57 [Dept. of Plant Sci., Univ. of Ife, Ile-Ife, Nigeria].

The effects of weed competition on cassava yields were assessed in small (0.01 ha) plots on an experimental farm in the tropical rain forest zone of Western Nigeria (mean annual rainfall 1500 mm). The most damaging effect of weeds on yield was noted during early canopy formation and early tuberisation (third month after planting) and it is recommended that, where labour is limiting, weeding should be carried out during the third month after planting. Weeding during this period was as effective in ensuring a high yield of cassava roots as weeding throughout the entire period of growth. Nigerian farmers use the West African hoe for weed control and commonly weed the cassava crop only once or twice, so timeliness of weeding operations may be crucial.

CAB (WA 25-537) JAFC

West Africa; cassava; timing

44102

PLUCKNETT, D.L.; SAIKI, D.F.; MOTOOKA, P.S. Weed control in taro (Colocasia esculenta (L.) Schott). In: Proceedings of the 1st Asian-Pacific Weed Control Interchange, June 19-22, 1967, Honolulu; East-West Center (1969), 90-93 [Kauai Branch Sta., Hawaii Agric. Exp. Sta.].

A brief review of current weeding practices and problems in Hawaii is given. Most taro is grown under flooded paddy cultures in the coastal valleys, where handweeding during the first three months of the crop until crop closure is normally sufficient to suppress weeds. In upland taro, plant spacings are wider, insufficient moisture reduces the crop canopy, and weed control by flooding is not possible. A number of herbicides and black plastic strip mulching have been under trial. Most

promising herbicides in lowland taro are: propanil, promexone, ametryne and TOK. In upland taro, trifluralin, prometryne, and ametryne give good weed control with little injury to the crop.

CAB (WA 18-2168) JAFC

taro; Pacific islands; timing; mulching; imported mulches; herbicides; water management

44103

RADIX. Weed problems? [in root crops in the Philippines]. Radix (1979), 2(2):13.

Results of trials at the Philippine Root Crop Research and Training Centre are translated into simple advice for farmers growing root crops. Farmers are advised to use longer planting materials and plant closer to shade out weeds, and to plant in straight rows both ways to facilitate crisscross cultivation. Cultivations should be done at weekly intervals until canopy closure.

-- JAFC

Southeast Asia; root and tuber crops; planting techniques; inter-row cultivations; timing

4.42 Cereals

44201

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. Tillage/weed control experiment. In: 1972 Report, Farming Systems Program, Ibadan, Nigeria (1973), 63-66 [PMB 5320, Ibadan].

Seven methods of weed control used at 3 and 6 weeks after sowing upland rice were compared. It is concluded that hand- and hoe weeding are still best, at least if only 2 weedings are done, that blade or tine-type weeders give better weed control when pulled by hand rather than by the walking tractor, and that rotary weeding (by walking tractor) is better than other mechanical weed control methods.

CAB (WA 23-732) WA

West Africa; upland rice; inter-row cultivation; manual implements; motor-powered implements

4.43 Perennial crops

44301

YEOH, C.H.; MAT TAIB, I. Weed control in Malaysian rubber smallholdings. In: Proceedings of the 6th Asian-Pacific Weed Science Society Conference, Jakarta, Indonesia, 1977 (1979), Vol. 2, 387-397 [Rubber Res. Inst. Malaysia, Kuala Lumpur, Malaysia].

Rubber smallholdings occupy the largest percentage of the land under agriculture in Malaysia. They also contribute the major portion to Malaysia's natural rubber production. Weeds, abundant on these farms, differ greatly from those found on estates. In a preliminary sampling involving 60 smallholdings, about 50 different species were identified. The major species are listed. The methods of weed control on small farms range from primitive to the use of herbicides. The advantages and disadvantages of the different methods are noted.

Recommended practices include the establishment of weed-suppressing legume covers in the inter-row area at the time of planting, the use of sheep and goats grazing the undergrowth in established rubber stands, intercropping in the inter-row area during early stages of rubber establishment, and the use of herbicides. In trials in nurseries or in fields with young rubber where the bark is still green, 0.6 kg paraquat a.i./ha was effective in the control of mixed weeds without causing damage to the rubber plants. The mixture developed by the RRIM, MSMA + 2,4-D-amine + sodium chlorate (2.2 kg + 1 kg + 5.6-22.4 kg/ha), was effective against most of the mixed weeds in immature rubber on small farms. The mixture has a broad spectrum of weed control, but does not control Imperata cylindrica. Dalapon at 16.8 kg + Teepol wetter 4.2 litres/ha and glyphosate + urea (2.2 kg + 16.8 kg/ha, respectively) were effective against I. cylindrica; subsequent treatments at the correct time gave more effective control.

CAB (WA 29-2838) WA/JAFC

Southeast Asia; rubber; cover crops; grazing; intercropping; herbicides

44302

TABORA, P.C. JR. Weed control in abaca in the Philippines. In: Symposium: Weed Control in Tropical Crops, Papers presented at the 9th Pest Control Council of the Philippines, Manila, 1978 (1979), 164-168 [Dept. of Horticulture, Univ. of the Philippines at Los Baños, College, Laguna, Philippines].

The paper focuses discussion on weed control in abaca (Musa textilis Nee) farms.

In abaca farming, the crop stage most vulnerable to weeds is the initial development phase. This is when the farm has just been opened or cleared of its forest vegetation. In time, the whole area becomes swamped with broadleaf vines. These vines are cleared by ring weeding 1 m around the abaca plant. Weeding usually takes 8 to 9 man-days/ha, which currently costs $10.67 to $13.33/ha on a contractual basis. This weeding is repeated three to four times annually for a period of 2 to 3 years. However, since most abaca farms are rather small (90% are 2 to 3 ha or less), the area is often planted to cash crops such as sweet potato (Ipomoea batatas (L.) Lam.) and cassava (Manihot esculenta Crantz). In larger abaca farms (5 to 10 ha) which have long been cleared, however, the farmer may opt to plough between the rows using animal-drawn equipment, especially if cash crops have not been established earlier. Ploughing is done three to four times a year using 6 to 7 man-days (currently rated at $13.33-$20.00/ha) for 2 years. In very large plantations where there is scarcity of labour and animal power, contact herbicides are used in combination with ring weeding. This is done two to four times a year and each application costs $10.67-$16/ha. Two-year-old farms may still requi. some weeding, but 3-year-old farms already have dense canopies which suppress the growth of weeds.

CAB (WA 29-4075) A (from text)

Southeast Asia; traditional systems; perennial cr ps; fibre crops; intercropping; sweet potato; cassava

44303

KOENRAADT, J. [Weeding in tree crops]. Surinaamse Landbouw (1962), 10, 30-2 [Nl, en].

On an estate growing citrus, coffee and cacao, man-hour requirements per ha were reduced from 24.55 to 9.6 by cutting weeds to a height of 40 cm 6 to 10 times per year, rather than cutting to a height of 5 cm twice per year. Cutting to the 40 cm height also reduced erosion, improved soil structure and lowered costs.

CAB (WA 12-1291) WA

coffee; cocoa; perennial crops; northern South America; slashing; timing

4.44 Vegetable crops

44401

SETH, A.K. Weed management in vegetable crops in Malaysia. In: (Proceedings), BIOTROP Workshop on Weed Control in Small Scale Farms, Jakarta (1977), 11 pp. [ICI Agric. (Malaysia) Sdn Berhad, Wisma Damansara, P.O. Box 284, Kuala Lumpur, 23-03, Malaysia].

On smallholder vegetable farms where many different crops are planted in quick succession, development of herbicide programmes for pre- and postplanting weed control poses special problems related to the complexity of use, the speed and timeliness of operations, and the dangers of residual phytotoxicity to the following crops. Field trials and wide farmer usage of paraquat-based preplanting weed management techniques have shown that these are simple to use, minimise the time and labour required for land pre-preparation, and reduce the postplanting weed population. Paraquat has also been used as a directed spray treatment for postplanting weed control in some of the fruit vegetables. In lowland farms, it has been shown to be of particular value in controlling weeds growing in the furrows between and on the sides of the beds after the planting of the main crop.

CAB (WA 28-2683) WA

vegetable crops; novel systems; minimum tillage; herbicides

4.45 Multiple cropping systems

44501

AKOBUNDU, I.O. Weed control strategies for multiple cropping systems of the humid and subhumid tropics. In: Weeds and Their Control in the Humid and Subhumid Tropics (ed. I.O. Akobundu), Proceedings of a conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 1978 (1980), 80-100 [Int. Inst. of Tropical Agric., PMB 5320, Ibadan, Nigeria].

Weed control methods in traditional (shifting cultivation) cropping systems of the humid tropics are reviewed, including natural fallowing, handweeding, burning, crop rotation, intercropping, and mechanical weed control. Increased food production in the tropics will involve replacing shifting cultivation with more intensive land use, with the adoption of appropriate weed control systems. Biological, chemical and cultural control techniques available for intensive food production systems based on intercropping are reviewed, including cover crop fallowing, use of low-growing intercrops, modification of plant density and canopy, and no-tillage and stale seedbed techniques. Weed research needs for intercropping systems are identified: more data on weed-crop competition, allelopathy, shifts in weed flora and appropriate chemical control technqiues are needed.

CAB (WA 30-3383) JAFC

fallow; crop rotation; intercropping; cover crops; land preparation; shifting cultivation

44502

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. 1977 Annual report. IITA, Oyo Road, PMB 5320, Ibadan, Nigeria (1978), 98 pp.

P. 59. Weed control in intercropping. Various methods of weed management were evaluated in maize, cassava (Manihot esculenta) and yam (Dioscorea rotundata) in monoculture and in mixed cropping patterns. Mixed crops generally produced fewer weeds at harvest (64%). Weed control methods were mechanical, biological (using a low-growing smother crop such as melon and sweet potato), chemical, or a combination of these. Primextra (metolachlor + atrazine) applied pre-em., the best herbicide tested, was not superior to a permanent ground cover of melon and sweet potato. Yams grown alone needed to be kept weed-free for the first 12-16 weeks after planting in order to minimise the yield reduction caused by weeds. Hoe weeding 3 times, growing melon and sweet potato, or applying a herbicide were equally effective. Intercropping yam with maize caused up to 25% reduction in yam yield compared with yams grown alone.

CAB (WA 28-3953) WA

West Africa; intercropping; maize; cassava; yam; cover crops; herbicides; timing

44503

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. Annual report for 1978. IITA, Oyo Road, PMB 5320, Ibadan, Nigeria (1979), 129 pp.

Pp. 71-72. Weed control in intercropping. Handweeding, biological weed control, chemical weed control and integrated weed management were evaluated in maize, cassava and yam (Dioscorea rotundata) cropping patterns. Results showed that weed competition in all cropping patterns was minimised by weeding during the first 12 weeks after planting. Provided the 1st weeding was carried out at 3 weeks after planting, 2 or 3 weedings were adequate. Biological control studies showed that the low-growing 'Egusi' melon (Citrullus vulgaris) effectively suppressed weeds without altering crop yields. Sweet potato (Ipomoea batatas) was equally competitive against weeds, but also reduced yam yield. A mixture of atrazine + metolachlor gave effective weed control in all the cropping patterns and resulted in crop yields equal to those from 3 handweedings.

CAB (WA 29-3927) WA

West Africa; intercropping; maize; cassava; yam; cover crops; herbicides; timing

44504

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. Research highlights for 1979. IITA, Oyo Road, PMB 5320, Ibadan, Nigeria (1980), 64 pp.

P. 15. Weed control and residue management in intercropping. Three or 4 handweedings were necessary to minimise the reduction in yield due to weeds in maize/cassava, maize/yam and maize/cassava/yam intercropping systems. Early season weed suppression with the low-growing 'Egusi' melon (Citrullus lanatus) followed by sweet potato (Ipomoea batatas) gave yields of maize, cassava and yam equal to those from 3 handweedings. This method of weed control also protects the soil from erosion in high-rainfall areas.

The economic advantage of chemical weed control over handweeding was established. For example, 2 handweedings cost, on average, 200 Naira/ha compared with 50 Naira/ha for chemical weed control. The herbicide mixture atrazine + metolachlor (as Primextra) applied pre-em. at rates from 2.5 to 3 kg total a.i./ha safely controlled most annual weeds in the intercropping systems mentioned above.

The use of leguminous cover crops following bush clearance is described. The cover crop is later killed with herbicide, and maize and cassava can be sown directly through the plant remains.

CAB (WA 30-1612) WA

West Africa; intercropping; maize; cassava; yam; cover crops; herbicides; mulching; economic analysis; minimum tillage; planting techniques

5. WEED CONTROL IN THE SEMI-ARID TROPICS

5.1 WEED CONTROL SYSTEMS (EXISTING AND INNOVATIVE)

5.11 Regional studies

51101

OGBORN, J.E.A. Weed problems and control practices in the semi-arid regions of Africa. In: Weeds and Their Control in the Humid and Subhumid Tropics (ed. I.O. Akobundu), Proceedings of a Conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria, 1978 (1980), 127-137 [Inst. for Agric. Res., Ahmadu Bello Univ., PMB 1044, Zaria, Nigeria].

Reviews research into weed control methods for the Nigerian hoe farming system as well as for mechanised large farms. Herbicides for the hoe farming system must have wide crop tolerance (e.g., linuron) and are best applied (to save water) as granules or by low volume sprayers. Supplementary hand hoeing will still be needed.

CAB (WA 30-3001) JAFC

West Africa; herbicides

51102

OGBORN, J.E.A. Weed control research for simple technology upland farming systems at Samaru. In: Proceedings of the 5th Conference of the Weed Science Society of Nigeria, held at the University of Ife, July 1975 (1976), 35-42 [Dep. Agron., Inst. Agric. Res., Ahmadu Bello University, PMB 1044, Zaria, Nigeria].

The weed control problems of simple-technology farmers in the Nigerian savanna are described. The shortage of water restricts the use of herbicides to granular or ultra-low volume applications. Research has shown that presowing broadcast application of mixtures of fertiliser and wettable-powder herbicides give appreciable weed control, thereby reducing the amount of hoeing required. However, the profitability has not been assessed. Presowing incorporation of herbicides is more appropriate to farmers using ox-power and should permit an increase in the area farmed by this system.

CAB (WA 28-1135) A

West Africa; herbicide application (granules); herbicide application (low volume); traditional systems

51103

FREY, J. [Empirical investigation of labour requirement in small farms in the Kenya Highlands]. Empirishe Untersuchungen über den Arbeitszeitbedarf in Kleinbetrieben in Hochland Kenias. Zeitschrift für Ausländische Landwirtschaft (1976), 15(3):351-363 [De, en].

Data on labour requirements in smallholdings were measured in a typical settlement scheme in the highlands of Kenya. The average size of holdings is between 9-10 acres, with main crops grown being maize and pyrethrum. Ploughing is done by private contractors with tractors and ploughs; all other field work is carried out by the small farmers using the traditional hand implements, 'jembe' and 'panga.' Cultivation of 1 acre of maize requires 254 man-hours and that of pyrethrum 792 man-hours. The work record chart shows clearly that the family labour capacity is not fully utilised throughout the year. An exception to this occurs for the labour peak in June/July when weeding needs to be carried out.

CAB (WAERSA 19-2893) WAERSA

highland and temperate zone; East Africa; traditional systems; maize; pyrethrum; economic analysis

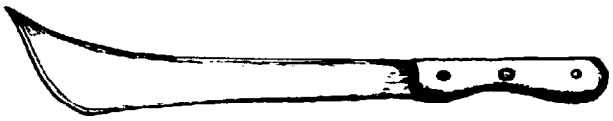


Figure 11. Indian panga. Ref nos. 51103, 51105, 51205

51104

FREY, H.J. [Intensifying small peasant farms through appropriate agricultural technology. Work studies in the Bahati settlement scheme in Kenya]. Intensivierung Heinbäuerlicher Betriebe durch angepasste Agrartechnik. Arbeitszeitstudien im Bahati Settlement Scheme, Kenia. IFO Forschungsberichte der Afrika-Studienstelle (1976), No. 55, 188 pp. [De].

The introductory examination of the problems of mechanisation in developing countries points out that horsepower/ha in Africa has been estimated at between 0.09 and 0.12. After a brief review of the general situation in Kenya, the main part of the study reports on a detailed survey of working procedures, tools and equipment used on the Bahati settlement scheme for maize, pyrethrum, other crops, and livestock. The survey showed that labour capacity was underemployed for most of the year, apart from the weeding period in June/July, and that yields and labour productivity were low. The final sections considered appropriate improved technologies for these conditions. Neither draught animals nor small tractors are suitable. Standard size tractors shared between farms would be most appropriate. Suitable farm plans and organisation are suggested.

CAB (WAERSA 19-3527) WAERSA

highland and temperate zone; East Africa; traditional systems; maize; pyrethrum, economic analysis

51105

ALLAN, A.Y. The relative importance of weed control and other cultural practices in Kenya maize. In: Proceedings of the 5th East African Weed Control Conference, Nairobi (1974), 1-10 [Maize Agron. Res. Project, Nat. Agric. Res. Stn., P.O. Box 450, Kitale, Kenya].

Some 30-50 million man-days, costing in the region of 150 million sh are spent every year weeding maize in Kenya. Trials were carried out at Kitale to compare the effect of weeding with effects of other cultural practices on yield. Weeding considerably increased yields at both high and low yield levels and this is important to farmers who get low yields. Competition trials showed that one weeding in maize 10 cm high gave a yield of nearly 95 hkg/ha in 1967 compared with 67 hkg/ha without weeding. Recommendations include the improvement of the tools and organisation of weeding, sowing earlier and the use of herbicides.

Seedbed preparation with the local hoe (jembe) or ox-ploughs is delayed until the onset of the rains, as the ground is too hard in the dry season. It is suggested instead that farmers prepare the ground at the end of the previous rainy season. By preparing the land earlier, it would be possible to dry-plant some of the crop: this would move some of the peak workload forward, enabling weeding to start earlier. The jembe used for intra-row weeding is heavy, slow and penetrates the ground several inches, cutting crop roots. It is suggested that lighter hoes be developed.

CAB (WA 23-2462) WA/JAFC

East Africa; traditional systems; novel systems; land preparation; hand tools; herbicides

Figure 12. Indian jembe. Ref nos. 51103, 51105.

51106

SHENK, M.; YOUNG, D.L.; FISHER, H.H.; LOCATELLI, E. [Relative agroeconomic viability of various weed control methods for small-scale producers in N.E. Brazil]. Viabilidad agroeconómica relativa de métodos alternativos de control de malezas para pequeños productores en el noreste de Brasil. In: Trabajos y Resúmenes, III Congreso Asociación

Latino-americano de Malezas "ALAM" y VII Reunión Argentina de Malezas y su Control "ASAM," Mar del Plata, 1976. 1356 Av. Corrientes 123, Buenos Aires, Argentina; ASAM. Vol. 4, 198-211 [Es] [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

Results of 2 years' investigations suggest that little economic advantage was to be gained by introducing mechanical or chemical weed control techniques to replace the current manual methods. Reasons for this include cheap labour and lack of alternative employment in the area, as well as the very small size of holdings, low level of education and general soil and climatic conditions.

IPPC WA

Brazil; traditional systems; economic analysis; social analysis

51107

YOUNG, D.L.; MILLER S.F.; FISHER, H.H.; SHENK, M.D. Selecting appropriate weed control systems for developing countries. Weed Science (1978) 26:3, 209-212, IPPC Paper B/21 Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA.

Herbicides can increase agricultural productivity and rural welfare where agronomic considerations or labor shortages favor their utilization, but ecological, social, and economic conditions in developing countries often favor alternative weed control methods. Traditional hoeing by peasant farmers in a Northeast Brazil upland region was found to be both effective and economical in comparison with other methods. In another Northeast Brazil region, government herbicide subsidies and payroll taxes were projected to encourage excessive use of herbicides at the expense of displaced workers with few alternative employment opportunities.

IPPC A

herbicides; economic analysis; social analysis; traditional systems; Brazil

5.12 Manual-powered systems

51201

OGBORN, J.E.A. Herbicides and hoe farmers. World Crops (1977), January/February, 9-11 [Inst. Agric. Res., Samaru, Nigeria].

The use of herbicides by hoe farmers in the savannah zones of Nigeria is described. Herbicides are only worthwhile there when the need to hoe weeds restricts the farmer's productive activity; in Northern Nigeria, this occurs in June and July in mixed crops. Persistent herbicides are not required and are probably undesirable after this period. Presowing applications of fertiliser/herbicide mixtures are broadcast by hand before the rains and provide adequate control because the 7-month dry season checks the growth of perennial weeds. In the future, ultra-low volume methods may be used. Rates are selected to give satisfactory weed control during June and July, and herbicides proposed are linuron, for use in a millet + sorghum mixture, and diuron for cotton. Newer herbicides, though technically suitable for other crop mixtures, may be too expensive.

CAB (WA 27-883) A

West Africa; sorghum; pearl millet; cotton; herbicides; traditional systems; herbicide application (granules); intercropping

51202

INSTITUTE FOR AGRICULTURAL RESEARCH. Farm systems and intercropping programme. (Report to the Board of Governors on the Institute's work 1975-76). PMB 1044, Samaru, Zaria, Nigeria; Institute for Agricultural Research (1977), 65 pp.

Pp. 35-41. General weed control in hoe farming systems. The objective of this study was to devise a simple method of herbicide application that could be integrated with hoe weeding by small-scale farmers. Three types of granular herbicide were compared, viz., manufactured granules, soil granules made at village level from wettable powders, and granular fertilisers mixed with herbicides (so-called 'herbilisers'). The latter showed several advantages and no serious disadvantages. In practice, a presowing broadcast application over the previous

year's ridges and furrows at the start of the rains was the most satisfactory treatment. The evaluation of herbicides in cotton and mixed crops of millet, sorghum and cowpeas (Vigna unguiculata) in different climatic zones was initiated. The results so far suggest that diuron is suitable for all the major cotton growing areas, and linuron and propazine show promise for the millet, sorghum and cowpea mixture. Other herbicides which may be important to the hoe farmer are triflu alin and norflurazon for use in cotton, atrazine in maize and sorghum, and alachlor in maize, cotton, cowpeas, groundnuts and soyabeans.

In addition to the granular applications, very low volume (VLV) liquid herbicide application was also examined; 2 models of spinning disc VLV sprayers for applying 10 litres/ha could be obtained commercially.

CAB (WA 28-3396) WA

West Africa; cotton; pearl millet; Vigna; sorghum; intercropping; herbicide application (granules); herbicide application (low volume)

51203

FORT, J. [A method for adapting draught animals to traditional food crop production methods in the Sahelian Zone]. Une méthode d'adaptation de la culture attelée à la technique des cultures vivrières en zone sahélienne Paris, France. Promotion Rurale (1973), 49, 15-19 [Fr].

Traditionally, farmers in the Sahelian zone of West Africa sow in holes made with the hoe, without previous soil tillage. With the new method, using draught animals, furrows are opened and the seed is placed by hand in the furrow. Afterwards, the inter-row space is cultivated, also by draught animals. The method is speedy and does not depart too much from the traditional approach to ploughing and sowing.

CAB (WAERSA 16-1846) TA

West Africa; land preparation; planting techniques; animal-drawn implements

see also no. 52403

51204

ABALU, G.O.I.; HARKNESS, C. Traditional versus improved groundnut practices: an economic analysis of production in Northern Nigeria. Experimental Agriculture (1979), 15(1):85-90 [Inst. for Agric. Res., Ahmadu Bello Univ., Zaria, Nigeria].

A 'package' of improved groundnut cultivation practices was compared to traditional growing practices by observing farmers' fields along the Zaria-Kano main road in Nigeria. The improved cultivation practices concerned with weed control were strict adherence to planting specifications and timeliness in weeding. Two seeds per stand were to be sown, about 2-5 cm deep, in stands 23 cm apart on ridges 90 cm apart. The first weeding was to be done on top of the ridges, 3-4 weeks after sowing, continued on the sides and furrows 1-3 weeks later, followed by a second weeding 3-4 weeks after the first. The improved practices produced superior yields, but some difficulty was encountered in getting the farmers to construct ridges which were the recommended distance apart, closer together than traditional ridges.

WRO JAFC

West Africa; groundnuts; novel systems; planting techniques; land preparation; timing

51205

MAKATIANI, J.B.S. Weed control and peasant farming. In: Proceedings of the 5th East African Weed Control Conference, Nairobi (1974), 35-43 [Western Agric. Res. Sta., P.O. Box 169, Kakamega, Kenya].

Present weed problems and weed control practices of Kenyan small farmers are briefly described. Little crop rotation is practiced, the principal crops being maize and beans for home consumption. Usually only one hand hoeing or 'panga' weeding is given, which is insufficient for good weed control. Machinery for hire is scarce and rarely available in good time, and hand labour is scarce at peak periods. Possible directions for weed research relevant to the needs of small farmers are outlined.

WRO JAFC

East Africa; traditional systems; maize

51206

VERSTEEG, M.N.; MALDONADO, D. Increased profitability using low doses of herbicide with supplementary weeding in smallholdings. PANS (1978), 24(3):327-332 [COPERHOLTA Project, Ministerio de Alimentacion, Zona IX, Apartado 102, Tarapota, Peru].

Lack of labour for weeding is one of the principal limits to production and family farm size in the upper Amazon valleys of San Martín, Peru, where slash-and-burn agriculture is being replaced by stable smallholder agriculture with mechanical land preparation. The application of pre-emergence herbicides at low rates in soyabean, cowpea and sunflower, together with supplementary handweeding, reduced weeding costs for smallholders by about 40% as compared with handweeding alone or with herbicide application at the recommended rate. It is suggested that the introduction of hoes or other weeding tools may be an alternative means to better weed control, but this option was not tested.

CAB (WA 28-1450) JAFC

Andean countries; highland and temperate zone; herbicides; soyabean; Vigna; sunflower

5.13 Animal draught systems

51301

INSTITUTE FOR AGRICULTURAL RESEARCH. Farm systems and intercropping programme. (Report to the Board of Governors on the Institute's work 1975-76) PMB 1044, Samaru, Zaria, Nigeria; Institute for Agricultural Research (1977), 65 pp.

Pp. 41-47. General weed control in draught animal farming systems. The objective of this study was to develop new equipment with a view to increasing the efficiency of cultivations and to establish draught animal cropping systems which include the use of herbicides. Data collected in the Yaba district suggest that farmers using draught animals actually spent more hours subsequently hoe weeding than farmers without draught animals. In 1974, a weeder attachment mounted on an Emcot ridger was successfully used to cultivate existing ridges immediately after the first rains. In 1975, sowing tubes mounted behind the weeding tyres enabled a range of crops to be established in one operation. Hoe weeding was reduced to an 11 inch band on either side of the ridge. In 1976, a high clearance straddle ridge toolbar fitted with rotary cultivators was used to cultivate a 6 inch band on either side of the crop row. With this system, hoe weeding was reduced to 80%. Herbicide application techniques for use in draught animal systems were evaluated. These included the use of very low volume (VLV) sprayers and soil mixtures either band-applied or broadcast. In addition to the surface active materials mentioned, trifluralin and dinitramine (both incorporated) can be used in cotton, groundnuts and grain legumes, vernolate can be used in groundnuts, and butylate in maize. In a trial carried out in cotton, diuron applied either with a knapsack sprayer or as a coating on a fertiliser ('herbiliser') increased yields compared with no herbicide.

CAB (WA 28-2958) WA

West Africa; traditional systems; novel systems; animal-drawn implements; herbicides; herbicide application (high volume); herbicide application (low volume); herbicide application (granules); planting techniques

51302

WEVERS, J.D.A.; DIBBITS, H.J. [Agricultural mechanization in Northern Nigeria]. Landbouwmechanisatie in het noorden van Nigeria. Landbouwkundig Tijdschrift (1977), 89(7):233-241 [Nl].

The authors took part in a mechanisation study under the auspices of the International Institute of Tropical Agriculture in Ibadan, which covered sociological, economic, agronomic and technological, as well as human ergonomic and livestock factors of mechanisation in a developing country. The study analyzes labour requirements, costs, and returns involved in using different types of ploughing and weeding equipment for growing maize under prevailing conditions in Northern Nigeria.

CAB (AEA 2-2340) AEA

West Africa; traditional systems; land preparation; inter-row cultivation; animal-drawn implements; (manual implements?); (motor-powered implements?); maize; economic analysis; social analysis

51303

ELLIOT, C.M.; BESSELL, J.E.; ROBERTS, R.A.J.; VANZETTI, N. Some Determinants of Agricultural Labour Productivity in Zambia. Universities of Nottingham and Zambia Agricultural Labour Productivity Investigation (UNZALPI), Report No. 3 (1970), School of Agriculture, University of Nottingham, Loughborough, Leics, England; University of Zambia, Lusaka, Zambia.

The results of a survey of agronomic practices carried out over two years (1967-69) in two districts in the Eastern and Central Provinces of Zambia are reported. The principal crops were maize and groundnuts. Technical details of the production process (e.g., planting distances, weeding tools) are not given, but the authors present a very comprehensive account of the cropping systems and management decisions for the maize and sorghum crops, with reference to cost and labour use. The large number of possible decisions at each stage of the production process are classified into six management systems. It is convincingly demonstrated that improved seeds and fertiliser have little effect on the total yield one farming family can produce. However, checkrow planting, followed by timely two-way cultivations supplemented by handweedings, can greatly reduce peak labour need per acre, thus enabling an increase up to ten-fold in the acreage one family can cultivate. Recommendations for action at village level, district level and central government level are included.

-- JAFC

Southern Africa; traditional systems; economic analysis; novel systems; planting techniques; inter-row cultivations

51304

MINISTRY OF AGRICULTURE AND WATER AFFAIRS, DEPARTMENT OF AGRICULTURE, ZAMBIA. Annual report of the weed control research and extension team, 1980. Mt. Makulu Research Station, P.O. Box 7, Chilanga, Zambia (1980), 122 pp.

Pp. 8-16. Small farm improvements. A maize management package, including a modified form of the checkrow planting method and a pre-emergent herbicide applied at low volume with a spinning-disc applicator, was tested on a pilot commercial basis. Technical problems with the checkrow planting method (increased silting up in two-way channels, causing shallow planting and weeds becoming established ahead of the crop) can probably be overcome, but the increased labour demand for planting at a time of peak labour demand is a serious drawback. Better plant populations on the checkrow and higher fertiliser rates (when these were applied) gave larger net profits than from traditional plantings. Returns to capital, however, were much lower. The low volume herbicide system worked well, but brought no increase in yield, net profit or return to capital, and its potential for labour-saving was limited, since it saves labour at a time after the largest labour peak. The potential benefits of a maize herbicide could include better early weeding of cotton, and increased time for planting sunflowers.

The 'improved' maize management package requires increased investment and inputs, increases the farmer's dependence on loans and extension service, and increases economic risks.

Other reports on the small farms research programme briefly discuss herbicide application, planting equipment, couch grass control, and ox and hand cultivation.

WRO JAFC

Southern Africa; novel systems; maize; planting techniques; herbicides; herbicide application (low volume)

51305

EVALUATION OF FARMING SYSTEMS AND AGRICULTURAL IMPLEMENTS PROJECT (EFSAIP). Animal draft systems study. Report No. 1 (1977), 167 pp. [Agric. Res. Station, Content Farm, Gaborone, Botswana].

The traditional cropping system of Botswana is described. Weed populations are low at the beginning of the rainy season (spring) and farmers broadcast a mixture of crop seed (mainly sorghum) onto unprepared land and cover it by mouldboard ploughing. Weeding is done by women using hand hoes when the sorghum is knee-high. It is slow (50 woman-hours per hectare) and usually only done once. Crop residues and weed grasses are grazed over the winter period. Three 'improved' cropping systems based on autumn mouldboard ploughing (AMP) and on two locally-developed toolbars (the Versatool and the

Makgonatsotlhel) are described (see nos. 51401, 52412, 52413). In the first year's trials comparing the 'improved' cropping systems and equipment with the traditional system, the traditional system gave higher yields than the Versatool and Makgonatsotlhel systems. The AMP system gave relatively high yields, but demanded higher inputs than the traditional system and may be less socially acceptable to farmers. Weed control: Autumn mouldboard ploughing after harvest prevents many weeds from maturing and setting seed, and also results in a very sparse weed population at the beginning of the rainy season. Postharvest sweeping as recommended in the other two systems appears correct in theory, but was impractical because of severe blockage of sweeps by weeds. However, inter-row weeding with sweeps (as recommended in the Versatool and Makgonatsotlhel systems) was rapid (average 5 hours/ha) and quite effective. An average of 7 hours/ha supplementary handweeding was needed in the rows.

-- JAFC

Southern Africa; traditional systems; novel systems; land preparation; inter-row cultivations; weed seed source reduction; animal-drawn implements; economic analysis; social analysis; sorghum; intercropping

51306

EVALUATION OF FARMING SYSTEMS AND AGRICULTURAL IMPLEMENTS PROJECT (EFSAIP). Animal draft systems study. Report No. 2 (1978), 106 pp. [Agric. Res. Station, Content Farm, Gaborone, Botswana].

Continuing work comparing traditional with 'improved' cropping systems for small-scale farmers (average holding 6 ha) of Botswana is described. Work on the Versatool system was discontinued after it was found to be very unsatisfactory in earlier trials (see no. 51305). Weed control: Autumn (postharvest) and spring (presowing) mouldboard ploughing resulted in fewer weeds at the beginning of the growing season, which were then easily controlled by inter-row cultivation. Inter-row cultivation using sweeps, following autumn ploughing, was a fast and effective means of weed control, but farmers were not eager to carry out a second weeding in the growing crop, and, in 1977-1978, high rainfall in late spring encouraged further weed germination, resulting in a very weedy crop at harvest, causing abandonment of postharvest sweeping operations due to blockage. High late-spring rainfall also slowed traditional handweeding so that only about half the planted area was weeded, resulting in severe competition to the growing crop.

-- JAFC

Southern Africa; traditional systems; novel systems; land preparation; inter-row cultivation; sorghum; Vigna; sunflower; animal-drawn implements; social analysis

see also SALMON, D. A review of EFSAIP. The Evaluation of Farming Systems and Agricultural Implements Project in Botswana. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK, Commonwealth Secretariat (1980), 147-152 [EFSAIP, P/Bag 0033, Gaborone, Botswana].

51307

ARMITAGE, M.S.; BROOK, C.E. The case for weed control to spearhead improvements in maize and cotton husbandry in Swaziland. In: Proceedings, 13th British Weed Control Conference, London, UK, British Crop Protection Council (1976), Vol. 1, 165-172 [En, fr] [Malkerns Res. Stn., Univ. of Botswana and Swaziland, P.O. Box 4, Malkerns, Swaziland].

Weeding is the most labour-demanding operation in husbandry and indirectly determines the area of subsistence crops and limits the area of cash crops on Swazi Nation Land. Since recommendation of several simultaneous changes in husbandry practice to small-scale farmers fails to produce improvement, it is suggested that only one change at a time be recommended. In this case, it is important to know whether the change will be effective in the absence of other modifications. To this end, nine husbandry factors were studied in maize and cotton: (1) lime, (2) fertiliser, (3) insecticide, (4) weeding (chemical and/or handweeding), (5) seed type, quality and dressing, (6) inter-row cultivation, (7) crop density, (8) planting technique and (9) timing of harvesting. Factors which affected the effectiveness of weeding were N

fertilisation and inter-row cultivation, which had a negative effect (perhaps due to root damage to the crop in the case of the latter), and crop density, which had a positive effect in both crops. Clean weeding consistently produced the greatest yield increases in both crops.

CAB (WA 26-1888) WA

Southern Africa; inter-row cultivation; herbicides; planting techniques; maize; cotton

51308

BINSWANGER, H.P.; SHETTY, S.V.R. Economic aspects of weed control in semi-arid tropical areas of India. In: Proceedings of the Weed Science Conference and Workshop in India, 1977, Vol. 1, 47-59 [ICRISAT, 1-11-256 Begumpet, Hyderabad-500016, A.P., India].

Data from ICRISAT village level studies is used to document the extent and timeliness of weed control activities by farmers in three distinct agro-climatic zones of India. The farmers' understanding of the weed problem and its constraints is examined. Budgets are presented for alternative weed control plans with and without herbicides to assess the potential for use of herbicides in these areas at the present and with the existing resource position. The implications for weed research are also explored. The studies began in 1975 in six villages in the Akola, Mahbubnagar and Sholapur districts. The three districts are quite different in climate. Weed control activity is guided by rational consideration. More effort is allocated to crops on better land and to crops with high value per unit area. Dry crops herbisides cannot at present be advocated on the basis of cost considerations in the semi-arid area of India, although they may be useful for spot weeding tough clumps of perennial weeds such as Cyperus rotundus and Cynodon dactylon. Interculture is done primarily by males, while handweeding is primarily done by hired female labour. Labour-saving due to herbicides would thus decrease income opportunities for the most disadvantaged labour group in India - landless female labourers.

CAB (WAERSA 21-954) AIDRDA/A

Indian subcontinent; traditional systems; herbicides; economic analysis; social analysis; perennial problem weeds

51309

DAVIES, E.L.P. (1979) The potential for introducing improved weed control methods to small farmers of the Indian semi-arid tropics. M. Agric. Sci. Thesis, University of Reading, U.K., 1979, 86 pp.

This project examined farmers' traditional weed control practices in four villages of the Indian semi-arid tropics, and trials of 'improved' weed control methods, using herbicides in the groundnut and sorghum crops, were carried out in the farmers' own fields. The report concludes that farmers practice excellent weed control and that the 'improved' methods involving herbicides have no place in the existing systems. Includes an interesting discussion of the difficulties of carrying out on-farm experiments.

CAB (WA 29-3924) JAFC

Indian subcontinent; traditional systems; novel systems; herbicides; groundnut; sorghum; economic analysis; social analysis

51310

SHETTY, S.V.R. Some agro-economical aspects of improved weed management systems in Indian semi-arid tropics. In: Proceedings, 15th British Weed Control Conference, Brighton, UK, British Crop Protection Council (1980), Volume 3, 899-910 [ICRISAT, 1-11-256 Begumpet, Hyderabad 500016, A.P., India].

Critically reviews work and presents essential tables from two earlier reports (nos. 51308 and 51309).

WRO JAFC

Indian subcontinent; traditional systems; herbicides; economic analysis; social analysis

51311

SHETTY, S.V.R.; KRANTZ, B.A.; OBIEN, S.S. Weed research needs of the small farmers. In: Proceedings of the Weed Science Conference and Workshop in India (1977), Vol. 1, 47-59 [Farming Systems Research Program, ICRISAT, 1-11-256 Begumpet, Hyderabad, India].

The authors discuss possible areas for weed research which could benefit small farmers. Herbicides can be useful in some situations, but their cost needs to be reduced. Research on integrated weed management systems should be conducted on the farm, and the entire cropping system should be taken into account. The paper describes the broad ridge and furrow system recently developed at ICRISAT. Broad (150 cm) ridges and furrows are established on a graded contour with an average slope of 0.6 to 0.8% in black soils and 0.4 to 0.6% in red soils, leading to a natural drainage way. Once established, these features are permanent and all future operations follow and maintain the broad ridges and furrows. Ploughing, ridging and planting are done with an animal-drawn two-wheeled tool carrier, the wheels and bullocks following the furrows. Boundary field bunds, which are a major source of weed seeds, can be eliminated, since the farmers can mark their fields by the number of ridges owned. A continuum of crops is maintained from the onset of the monsoon as long as possible, competing with weed growth. Early tillage (black soil), cutting, spraying or pasturing (red soil) immediately after harvest prevents weeds going to seed. The broad ridge and furrow system also aids timeliness in land preparation and distributes water more evenly over the field.

WRO JAFC

Indian subcontinent; novel systems; animal-drawn implements; timing; land preparation; weed seed source reduction

51312

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS. ICRISAT Annual Report 1976-1977. (1979) 240 pp. [ICRISAT, 1-11-256 Begumpet, Hyderabad, 500016, Andhra Pradesh, India].

P. 173. Weed management in 'Steps in Improved Technology' trial. Weed growth early in the rainy season is very rapid and, if weeds are not removed in time, serious yield reductions can result. With alfisols, which dry rapidly after a rain, handweeding can be easily achieved. However, with vertisols, one may face serious problems when frequent rains while crops are in the seedling stage prevent the control of weeds by cultural or handweeding methods. With improved management, where alachlor was used at the rate of 0.75 kg/ha and where effective cultivation was possible in the broad bed and furrow system, only 10 woman-days/ha were needed. Thus, the handweeding cost/ha was Rs 171 more with traditional than with improved management. With alfisols, the total of two handweedings required 30 and 56 woman-days/ha for improved and traditional management, respectively; handweeding costs with traditional and improved treatments were Rs 252 and 135/ha, respectively.

Pp. 174-175. Weed management by intercropping. Two pigeon peabased intercropping systems were investigated. Intercrops of cowpea and maize suppressed weeds in the early stages to the greatest extent, followed by mung, sorghum, and groundnuts. Weed infestation on both soil types was about the same in the early part of the season, but late-season weeds yielded 2-4 times higher weed weights in vertisols than in alfisols. The effect of intercrops on weed growth was perceptible even by the time of first handweeding at 25 days. Though cowpea efficiently suppressed weeds in the early stages, they reappeared after harvest. Systems with maize and sorghum as intercrops recorded less weed growth at the final harvest of pigeon pea. Direct weed control studies were also conducted to evaluate different herbicides on sorghum/pigeon pea intercrops. In general, triazine herbicides like ametryne, prometryne and terbutryne performed well and were safe for both pigeon pea and sorghum. Fluchloralin was excellent in pigeon pea, but toxic to sorghum, while atrazine was quite safe in sorghum, but toxic to pigeon pea.

CAB (WA 28-2960) WA

Indian subcontinent; novel systems; economic analysis; intercropping; Vigna; Cajanus; maize; groundnuts; herbicides

see also no. 54702

51313

BEN-NUN, R. Proposals for the Introduction of Multicropping - New Agrotechniques - Improved Implements in Irrigated Agriculture in the Lower Mekong Basin. Documentation and Publication Section, Centre for International Agricultural Cooperation, Rehovot, Israel, 1973.

The author considers that multicropping has not been sufficiently promoted in the Mekong Basin, despite evidence that only such a system can justify economically the expensive irrigation projects established in the area. Present constraints to the introduction of multicropping systems are outlined, and some suggestions for overcoming them are put forward, including the introduction of daylength-insensitive rice varieties, new implements and planting techniques. A number of possible crop rotations for irrigation projects are described. Recommended cultural practices including soil preparation, varieties, seed treatment, sowing date, spacing, fertiliser, irrigation techniques, weeding, pest control, and harvesting are described in considerable detail for the following crops: rice, sorghum, groundnut, maize, cotton, green manure, soyabeans, and sweet potato. A number of local tilling techniques and implements of Southeast Asia are described, and the results of experiments comparing tillage techniques are presented. A proposed new tillage technique (for tractor) is outlined. Eleven low-cost implements which are recommended for use in the proposed multicropping systems, including a rotary weeder for rice and an animal-drawn adjustable tiller for row crops, are described and their operation detailed.

-- JAFC

Southeast Asia; irrigated crops; paddy rice; upland rice; maize; sorghum; cotton, soyabean; sweet potato; sequential cropping; crop rotations; novel systems; land preparation; planting techniques; inter-row cultivation; manual implements; animal-drawn implements; motor-powered implements

51314

CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAIZ Y TRIGO (CIMMYT). The Puebla Project 1967-69: Progress Report of a Program to Rapidly Increase Corn Yields on Small Holdings. (1970), 120 pp. [CIMMYT, Apartado Postal 6-641, Mexico 6, D.F., Mexico].

This is a report on a project in Puebla State, Mexico, with the aim of increasing maize yields of smallholders through the introduction of new high yielding varieties, fertiliser and corresponding changes in farming practices. Traditional weed control practices for the maize crop are described (pp. 21-22), and a table of animal and human labour requirements for ploughing, cultivations and handweedings are given (p. 91). The weed control practice usually employed is as follows: at planting, seed is placed in hills at the bottom of furrows. After 3-4 weeks, when the maize is 20-30 cm high, the farmer ploughs between the rows, turning the soil into the furrows and around the crop plants to bury the weeds. This operation is repeated about 3 weeks later, leaving the rows of maize as ridges and the inter-rows as furrows. After the second cultivation, the broadleaved weeds which have escaped covering are cut back with a sickle and used as forage. Traditional ox- or mule-drawn ploughs are used. In 1967, only 1% of the farmers surveyed used tractors and 1% used herbicides.

WRO JAFC

Central America; traditional systems; maize; land preparation; inter-row cultivation; economic analysis

51315

SCOLARI, D.D.G.; YOUNG, D.L. [Comparative costs of different weed control methods]. In: Sociedad Colombiana de Control de Malezas y Fisiología Vegetal, "COMALFI." Resúmenes de los Trabajos en el VII Seminario, Bogotá (1975), 11-12 [Es] [IPEANE, Recife, Brazil].

The costs are given of various chemical, mechanical, manual and integrated methods of weed control in maize and bean crops in Brazil. It is felt that, for smallholders using family labour, traditional manual methods remain the most economical.

IPPC WA

Brazil; traditional systems; economic analysis; inter-row cultivations; novel systems; herbicides; maize; Phaseolus

see also SCOLARI, D.D.G.; YOUNG, D.L. [Comparative costs of different methods of weed control in corn and beans]. Custos comparativós de diferentes métodos de contrôle de ervas daninhas em milho e feijão. Paper presented at the 10th Annual Meeting of the Brazilian Weed Society, Santa Maria, RGS, Brazil, July 1974 (the same information in Portuguese)

51316

SCOLARI, D.D.G.; YOUNG, D.L. [An agronomic and economic evaluation of weed control systems in the Agreste area of Pernambuco State]. Avaliacão agronômica e econômica de sistemas de controle de ervas daninhas no Agreste Pernambucano. Pesquisas Agropecuarias Brasileiras (1977), 12, 187-196 [Pt, en] [CPAC/EMBRAPA, CP 70.0020-70.600 Planaltina, D.F. Brazil].

Two identical experiments were conducted in 1974 at Caruaru, Pernambuco State, to assess the effectiveness and profitability in maize and beans of 12 different weed control systems - manual, mechanical, chemical and integrated. Yields from unweeded controls averaged 5% (for maize) and 26% (for beans) of the yields obtained with overall weed control. Partial control systems (mechanical cultivation in the inter-row only, or herbicides only within the rows) gave an average of 64 and 46% respectively of the yields obtained with overall weed control. Differences in yield between systems giving the same level of control were not significant, indicating that the methods of weeding were equally effective. At 1974 prices, the most cost-effective treatment for maize grown alone was simazine at 1.5 kg/ha pre-em. with a benefit/cost ratio of 6.03. If only one manual or mechanical weeding, instead of two, gave adequate control, however, this would be the most economical. For beans alone, the most cost-effective treatment consisted of two cultivations with an animal-drawn implement plus hoeing in the rows (benefit/cost ratio 3.4). Evidence from other sources, however, suggested that the wider row spacing needed for animal traction led to reduced yields; if cultivators were precluded on that account, traditional hoeing remained the most cost-effective treatment.

IPPC WAERSA

Brazil; maize; Phaseolus; inter-row cultivation; herbicides; economic analysis

51317

SANTOS, D.M. DOS; PEREIRA FILHO, I.A.; LEMOS, J.W. VERAS. [Comparison of systems of weed control in sole crop and intercropped maize and beans (Phaseolus vulgaris)]. In: Resumos, 8° Congresso Brasileiro de Herbicidas e Ervas Daninhas, Ilhéus (1980), 42 [Pt] Abstract only [Empresa Brasileira de Pesquisa Agropecuaria, Penedo, A.L., Brasil].

Experiments were carried out in the fields of the experimental station of the Ministry of Agriculture, Santana do Ipanema, in the Sertão region of Alagoas state (Northeast Brazil) which compared cultural, manual, mechanical and chemical methods of weed control. The experiment attempted to follow closely the techniques used by local farmers. The most effective treatment was 'two hoe weedings' followed by 'two weedings with animal-drawn cultivators plus supplementary handweedings in the rows.' The herbicides used were ineffective in controlling weeds at low dosages, and were phytotoxic, particularly to the beans, at higher dosages.

WRO A

Brazil; maize; Phaseolus; intercropping; inter-row cultivation; herbicides

5.14 Minimum tillage systems

51401

GIBBON, D.; HARVEY, J.; HUBBARD, K. A minimum tillage system for Botswana. World Crops (1974), 26(5):229-234 [En, fr. es] [Agricultural Research Station, Gaborone, Botswana].

The implementation of a more reliable crop production system, based on soil and water conservation, crop rotation (including a bare fallow), efficient weed control, subsoiling or chisel ploughing, rapid sowing, fertiliser placement and steerage hoeing, and made possible by the development of low-draught minimum tillage equipment which could be attached to an animal-drawn carrier is described.

CAB (CAB Annotated Bibliography no. 25-19) CAB

Southern Africa; novel systems; minimum tillage; animal-drawn implements; fallow; crop rotation; sorghum

see also nos. 52412, 52413, 51305, 51306

51402

DRYDEN, R.D.; KRISHNAMOORTHY, C.H. Year round tillage. Indian Journal of Weed Science (1977), 9(1):14-18 [Andhra Pradesh Agric. Univ., Rajendranagar, Hyderabad-500030, India].

To assist the farmer in controlling weeds and to enable him to plant early under improved seedbed conditions with his bullock-power country (chisel) plough, blade harrow and seeding methods, a year-round minimum tillage plan was developed. The programme consists of surface tillage with the country plough and/or the wide blade harrow beginning immediately after harvest and, as soil moisture permits, following summer and premonsoon showers.

CAB (WA 28-3399) WA

Indian subcontinent; novel systems; minimum tillage; land preparation

51403

GINGRICH, J.; SAMIANO, A.; VILLA, F.; SABIO, E.A.; FISHER, H.H. Reduced tillage in dry season corn in Batangas and Cavite, Philippines. Paper presented at the 1981 Annual Meeting of the Weed Science Society of America, Las Vegas, Nevada, USA, Feb. 1981 [Nat. Crop Protection Center, Laguna, Philippines].

After harvest of the 120-day, wet season upland rice crop, the small farmer in Batangas and Cavite hurries to prepare the soil and plant 100-day feed corn as the dry season fast approaches. Traditional land preparation, consisting of one to two carabao ploughings and harrowings and removal of rice stubble before furrowing, considerably delays corn planting and increases risk of moisture stress. Traditional weed control consists of two draught cultivations with the mouldboard plough. By adopting minimum or zero tillage, the farmer may conserve soil moisture by planting earlier and by not opening and exposing the soil to excessive drying. The soil dries quickly in the dry season and becomes difficult to till with the carabao, so less human and animal energy would be required under reduced tillage systems. Increased costs for herbicides such as atrazine, glyphosate and paraquat may be offset by higher net revenues from higher yields under reduced tillage systems. Preliminary results from three experiments conducted on farmers' fields show that delayed planting greatly increases the probability of moisture stress. Average yields of two experiments initiated early (mid-October) were 4514 and 4857 kg/ha, while the experiment planted late (mid-November) yielded only 2246 kg/ha. In both October experiments, all weed control treatments utilising minimum and zero tillage yielded significantly more than the farmers' traditional land preparation, or 4979 and 4646 versus 4179 kg/ha. At Tanauan, Batangas (October planted), where weed growth was exceptionally heavy, all zero and minimum tillage practices resulted in significantly fewer weeds at harvest than the farmers' land preparation. These preliminary results suggest that reduced tillage practices may have potential in significantly improving Batangas and Cavite dry season feed corn production.

IPPC A

Southeast Asia; traditional systems; novel systems; minimum tillage; maize; herbicides

51404

HAYWARD, D.M.; WILES, T.L.; WATSON, G.A. Progress in the development of no-tillage systems for maize and soyabeans in the tropics. Outlook on Agriculture (1980), 10(5):255-261 [ICI Plant Protection Division, Fernhurst, Haslemere, Surrey, UK].

Research into no-till production systems for maize and soyabean in Nigeria and Latin America is reviewed. It is stated that it is common practice in Central America (especially the hilly areas of El Salvador) to hand-sow maize into an uncultivated seedbed in which paraquat has been used to kill weed growth. Weeding in the crop is done with directed sprays of paraquat, sometimes mixed with 2,4-D, using a knapsack sprayer. As the maize matures, the stalks are bent downwards to allow the cobs to dry out for harvesting. Paraquat is sprayed again around the base of the maize to eliminate weeds and a crop of beans is hand-sown. The beans climb up the maize stalks. At harvest, all negative material is left to die during the dry season.

CAB (WA 30-2014) JAFC

minimum tillage; novel systems; maize; soyabean; herbicides

5.2 TOOLS AND TECHNIQUES

5.21 Techniques for land preparation and planting

52101

TOIT, J.J. DU. Checkrow planting and the control of weeds. Farming in South Africa (1930), 5(55):317-319.

Maize can be planted in hills by a checkrow planter in such a way that lands can be cultivated crosswise as well as lengthwise, minimising the need for hand hoeing. The adaptation of a horse- or oxen-drawn planter for checkrow planting, and the planting process itself, are described in detail.

ITDG JAFC

Southern Africa; planting techniques; animal-drawn implements; maize

5.22 Techniques for weeding in the crop

52201

THOMAS, P.E.L. Inter-row weed slashing. Effective control in maize. Farmer, Rhodesia (1978), 49(6):25-27 [Henderson Res. Sta., Salisbury, Rhodesia].

A system of inter-row slashing of weeds in maize is described. The slashed weeds form a mulch which reduces runoff and soil erosion and discourages the germination of more weeds. However, the system requires that in-row weeds must be adequately controlled by some other means and that fertilisers should be band-applied. Preliminary results of trials carried out on Henderson clay loam soils showed that yields of maize from slashed and inter-row weeded crops were similar.

CAB (WA 28-2085) WA

Southern Africa; slashing; mulching; novel systems; maize

52202

AGRONOMY INSTITUTE, ZIMBABWE, WEED RESEARCH TEAM. Annual Report 1978-1979. (1980), 41 pp. [Weed Research Team, Private Bag 222A, Salisbury, Zimbabwe].

Pp. 22-27. Systems of weed control in maize and soyabeans. (P.E.L. Thomas and H.J.A. van Lindert). The results of studies comparing different systems of weed control in maize and soyabeans (hand cultivation, slashing, herbicides, fertiliser placement and combinations of these) are presented. Inter-row weed slashing (requiring approx. 90 man-hours/ha) is an effective method of weed control which normally requires less labour than handweeding (approx. 120 man-hours/ha). Slashing can also be done in wet weather, an advantage over handweeding, and the shortened inter-row weeds help reduce soil erosion and water runoff. However, slashing is only likely to succeed in vigorous and competitive crops. Where maize growth was retarded by drought or lack of fertiliser, handweeding gave better yields than slashing.

CAB (WA 30-1856) JAFC

Southern Africa; slashing; mulching; novel systems; maize; soyabean; herbicides

5.23 Hand tools and manually-operated implements

52301

ANDREWS, C.J.; SHELDRICK, M. Hoeing survey in Northern Nigeria. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK; Commonwealth Secretariat (1980), 153-161 [Nat. Coll. Agric. Eng., Silsoe, Bedford, UK].

Hand tools are very important in shifting cultivation on ridges; these are made at the beginning of the rainy season by a one-pass form of cultivation which involves soil inversion first on one side of the ridge, then on the other, using a plough hoe. When hoe weeding takes place, the ridges are rebuilt, covering the weed trash from the original ridging; the

ridges are allowed to erode again and the process repeated. The various types of hand hoe used are described, with photographs.

CAB (WA 30-1272) WA

West Africa; hand tools; traditional systems

52302

INTERNATIONAL LAND DEVELOPMENT CONSULTANTS N.V. (ILACO), ARNHEM. Galole pilot demonstration and training project. Final report on studies on working methods in the cultivation of cotton at Galole. Rep. Int. Land Devel. Consultants N.V. (ILACO) (1969), 7302.

P. 32. This report includes tabulated data on the cost and efficiency of hoeing and handweeding in Kenyan cotton. The relative merits of the Dutch hoe and jembe (local hoe), optimum times for weeding, and effect of weeds on seed cotton yield are among the aspects considered.

CAB (WA 20-464) WA

East Africa; hand tools; cotton; timing

see also no 11003. See also Druijff, A.H; Kerkhoven, G.J. Effect of efficient weeding on yields of irrigated cotton in Eastern Kenya. PANS (1970), 16(4), 596-605.

52303

AVÉ, J.B. [A native working method in Indonesia]. Un procédé de labour original en Indonésie. Journal d'Agriculture Tropicale et de Botanique Appliquée (1977), 24(2-3):125-130 [Fr] [Rijksmuseum voor Volkenkunde, Leiden, Netherlands].

The use of a long pointed stick (called kabanda in Sumoa, suak in Timor, and ongkal in Sumatra) is described. It is used to clear the land of weeds, especially Imperata cylindrica, at the end of the dry season and is more efficient than a plough, although it requires much labour. It is used chiefly on collective land.

CAB (WA 29-2689) ATA

Southeast Asia; hand tools; land preparation; perennial problem weeds

5.24 Animal-drawn implements and motor-powered implements

52401

MUCKLE, T.B.; CROSSLEY, C.P.; KILGOUR, J. The 'Snail' - a low-cost primary cultivation system for developing countries. World Crops (1973), 25(5):226-228 [Nat. College of Agric. Engineering, Silsoe, Bedford, UK].

The development of a 'low-cost' (1973 target price about £100) cultivation machine, able to exert a tractive force of 4-5 kN in any soil condition, is described. The machine consists of a modified ox-plough guided by one person, and a self-propelled winch equipped with an anchor. The power unit is guided and controlled by a second person.

In use, the plough is first held stationary while the power unit is driven away, feeding out the cable until the limit of the cable is reached. The plough is then pulled through the soil towards the power unit by the winch, the power unit being held stationary by its anchor.

This machine can carry out cultivations throughout the year, but it is especially intended for land preparation during the dry season, when the force needed to pull an implement through the soil is very high.

The machine is designed to be manufactured in developing countries, using local labour and materials.

WRO JAFC

land preparation; motor-powered implements

52402

WEVERS, J.D.A.; KUIPERS, H. Tillage as a weed control measure in the tropics. [Paper in] Proceedings of the 7th Conference of the International Soil Tillage Research Organization, Sweden, 1976. Rapporter från Jordbearbetningsavdelningen (1976), No. 45, 47.1-47.6 [Soil Till. Lab., Agric. Univ., Wageningen, Netherlands].

Chemical weed control in the tropics is restricted because of high costs, environmental consequences and lack of education on the part of most farmers. Proper tillage operations can reduce weed problems enormously.

Results of tillage and inter-row cultivation trials carried out in the savannah zone of Northern Nigeria are presented. Weed growth at three levels of mechanisation (animal power, power tillers and large tractors) was studied in separate experiments. At each level of mechanisation, weed growth after different tillage operations was compared. Mouldboard ploughing at all mechanisation levels was effective in suppressing annual weed growth; moreover, deep tillage at the beginning of the dry season, when soil moisture content is still rather high, followed by repeated operations appears to result in a high degree of desiccation of perennial weeds. However, the traditional way of primary cultivations by ridge splitting, which also reverses much of the topsoil, was thought to be a good alternative to mouldboard ploughing, and required less labour.

Timely inter-row cultivations can keep weed growth under control until crop closure. Tall crops can be earthed up by ridges, which were effective in controlling weeds even in the row; for lower growing crops, planting on ridges and tine cultivation with reridging gave satisfactory weed control.

CAB (WA 30-1999) WA/JAFC

West Africa; land preparation; inter-row cultivation; animal-drawn implements; motor-powered implements; economic analysis

52403

FORT, J. [Mechanisation of traditional agricultural practices in the Sahelian Zone]. Mécanisation des pratiques agricoles traditionelles en zone sahélienne du nord. Antony-Seine, France. Machinisme Agricloe Tropical (1973), 41, 34-40 [Fr, en].

The short rainy season in the Sahelian zone induced the search for means of speedy performance of crop establishment operations. Tests have been successfully conducted in Niger Republic on light soils with animal-drawn equipment, which secures tillage on a 45 cm wide strip while making furrows for planting by hand, and providing at the same time for mechanical weeding. As far as the use of dromedaries as draught animals is concerned, an improved harnessing system was developed and working rules are indicated.

CAB (WAERSA 16-1847) TA

West Africa; land preparation; animal-drawn implements

see also no. 51203.

52404

SHULMAN, R. Strategy for the Advancement of Animal Traction in Mali. Report of a study carried out for United States Agency for International Development, Mali and the Division de Machinisme Agricole, Mali, June-October, 1979, Contract No. 688-79-514, (1979), 55 pp. [Dept. of Crop Sci., California Polytech. State Univ., San Luis Obispo, CA 93401, USA].

This study provides technical information from the fields of agronomy, agricultural engineering and animal science relevant to programmes to improve animal traction in Mali. The high labour requirement for weed control is the greatest constraint on the expansion of total cultivated area. It can be reduced by improved equipment for sowing in rows, for controlling weeds closer to the crop plants, and for greater frequency in inter-row cultivation. Possible improvements in soil preparation and weed control are discussed (pp. 12-20).

-- JAFC

West Africa; animal-drawn implements; novel systems; land preparation; planting techniques

52405

OGBORN, J.E.A. Straddle ridge cultivation and equipment for the heavy lands of the African Savanna. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK; Commonwealth Secretariat (1980), 49-57 [Dep. Agron., Inst. Agric. Res., PMB 1044, Zaria, Nigeria].

The Strad multipurpose toolbar consists of 2 box-section legs at an angle of 49° to each other which straddle a 76 cm ridge and support 2 or 4 gangs of rotary weeders with 3 rotary discs/gang. It is designed to operate in hard, dry conditions on heavy land and is pulled by cattle. A central tine with an A-blade to cultivate the top of the ridge is hollow and can be fitted with a seeder box. The forward speed may be up to 3.6 km/h for 3 h continuous operation. Useful additions might include a band herbicide applicator and a precision planter. The system is well adapted to the use of preplant incorporated herbicides broadcast overall. Separate ridging and hoe weeding would have required 600-700 man-hours/ha to produce cotton at Samaru. The introduction of the straddle row weeder halved the post-em. labour requirement, and the central tine fitted to cultivate the top of the ridge further reduced the labour requirement (to 256 h/ha) and increased the yield. The addition of herbicides (trifluralin at 0.8 kg/ha) further reduced the labour requirement to 189 h/ha.

CAB (WA 30-1275) WA

West Africa; novel systems; animal-drawn implements; cotton; land preparation; herbicides

52406

STOKES, A.R. Mechanisation and the peasant farmer. World Crops (Dec. 1963), 444-450 [Parnell House, 25 Wilton Rd., London SW1, UK].

The impact of the tractor on upland farming in Northern Nigeria is discussed. Improved ox-drawn mulching, which can be used to take advantage of the greater yield potential of tied-ridge farming, is thought to have greater potential for increasing yields than introduction of tractors. Ox-powered implements were compared at Samaru Research Station, including the Emcot plough, a one-row basic multipurpose tool frame, a 1-2 row complete multipurpose tool frame, and the NIAE and 'Polyculture' tool frames. Production costs per acre for each operation involved in the production of groundnut, sorghum and maize are tabulated for each implement. Work on wheeled ox-drawn groundnut lifters showed that the remains of ridges from which groundnuts had been harvested remained nearly free from weeds throughout the dry season and into the following rains, possibly because weed seeds were deflected into the furrows. Dry planting into these reduced ridges immediately before the rains gave excellent germination and survival of groundnuts and millet with very little weed competition. Weeds in the furrows could be eliminated by several intercultivations with a ridger, which would also earth up the crop during the growing season. Planting into the reduced ridge also eliminates the heavy operation of splitting ridges at a season when the animals are in poor condition.

-- JAFC

West Africa; groundnut; maize; sorghum; pearl millet; animal-drawn implements; inter-row cultivation; economic analysis; motor-powered implements; land preparation

52407

MUSA, H.L. Traditional tillage operations and development and use of animal drawn equipment. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK; Commonwealth Secretariat (1980), 29-36 [Dep. Agric. Eng., Inst. Agric. Res., PMB 1044, Zaria, Nigeria].

Tillage and crop production techniques used by Nigerian small-holder farmers are described. Includes a table specifying the hand tools used in each operation and the time taken per hectare.

Short- and long-handled hoes are described. Weeding constitutes the greatest bottleneck period for the traditional farmer; two weeks' delay may halve the yield. The 4 basic manual weeding practices are hand pulling, hoe weeding, ridge side hoe scraping and ridge remoulding. Hoe weeding is used to uproot weeds for desiccation and shaking soil off the roots may be necessary. The Churbe method involves the use of a ridging hoe to scoop and invert soil and weeds from the side of the ridge into the furrow; after 2-4 weeks, when the weeds have decayed, the ridges are remoulded. A straddle row rotary weeder has been designed with a high clearance frame and is pulled by an animal; weeding knives are mounted on rotors set on an inverted U frame. In tests, it averaged 35 m/min

forward speed (6.5 h/ha) and worked best in friable soil with weeds at the 2- to 3-leaf stage. The fitting of scrapers prevented clogging of the weeding knives.

CAB (WA 30-1274) WA

West Africa; traditional systems; land preparation; hand tools; animal-drawn implements

52408

PAPA CHAM. Appropriate tillage systems evaluation by the Department of Agricultural Engineering in the Gambia. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK; Commonwealth Secretariat (1980), 87-94 [Yundum Exp. Sta., Yundum, Gambia].

The Department has embarked on long-term trials to study minimum tillage. The Sine Houe Package was adopted for cultivation and consists of a T-shaped frame with handles and a head wheel, 5 weeding/cultivating tines, a 9 inch mouldboard plough, a groundnut lifter, a ridging attachment, and a 3 m traction chain. The Package was tested and modifications made and suggested to the manufacturer; 1500 modified implements were issued on credit to farmers in 1978 and another 700 were expected in 1979.

CAB (WA 30-1277) WA

West Africa; animal-drawn implements; novel systems; minimum tillage; land preparation

52409

MATHEWS, M.D.P.; PULLEN, D.W.M. Cultivation trials with ox-drawn implements using N'dama cattle in the Gambia. Report Series, Overseas Department, National Institute of Agricultural Engineering (1976), 48 pp. [Nat. Inst. Agric. Engng., Silsoe, Bedford, UK].

Groundnut cultivation trials. Weed control at Yundum, especially on direct-sown plots, was a problem throughout the season. Ploughing was the best method of weed control and next best was tine cultivation combined with mechanical weeding (Sine Hoe and Long-handled chop hoe).

Cotton cultivation trials. Again, mechanical weeding systems were significantly faster when combined with ploughing and tine cultivation.

Summary of cropping practices. Mechanical weeding of all crops is quick and easy if it is carried out early and regularly and leaves only a small amount of around-the-plant handweeding. Trials showed that long-handled hoes were satisfactory and have great potential. Hand-sown millet (Panicum miliaceum) can be cross-weeded with the Sine Hoe because it is planted on-the-square.

CAB (WA 26-519) WA

West Africa; animal-drawn implements; hand tools; land preparation; planting techniques; groundnut; cotton; local cereals; inter-row cultivation

52410

DIHENGA, H. Tanzania's experience in appropriate technology for tillage operations. In: Proceedings of the Appropriate Tillage Workshop, Zaria, Nigeria, 1979, London, UK; Commonwealth Secretariat (1980), 117-125 [Dep. Agric. Eng., Fac. Agric., Univ. Dar-es-Salaam, P.O. Box 643, Morogoro, Tanzania].

The use of Howard-Rotoseeders and paraquat effected considerable savings in time, power and labour in minimum tillage trials in dry, marginal areas. A system approach based on a tool carrier system is recommended and Ubungo Farmers Implements of Tanzania are now manufacturing their own toolbar. More trials with minimum tillage are recommended with the supplementary use of chemicals and/or mulching for improving weed control.

CAB (WA 30-1278) WA

East Africa; land preparation; animal-drawn implements; planting techniques; minimum tillage; herbicides

52411

GIBBON, D.; HESLOP, C.; HARVEY, J. The Hashasha and Atulba toolbar. Development Studies Discussion Paper, University of East Anglia (1978), No. 21, 40 pp. [Overseas Development Group, East Anglia Univ., Norwich, UK].

The animal-drawn equipment described was designed for construction in a field workshop and use in sandy, noncompacting, unstable soils in semi-arid regions such as the Sudan. The Hashasha weeder has tubular steel handles and a frame of wood and metal (2.5 X 3.8 cm bar) supported by a skid and 3 horizontal A-shaped overlapping sweeps, each having 2 blades swept at 60° and a single chisel point. The sweep and skid heights are adjustable, the implement, pulled by 2 oxen, working well at 5-7 cm depths with a working width of 80 cm, and weeding 1½ ha in 6 h. It is suitable for weeding land before planting and inter-row weeding of millet grown 1-1½ m apart. The Atulba toolbar was designed for sweeping, planting and inter-row weeding of groundnut crops. It is made of 2.5 X 3.8 cm solid metal bar and angle iron. The 2 skids are 120 cm apart and the implement is set up differently for each operation. For planting, a hopper made from an 18 litre petrol can, 2 funnels with plastic tubes, and stems 60 cm apart, carrying chisel openers and hinged devices for covering the seed, are attached. The seed feed system uses seed plates at each end of a horizontal bar with a pendulum and spring attached; the rate and timing of seed flow can be controlled by pulling a light rope attached to the pendulum.

CAB (AEA 4-2736) AEA

East Africa; animal-drawn implements; land preparation; planting techniques; inter-row cultivation

52412

HUBBARD, K.; HARVEY, J.; GIBBON, D. The Versatool: an animal drawn tool carrier for crop production systems in semi-arid regions. Botswana, Division of Agricultural Research, Dryland Farming Research Scheme, Technical Bulletin No. 6 (1974), 28 pp. [Agric. Res. Station, Gaborone, Botswana].

The construction and use of the Versatool (an animal-drawn, two-wheeled implement carrier to which can be attached a number of implements including a chisel plough, subsoil plough, sweeps, a steerage hoe, markers, planters and fertiliser-application equipment, as well as being used as a simple carrier when all implements are removed) are described. It is intended for use in an integrated farming system developed for Botswana (see no. 51401). The whole tool carrier, except for the wheels, can be made using welding equipment, a drill, a saw, a common range of metals and a minimum of skill in metal work. A detailed description, drawings, specifications, and photographs of the toolbar and associated implements are included.

-- JAFC

Southern Africa; novel systems; animal-drawn implements; land preparation; inter-row cultivations

see also nos. 51305, 51306

52413

MOCHUDI FARMERS' BRIGADE, BOTSWANA. The Mochudi toolbar. 'Makgonatsotlhel: The machine which can do everything. Agricultural Information Service, Ministry of Agriculture, Gaborone, Botswana (1975), 17 pp. [Mochudi Farmers' Brigade, Box 208, Mochudi, Botswana].

The use of the Mochudi toolbar (an animal-drawn, two-wheeled toolbar to which can also be attached a planter, fertiliser applicator, disc hillers, sweeps, or a standard mouldboard plough, which can be used as a carrier when all implements are removed) is described, with many photographs and a line drawing of the toolbar. More information and a set of scale drawings are available on request from the Brigade.

-- JAFC

Southern Africa; animal-drawn implements; land preparation; inter-row cultivation

see also nos. 51305, 51306

52414

MEYER, E.; BEER, A.G. DE. An evaluation of various types of cultivators for weed control in sugarcane. Proceedings, South African Sugar Technologists' Association (1975), No. 49, 154-156 [South African Sugar Association Exp. Sta. Mount Edgecombe, Natal, S. Afric a].

Thirteen types of mechanical cultivators were tested under a variety of soil type and soil moisture conditions on 3 types of weeds at 3 different growth stages. Effectiveness was judged on a performance scale of 1 to 9 and significant differences were found between treatments. Factors such as timeliness of operation and type of weed became more important with the lighter implements.

Two mule-drawn implements (a mule-drawn cultivator with tines and a cultivator with sweeps) were included in the trials. It is concluded that they gave sufficiently good results to justify their widespread use even today. They are recommended for steep slopes where other machinery is inefficient, since they work very slowly. Like most implements, they were most effective on small weeds and lighter soils.

CAB (WA 26-998) WA/JAFC

Southern Africa; sugarcane; animal-drawn implements; motor-powered implements; inter-row cultivation

see also no. 52416

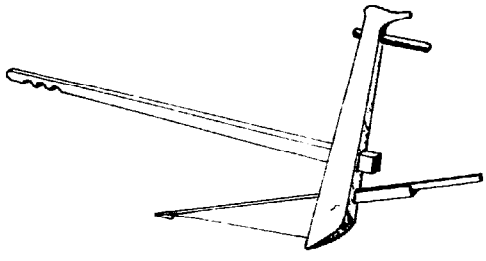


Figure 13. Indian country or "desi" plough. Ref no. 52415

52415

FOSTER, J.H. The economics of the mold-board plow and three-tine cultivator in two districts in Uttar Pradesh. Indian Journal of Agricultural Economics (1966), 21(2):47-66.

This study examines the benefits from use of the mouldboard plough and three-tine cultivator as substitutes for the wooden deshi plough, based on the actual use of these implements by farmers, which is described. Farmers adopt the mouldboard plough primarily because of its assistance in control of weeds, especially grasses. It is not used as a substitute for the deshi plough nor does it save time in seedbed preparation. The three-tine cultivator does save substantial time when it is used as a substitute for the deshi plough, this being the primary reason given for its adoption by farmers, although half the farmers in one district surveyed felt that the cultivator also helps in grass weed control. Richer farmers with two or more pairs of bullocks prior to adoption of the new implements may be able to greatly increase their income by substitution of the plough and cultivator for the deshi, since the implements make possible the disposal of one pair of bullocks. For the small farmer, in contrast, the adjustments necessary to profit from savings in bullock-hours and person-hours may not be feasible or attractive. A fuller report of this study is available from the Head, Dept. of Agric. Economics, Allahabad Agric. Institute, Allahabad, U.P. India.

-- JAFC

Indian subcontinent; animal-drawn implements; land preparation; economic analysis; social analysis

52416

PANJE, R.R.; MENON, R.G. The I.I.S.R. weeder-mulcher is ideal for sugarcane. Indian Farming (1967), 17(2):7-8, 47 [Indian Institute of Sugarcane Research, Lucknow, India].

A simple animal-drawn implement for combined weeding and mulching in sugarcane has been constructed in India. Four blades are equally spaced on a horizontally rotating axis. Each blade is locked into its appropriate lowermost position by a manually-operated latch. Weeds are uprooted by slicing the blade through the subsurface soil at a depth of 5 cm. When excess weeds begin to clog the blade, the latch is unlocked and the next blade falls into position. Collected weeds are deposited in a heap to serve as an organic mulch. The loose topsoil acts as a soil mulch. The implement is most effective on soils subject to crust formation.

Construction details are given in an ITDG leaflet (no. 12105), which states that this implement is suitable for many row crops.

CAB (WA 17-958) TA

Indian subcontinent; animal-drawn implements; inter-row cultivation; mulching; sugarcane

5.25 Herbicides and herbicide application

52501

VERNON, R. Herbicides for small-scale farmers. Mount Makulu Research Station, Zambia, Mimeo, 2 pp., no date (1976?).

This leaflet states that small farmers rarely use herbicides, as available herbicides lack sufficient selectivity and need accurate sprayer calibration. It recommends applying atrazine, which is highly selective, to the soil after sowing maize, and using the Micron 'Handy' sprayer which needs no calibration.

WRO JAFC

Southern Africa; maize; herbicides; herbicide application (low volume)

52502

SHARMAN, C. Herbicide development in peasant farming. In: Proceedings, 10th British Weed Control Conference, Brighton, Uk, British Crop Protection Council (1970), 685-688 [Dept. Conservation and Extension, P.O. Box 191, Sinoia, Zimbabwe].

The increase in the acreage of cash crops grown on peasant farms in Rhodesia has led to a number of problems. One of the greatest is weed control, especially in wet years when the labour available cannot cope with the increased acreage using traditior single-row ox-drawn cultivators or by handweeding. This paper discusses the initial introduction of a herbicide into these areas. It includes descriptions of hand-held spraying equipment and that mounted on an ox-drawn cart. Particular attention is given to the practical problems met in the field.

CAB (WA 20-1912) JAFC

Southern Africa; herbicide application (high volume); animal-drawn implements

5.3 CONTROL OF PROBLEM WEEDS

5.31 Parasitic weeds

53101

GIRLING, D.J.; GREATHEAD, D.J.; MOHYUDDIN, A.I.; SANKARAN, T. The potential for biological control in the suppression of parasitic weeds. Biocontrol News and Information, Sample Issue, September 1979, 7-16 [Commonwealth Inst. Biol. Control, Curepe, Trinidad, West Indies].

This review article covers biological, chemical and cultural control of witchweeds (Striga spp.), broomrapes (Orobanche spp.) and mistletoes (Loranthaceae), including crop tolerance of the parasites and germination stimulants. Includes a reference (Chal"kov, K. 1973 [A biological method for the control of Orobanche] Rastit. Zashch. 21, 20-24) to the use of the agromyzid fly Phytomyza orobanchiae Kalt. for the control of Orobanche ramosa in Eastern Europe. Larvae of P. orobanchiae feed on the reproductive tissues of the weed and overwinter as pupae in the stem. Plants containing pupae are collected and kept in special rooms (sic) over winter, for distribution and release in tobacco fields the following spring. Special platforms with sugar or honey for the adult flies are also supplied.

Flooding destroys the seeds of some Orobanche species (O. crenata and O. cernua), allowing rotations with rice to be used as a control measure in some areas (also see no. 53104). Cattle and goats graze on Orobanche, but the seeds can pass through them unharmed and be further spread.

CAB (WA 29-1156) JAFC

highland and temperate zone; parasitic weeds; biological control; crop rotation; water management; grazing

53102

PIETERSE, A.H. The broomrapes (Orobanchaceae) - a review. Abstracts on Tropical Agriculture (1979), 5(3):9-35 [Dept. of Agric. Research, Royal Tropical Inst., Amsterdam, Netherlands].

A review of taxonomy, distribution, biology, and manual and chemical control. Includes the information that flooding suppresses Orobanche by killing the seeds in the soil, so rotation with rice can be useful. Rotation with the trap crops, lucerne, maize, clover, rape, mustard, capsicums, castorbeans, sesame, millet and linseed, is also recommended.

CAB (WA 30-3620) JAFC

parasitic weeds; biological control; herbicides; crop rotation; cultivar selection; water management; highland and temperate zone

53103

KABULOV, D.T.; KHALIMOV, M.KH. [Some biological characteristics of Egyptian broomrape and ways of controlling it by means of the fungus Fusarium]. Nauchnye Trudy Biologicheskogo Fakulteta, Samarkandskiĭ Gosudarstvennyĭ Universitet imeni A. Navoi (Botanika) (1974), No. 207, 167-173 [Ru] [Biol. Fak. Samarkand, Gos. Univ., Uzbek SSR].

The fungus (Fusarium orobanches), distributed in the tobacco plantations of Urgutskiĭ District, causes rotting of the flower-bearing shoots and nodules of broomrape (Orobanche aegyptiaca) without affecting the tobacco host plants. Fungal growth was optimal at soil temperatures of 18-25°C and soil moisture contents of 68-80%. Fungi cultured on potato agar in flasks retained their viability for 2-3 years. For application of the fungus to the soil, a 1:1 mixture of cattle concentrate feed with finely chopped straw was used; the mixture was soaked in water and sterilised or partly sterilised by steam to eliminate antagonists of the fungus, and then mixed with cultures of the fungus. Application of the fungus in tobacco-planting holes at a depth of 15-25 cm prevented broomrape shoots from emerging.

CAB (WA 26-2099) WA

highland and temperate zone; parasitic weeds; biological control; tobacco

53104

PALKIN, YU; PROKUDINA, F. [Cultural control of broomrape]. Kartofel' i Ovoshchi (1973), 18(7):35-36 [Ru] [Vses. n-i Inst. orosh. Ovoshchevod. Bakhchevod., Astrakhan, USSR].

Anaerobic conditions were simulated by keeping broomrape (Orobanche aegyptiaca) seed under water for 1½-6 months, periodically changing the water; the seed was then dried and mixed with soil. Immersion for 1½-6 months reduced the number of attachments of broomrape to watermelon host plants from 137 in the control to 6 to 0.6 in 1971 and from 55 in the control to 0 in 1972; the leaf surface area of the watermelons increased 3-6 times. Flooding the soil from 18 August 1971 to 26 May 1972 killed all broomrape seeds; infestation amounting to 11.5 broomrapes/plant in unflooded controls reduced the leaf surface area of melons by 67-75%. Flooding in autumn was less effective than flooding in summer; flooding for 2 months in summer was highly effective. Five to eight broomrape shoots/m^2 reduced melon yields to 19 t/ha in 1964, but melons grown in 1967 after cropping with rice were almost free from broomrape and yields increased to 24 t/ha. Flooding for 2 years for fish farming completely killed broomrape seeds. The rotation of watermelons with rice or fish is recommended.

CAB (WA 22-2943) WA

highland and temperate zone; parasitic weeds; vegetable crops; paddy rice; fallow; water management

53105

KRISHNAMURTY, S.; UMAMAHESWARA RAO, M. Control Orobanche through crop rotation. Indian Farming (1976), 25(10):23 [Central Tobacco Res. Inst., Rajahmundry, Tamil Nadu, India].

The easiest way to control Orobanche (ramosa) on tobacco is by hand pulling when the parasite is 6 inches high; complete eradication was achieved by systematic hand removal for 3 years at Rajamundry, but labour shortage is the problem. The application of 0.1% allyl alcohol can alleviate the problem. Alternate cropping is an effective method of control, even though Orobanche seeds can survive for 10 years in the soil. The maximum number of Orobanche shoots was recorded in fallow-tobacco plots and the least in tobacco after sorghum; the incidence was also low in tobacco after maize. Paddy in kharif, followed by tobacco in the rabi

season, is the most profitable rotation in the tobacco areas of Eastern and Western Godavari; a general decline in both the population and weight of Orbannche was noticed in this 1-year 2-crop rotation.

CAB (WA 26-342) WA

highland and temperate zone; parasitic weeds; herbicides; crop rotation; tobacco; paddy rice; maize; sorghum

53106

JACOBSOHN, R.; GREENBERGER, A.; KATAN, J.; LEVI, M.; ALON, H. Control of Egyptian broomrape (Orobanche aegyptiaca) and other weeds by means of solar heating of the soil by polyethylene mulching. Weed Science (1980), 28(3):312-316 [Div. Vegetable Crops, Agric. Res. Organization, The Volcani Center, Bet Dagan, Israel].

Mulching the soil with polyethylene sheets before sowing during the hot season increased the soil temperatures, which resulted in the control of soil-borne pathogens and weeds. This method was tested in a field heavily infested with Egyptian broomrape (Orobanche aegyptiaca L.). Soil was irrigated and mulched for 36 days during August-September 1977, prior to sowing carrot (Daucus carota L. 'Nantes Tip Top') seeds. Mulching increased soil temperatures by 8 to 12°C, up to 56°C in the top 5 cm. In the nonmulched plots, the carrot plants became stunted due to heavy parasitisation with broomrape and they were completely destroyed by the end of the season. In contrast, broomrape and other weeds were controlled in the mulched plots and the carrot plants grew normally. This effect was less pronounced in the border rows of the mulched plots. Mulching also greatly reduced the infestation of other weeds. Egyptian broomrape was also controlled in two other field experiments with carrots and eggplants (Solanum melongena L. 'Black oval'). As compared with fumigation, this new method of control is economical, simple, nonhazardous, and does not employ toxic materials.

CAB (WA 30-902) A

Middle East; vegetable crops; grain legumes; parasitic weeds; mulching; fallow; imported mulches

53107

LUBENOV, J. [On the parasitic weed problem in Bulgaria]. In: Symposium on Parasitic Weeds, Malta, 1973, Wageningen, Netherlands; European Weed Research Council (1973), 18-27 [Fr, en, de] [Inst. pour la Protection des Plantes, P.O. Box 238, Sofia, Bulgaria].

Reviews Bulgarian research on the biology and control of Orobanche spp. and Cuscuta spp. Includes the information that, in a trial in 1966, stocking 12 geese on 6 ha of tobacco infested with O. ramosa resulted in the consumption of the weed shoots without harming the crop. (Reference: Kirtchev, R. 1966, Bulg. tjunjun, 11(1): 16-17)

CAB (WA 23-325) JAFC

highland and temperate zone; tobacco; parasitic weeds; grazing; herbicides

53108

OGBORN, J.E.A. Methods of controlling Striga hermontheca for West African farmers. [Paper presented at the] Agricultural Research Seminar, "Sorghum-millet research in West Africa," Bambey, Senegal (1970), pp. 22 [Inst. Agric. Res., Samaru, PMB 1044, Zaria, Nigeria].

West African cultivators cannot afford expensive equipment and their only favourable circumstance is that they have a surplus of family labour during the period of S. hermontheca emergence from August onwards. Hand pulling is the main control method; plants are pulled out once or twice a season after flowering and the formation of a woody stem, but before the seed has matured. Nearly 2 million S. hermontheca plants weighing 3.5 t had to be removed by hand (with weekly weeding) to increase grain yields of sorghum cv. Short Kaura from 0.25 to 0.68 t/ha (an increase of Nigeria £12/ha) in 1968. Hand pulling stimulated S. hermontheca emergence and was less effective than a single application of herbicide as granules. The application of 80 kg N/ha (3 times the normal rate) 4 weeks after sowing sorghum gave substantial suppression of S. hermontheca and was profitable when grain prices exceeded 7.2 pence/kg. Very high proportions of sorghum and millet are grown as mixed crops at low densities and control of S. hermontheca would be expected to produce the greatest yield increase in these heavily infested

crops intensively grown close to centres of habitation. Herbicide trials showed that 2,4-D was unsuitable for use in mixed crops. Sixteen other foliar acting herbicides applied during flowering killed S. hermontheca with rates < 0.6 kg/ha in 1967. Herbicides as 0.05% solutions were applied (before flowering) in total spray volumes of 575-924 litres/ha in the course of 11 weekly applications in 1969. Linuron and ametryne were effective and are well tolerated by tropical legume intercrops; ametryne controlled S. hermontheca infestations amounting to 100,000 plants/ha at a cost of £1.25/ha for the herbicide in 2 trials. Granular materials, easily applied by hand, have been tested as soil applications since 1967. 2,4-D and MCPA granular were toxic to some strains of sorghum at rates > 1 kg/ha and 2,4-D granular did not persist long enough to give effective control. Nitralin and triallate showed strong residual activity at rates as low as 0.03 kg/ha, making control with a single application feasible. The application of herbicide + fertiliser mixtures, systemic herbicides, and the stimulation of seed germination are discussed.

CAB (WA 21-594) WA

West Africa; parasitic weeds; novel systems; herbicides; herbicide application (granules); sorghum; pearl millet; intercropping

53109

OGBORN, J.E.A. The control of Striga hermonthica in peasant farming. In: Proceedings, 11th British Weed Control Conference, London, UK, British Crop Protection Council (1972), 1068-1077 [Inst. Agric. Res., Ahmadu Bello Univ., PMB 1044, Zaria, Nigeria].

Sorghum is the staple food grain of Northern Nigerian peasant farmers, but is often parasitised by S. hermonthica; its control on sorghum in mixed crops is discussed. Intensive handweeding is not attempted by farmers and is uneconomic. Farmers near Samaru regard an infestation of 1-2 S. hermonthica plants/m^2 (10-20 thousand/ha) in the crop as acceptable (equivalent to about 10% loss of yield). A satisfactory spot sprayer costing only 5 Nigerian shillings was developed in 1971; with this pistol grip sprayer, farmers can treat individual S. hermonthica plants up to 1 m away with relatively coarse drift-free droplets produced by an adjustable nozzle. The sprayer delivers almost exactly 1 ml/stroke; spot treatment with ametryne at 0.4 mg/ml of solution using a total rate of 20 g a.i./ha was effective in village trials. The cost was 3 shillings/ha, including the cost of the sprayer. Spot sprays of atrazine, linuron and MCPA also controlled S. hermonthica at rates below 0.5 kg/ha; groundnuts and cowpeas (Vigna sp.) tolerated 0.2 kg ametryne/ha. Cowpeas are more tolerant of fluorodifen than of ametryne, but both groundnuts and cowpeas tolerate linuron. With the aid of the spot sprayer, it should be possible to organise the virtual eradication of S. hermonthica by persistent communal efforts at village level.

CAB (WA 23-287) WA

West Africa; parasitic weeds; sorghum; intercropping; herbicides; herbicide application (low volume); Vigna; groundnuts

53110

OGBORN, J.E.A.; MANSFIELD, R.A. The potential use of germinators for Striga control by African peasant farmers. In: Supplement to the Proceedings of the 2nd Symposium on Parasitic Weeds (eds. Musselman, L.J., Worsham, A.D. and Eplee, R.E.), North Carolina State University, Raleigh, NC, (1979), 29-37 [Inst. for Agric. Res., Zaria, Nigeria].

Methods of applying ethepon or strigol analogs in the absence of cereal host crops are described. It is also profitable to make direct applications in the season of cereal cropping. Strigol analogs should be applied at the start of the rains, ethepon at planting. Strigol analogs can be directly applied by hoe farmers, providing that the formulations are stable when surface applied. Ethepon cannot be directly applied by hoe farmers until special equipment is developed. Animal-power farmers can use both types of germinators in direct applications.

WRO A

West Africa; parasitic weeds; herbicides; maize; sorghum; pearl millet

53111

RENEAUD, H. [Control of Striga asiatica, a rice weed in the Camoro Islands]. Lutte contre Striga asiatica, plante parasite du riz aux Comores. Agronomie Tropicale (1980), 35(1):2, 4, 61-63 [Fr, en, es, fr] [Inst. de Rechèrches Agronomiques Tropicales (IRAT), Bobo Osoulasso, Upper Volta].

Striga asiatica attacks maize, sugarcane, paddy and upland rice. Upland rice, representing 80% of the farm crops, is most susceptible. A series of herbicides were evaluated for Striga control - pre-emergence applications were not successful, and postemergence application of 2,4-D (4 litres of Desormane 600/ha) killed only the aerial parts of the parasite without improving rice yield. Catch cropping and trap cropping are discussed, and integrated control of Striga asiatica, using chemical control in combination with the use of economic trap crops and resistant varieties, is recommended.

-- ATA

Southern Africa; parasitic weeds; crop rotation; sequential cropping; herbicides; maize; sugarcane; paddy rice; upland rice

53112

PARKER, C.; REID, D.C. Testing sorghum and other crops for resistance to witchweed. In: Eighth Report, Agricultural Council, Weed Research Organization, 1978-1979 (1980), 76-83 ISBN 0-7084-0164-3 [ARC Weed Res. Org., Yarnton, Oxford OX5 1PF, UK].

Although witchweeds (Striga spp.) can be partially controlled by rotation, catch cropping, irrigation, improved soil fertility, and hand pulling, most of these practices are impracticable for a majority of the smallholders on infertile soils in semi-arid areas, where the problem is most severe. The alternative approach is to breed resistant varieties of the host crops.

Pot experiments confirmed the resistance to Striga hermontheca of low-stimulant sorghum varieties selected by breeders in Northern Nigeria and also revealed resistance to a wide range of strains of both S. hermontheca and S. asiatica. Stimulant-positive varieties showed inconsistent results. Varieties selected by ICRISAT for their low stimulation of the Indian S. asiatica proved relatively susceptible to several strains of S. hermontheca. Laboratory germination studies showed that, whereas the exudate activity of low-stimulant varieties may be 100 times less than in susceptible varieties, the difference may only be about 5 times less in the case of S. hermontheca. The pot experiments showed an almost perfect specificity of certain strains of S. hermontheca to bulrush millet (Pennisetum americanum) and also showed that, generally, strains of the parasite associated with sorghum did not germinate in response to millet and vice versa. Four strains of S. gesneroides were found to be specific to their original hosts, but exudate tests showed that this specificity was not due to simple differences in germination requirement.

CAB (WA 30-469) WA

parasitic weeds; sorghum; cultivar selection; pearl millet

5.32 Perennial problem weeds

53201

BALTAZAR, A.M. Cyperus rotundus and its control in vegetable crops. In: Philippines, Pest Control Council of the Philippines: Developments in Pest Management in the Philippines (1980), 184-196 [Nat. Crop Protection Center, Univ. Philippines at Los Baños, Philippines].

Control of Cyperus rotundus in vegetable crops in the Philippines by cultivations, mulching, intercropping, competitive cropping and herbicides, is discussed. Mulching 5-10 cm thick with rice straw and hulls, sugarcane bagasse, coconut leaves and other local materials is an effective method of weed control when combined with one handweeding or herbicide treatment. Cultivation to deplete food reserves is best carried out when C. rotundus shoots are 18 to 20 days old, before flowering. Cultivation is not a practical method of control in the wet season. No completely satisfactory herbicide for controlling C. rotundus in vegetable crops has yet been found.

-- JAFC

Southeast Asia; perennial problem weeds; vegetable crops; mulching; imported mulches; inter-row cultivation; herbicides

53202

BATTEN, G.J. Controlling scrubweeds with goats. NZ Journ. of Agric. (1979), IPPC Paper B/26 Min. of Agric. and Forestry, New Zealand.

This article describes how goats can be an all-purpose, low-cost income-earning, ecologically acceptable alternative to the more commonly used methods of scrubweed control--mechanical, chemical, or burning.

IPPC A

biological control; utilisation (of 'weeds');

5.33 Annual problem weeds

53301

PAMPLONA, P.P.; IMLAN, J.S. Methods of controlling Rottboellia exaltata in corn. Philippine Weed Science Bulletin (1977), 4, 14-20 [Mindanao Inst. Tech., Kabacan, Cotabato, Philippines].

Experiments were conducted during the dry season of 1975-76 to identify effective systems of controlling Rottboellia exaltata in maize which are suitable for adoption by farmers. Uncontrolled R. exaltata growth reduced yields by 63 to 71%. The farmers' usual method of weeding, which is off-barring (moving soil away from the crop row into the inter-row) 12 days after sowing (DAS) followed by earthing-up at 26 DAS with the use of an animal-drawn plough, gave insufficient control; yields were reduced by 23%. Treatments which gave yields comparable to a handweeded control were: off-barring and handweeding in the row at 12 DAS followed by earthing-up at 26 DAS; band application of trifluralin between the rows followed by either handweeding in the rows at 12 DAS, earthing-up at 26 DAS, or both; off-barring and handweeding in the rows at 12 DAS followed by paraquat/2,4-D application; and pre-em. application of atrazine, in combination with either earthing-up or directed paraquat/2,4-D application at 26 DAS.

These experiments were preceded by a survey of farmers' weed control methods in maize in Southern Mindanao. Few farmers used handweeding in association with off-barring or earthing-up to control weeds in the row. Some farmers, however, used the square method of planting, enabling them to off-bar twice at right angles. This controlled weeds much better than one off-barring, but yields were still lower than when a supplementary handweeding, to remove weeds from around the base of the corn plants, was carried out.

CAB (WA 28-2308) WA/JAFC

Southeast Asia; annual problem weeds; maize; traditional systems; novel systems; planting techniques; inter-row cultivation, herbicides

53302

PAMPLONA, P.P. Approaches to the control of Rottboellia exaltata L.F. in corn in the Philippines. In: Pest Control Council of the Philippines: Developments in Pest Management in the Philippines (1980), 286-295 [Univ. of Southern Mindanao, Kabacan, North Cotabato, Philippines].

Most farmers in the Philippines control Rottboellia exaltata in maize by off-barring (moving soil away from the crop row into the inter-row), followed by earthing-up. One supplemental weeding to remove weeds in or near the rows immediately after properly-timed off-barring at 12 to 16 days after sowing maize (DAS) has been experimentally found to practically overcome weed competition and increase yields by 33%. Few farmers give a supplemental weeding at present, due to the labour involved and the sharp trichomes on R. exaltata which hurt bare hands, but this practice appears to be increasing. Planting in the 'square method,' followed by off-barring twice at right angles, results in fewer weeds left in and around the maize hills and a greatly reduced time needed for supplementary weeding. Directed paraquat sprays are an alternative to handweeding.

At present, controlling R. exaltata is an endless task because the plants are allowed to reseed. Depletion of seeds in the soil may be hastened by cultivating the field several times at 10 to 15 day intervals before planting the maize. It is suggested that supplementary weedings of R. exaltata should be carried out until 60 DAS so the weed will have no chance to produce seed before harvest, and that farm boundaries should be kept clear, but eradication of the weed is not possible unless a concerted effort is made by neighboring farmers over a large area. Farmers in Allah Valley (South Cotabato) have conducted an

intensive campaign to eradicate R. exaltata through these measures, which has largely succeeded. The remaining weed species can be controlled with atrazine.

-- JAFC

Southeast Asia; annual problem weeds; maize; traditional systems; novel systems; planting techniques; inter-row cultivation; weed seed source reduction; herbicides

53303

INTERNATIONAL PLANT PROTECTION CENTER, OREGON STATE UNIVERSITY, USA. Weed Control Systems and Systems Utilization for Representative Farms in Developing Countries, Periodic Report 1978-79. (1979), 56 pp.

Pp. 10-11. Rottboellia exaltata. In the maize-growing sectors of Mindanao, R. exaltata has become the main weed menace. Results from handweeding experimental plots reveal that local farmers are suffering a 24% average crop loss from this weed alone when the normal procedure of one cultivation and a hilling operation are practised. The cultivation misses weeds in the crop row and handweeding is not a common practice. Also, R. exaltata competes throughout the season and can exert its most damaging effect late in the season. Monocrop maize and the associated cultural practices tend to encourage weed expansion. Also, regional maize-growing farms generally fall in the 3 to 5 ha range, thus precluding sufficient time or labour adequate to weed the planted area. In addition to herbicide treatments, two other approaches for control were investigated. Adding one correctly timed handweeding to the present cultivation-hilling routine could cut weed-caused yield losses to approximately 5%. Growing mung bean (Vigna radiata) between the maize rows not only reduced the weed competition, but also provided additional income as mung sells at 6 to 10 times the value of maize.

IPPC WA

Southeast Asia; annual problem weeds; maize; traditional systems; novel systems; timing; herbicides; intercropping; Vigna; economic analysis

see also no. 54101

5.4 WEED CONTROL IN PARTICULAR CROPS

5.41 Cereals

54101

FISHER, H.H.; MARGATE, L.Z.; LOPEZ, F.A. Weed control systems in white feed corn in the Philippines. (Abstract of paper presented at the 77th Annual Meeting of the American Society for Horticultural Science, Fort Collins, Colorado, July-August 1980). HortScience (1980), 16(3, Section 2):413 [Int. Plant Prot. Center, Oregon State Univ., Corvallis, OR 97331, USA].

Dense populations of Rottboellia exaltata are reported in monocropped maize in the Philippines. In a series of trials, uncontrolled R. exaltata reduced yields about 50%. R. exaltata germinated continuously up to harvest. Two cultivations using draught animals controlled R. exaltata to some extent, but yields were still reduced 24%. Traditional handweeding 3 times failed to reduce the R. exaltata population in the maize rows. The best control of R. exaltata was achieved by 2 cultivations + handweeding in the maize row. The best economic return was achieved by intercropping maize with mung bean. The use of herbicides was uneconomic.

CAB (WA 30-1663) WA

Southeast Asia; maize; annual problem weeds; intercropping; Vigna; economic analysis; inter-row cultivation; timing

54102

MERCADO, A.C. JR.; VILLEGAS, L.M. The cultural operations in growing corn. The Philippines recommends for corn - 1970/71 [College of Agriculture, Univ. of the Philippines, College, Laguna, 22-3, Philippines].

Recommended practices for land preparation, planting, and cultivation of maize are described. Ploughing should be 5 to 8 inches deep for an animal-drawn plough, or 12 to 14 inches deep with a tractor. Heavy soils, or areas with greater weed growth, may need to be ploughed several times. Ploughing is followed by harrowing (with an animal-drawn native harrow) and planting. The recommended planting density is 50,000 to 60,000 plants per hectare in rows 75 cm apart, and in hills

25 cm apart with one plant/hill, or 50 cm apart with two plants/hill. Cultivations can be carried out from about two weeks after planting until the corn plants are 18 inches tall without damage to the crop. Depth of cultivation should not be more than 5 cm to minimise root pruning; the native plough usually cultivates too deeply. After cultivation, the maize plants should be hilled up to cover the roots at the stem base and destroy weeds in the rows.

WRO JAFC

maize; Southeast Asia; novel systems; planting techniques; timing; inter-row cultivation

54103

PAMPLONA, P.P.; MADRID, M.T. JR. Weed control in corn and sorghum in the Philippines. In: Symposium, Weed Control in Tropical Crops, Manila (1978), 101-111 [Dep. Agron., Univ. S. Mindanao, Kabacan, N. Cotabato, Philippines].

Cropping systems used in maize and sorghum, losses caused by weeds, weed competition, seedbed preparation, inter-row cultivation, chemical weed control, weed control in intercropping involving maize as the major crop, and the control of Rottboellia exaltata and Sorghum halepense are the topics reviewed.

CAB (WA 29-3547) WA

Southeast Asia; traditional systems; maize; sorghum; novel systems; herbicides; perennial problem weeds; annual problem weeds; land preparation; inter-row cultivation; intercropping

54104

SHETTY, S.V.R. Approaches to integrated weed management in maize and sorghum in tropical and subtropical areas. In: Proceedings of the 7th Asian-Pacific Weed Science Society Conference, Sydney, Australia (1979), 87-93 [Farming Systems Res. Program, ICRISAT, 1-11-256 Begumpet, Hyderabad 500 016, AP, India].

The nature and extent of the weed problems in maize and sorghum are reviewed and the various control and management measures adopted discussed. The present status of weed research in sorghum- and maize-based cropping systems is reviewed and the future need for an integrated weed management approach is stressed. The proper combination of agronomic methods, mechanical tillage and supplemental use of herbicides, if necessary, may give maximum stability to the integrated weed management programmes for maize- and sorghum-based farming systems.

CAB (WA 29-3546) A

maize; sorghum; traditional systems; intercropping; herbicides; novel systems

54105

SHETTY, S.V.R. Weed control in sorghum in the tropics. In: Symposium, Weed Control in Tropical Crops, Manila (1978), 81-100 [ICRISAT, 1-11-256 Begumpet, Hyderabad 500016, AP, India].

The critical period of crop-weed competition in sorghum is the first 20 to 30 days of crop growth. Handweeding, the most common weed control method, is only effective when done in time. Mechanical methods such as inter-row cultivation, rotary hoeing, and flame cultivation are also used. Herbicides are beginning to be used where labour is expensive and physical and cultural methods difficult to practise. Atrazine and propazine are the most widely used pre-em. herbicides and 2,4-D the most common post-em. Striga can only be controlled by combining a number of practices. The nature and extent of the weed problems in sorghum are reviewed and the various control measures are discussed. Particular emphasis is focused on weed management in sorghum-based cropping systems. The present status of weed research in sorghum-based cropping systems is reviewed and the need for an integrated weed management approach is stressed.

CAB (WA 29-3556) A

sorghum; intercropping; herbicides; timing; parasitic weeds

Experiment Station, Paramaribo, Suriname, Vol. 15, 266-271 [Faculty of Agric., Univ. of the West Indies, Mona, Kingston, Jamaica].

This article reviews the suitability of four broad methods of weed control in groundnuts: cultural (through high plant populations, land preparation, crop rotation, etc.), chemical, mechanical and manual. It concludes that one specific package of technological practices cannot be given, but that it should be modified according to the circumstances (farm size, labour availability, prices of inputs, etc.).

ATA (6-32688) ATA

Caribbean; groundnuts; novel systems; herbicides; economic analysis

54305

CHANDRA MOHAN, J.; MOHAMMED ALI, A. Yield response of irrigated groundnut to organic mulches. Indian Journal of Agricultural Sciences (1969), 39(2):196-199.

The effect of leaf and straw mulches (applied one month after sowing) on yield of irrigated groundnut crops was studied for 4 seasons in India. The field trials showed that the mulches increased yields. Their use is profitable for irrigated groundnut crops, especially those grown during the dry season, provided waste rice straw, leaf or similar organic matter are available in abundance. The number of irrigations could be reduced from 8 to 6, and weed growth was found to be less in the mulched plots.

CAB (WA 20-75) TA

Indian subcontinent; groundnut; irrigated crops; mulching; imported mulches; economic analysis; mulching

54306

SCHÖNHER, S.; MBUGUA, E.S. Bean production in Kenya's central and eastern provinces. Occasional Paper, Institute for Development Studies, University of Nairobi (1976), No. 23, 69 pp.

This report is on a survey of bean production carried out in 1975. The survey was based on eight districts where 242 farmers and 72 other interested persons, ranging from marketing to governmental administrative personnel, were interviewed. The report reviews the present situation, including seed types used, crop husbandry practices, yield levels, storage, marketing and pricing, and the extension services offered for bean production. The second part discusses the economics of bean production as well as the basic constraints on the intensification and expansion of bean production, both in high-rainfall, small-farm areas as well as in dryer areas where farms are larger and land is not such a limiting factor. Specific problems are discussed relating to seeds, land preparation, planting systems, plant density, the application of fertiliser and manure, weed control, pests and diseases, storage, marketing and pricing. Finally, an extension project is proposed and described in some detail, which would promote the production of beans in Kenya. The infrastructural support which would be needed for expanded bean production is also described, particularly a wider availability of inputs and a viable marketing and pricing system.

CAB (WAERSA 20-776) WAERSA

East Africa; traditional systems; Phaseolus; economic analysis; novel systems; humid tropics;

5.44 Fibre crops

54401

RANGAIAH, P.K. Mechanical control of cotton weeds. Indian Farming (1966), 16(2):30-31 [Agric. Coll. and Res. Inst., Coimbatore, Madras, India].

In Madras State, in irrigated cotton top-dressed with ammonium sulphate, hoeing is normally done two or three times by hired labourers using hand hoes and mamutty (short-handled digging hoes). The use of a 'junior hoe' cultivator between the crop rows when the cotton plants are 1 foot tall, followed by intercultivations using a desi plough about 1 week later, replaced all but a single manual weeding operation (carried out when the plants are 4-6 in. high), reduced the cost of cultivation by 10%, and increased cotton

54106

UPADHYAY, U.C.; KHAN, Q.A.; NANDAWATE, H.D. Studies on weed management in sorghum. In: Proceedings of the 7th Asian-Pacific Weed Science Society Conference, Sydney, Australia (1979), 95-97 [Marathwada Agric. Univ., Parbhani M.S., India].

A field trial was conducted in the monsoon season of 1976/77 and 1977/78 to study the efficacy in sorghum of some herbicides in comparison with normal cultural practices. Data of both the years were pooled and the maximum sorghum grain yield of 7215 kg/ha occurred in weed-free plots, followed by atrazine applied pre-em. and post-em. at 1 kg/ha (6892 kg/ha). The use of atrazine overcomes the problems with cultural control in heavy clay soils during the monsoon season. Moreover, atrazine costs Rs 32/ha more than normal cultural practices, but the additional increase of 395 kg/ha of sorghum grain, realising Rs 395/ha, makes it an economic form of weed control.

CAB (WA 29-3144) A

Indian subcontinent; sorghum; herbicides; economic analysis

54107

THOMPSON, P.G. Growing broom corn. Fiji Farmer (1966), 2(3):46-48 [Agric. Stn., Sigatoka, Fiji].

Recommendations for broom corn (a variety of Sorghum bicolor L. grown for the long heads which are used in making brooms) include one ploughing and two cultivations (with time for the weeds to germinate in between) before sowing, one hoe weeding (and thinning to a final stand of 14-15,000 plants per acre) when the crop is 6-8 in. high, followed by a horse hoeing 10 days later.

CAB (WA 16-1567) JAFC

Pacific islands; sorghum; novel systems

5.42 Sugarcane

54201

OBIEN, S.R.; BALTAZAR, A.M. Weed control in sugarcane in the Philippines. In: Symposium: Weed Control in Tropical Crops, Papers presented at the 9th Pest Control Council of the Philippines, Manila (1978), 45-55 [Philippine Tobacco Res. Training Center, Batac, Ilocos Norte, Philippines].

Weeds are one of the major constraints to high yield in sugarcane production in the Philippines. About 106 weed species belonging to 32 families are found in association with the crop. The critical period of weed competition is within the first 4 months of the crop life cycle. Weed control should be started as soon as possible after planting or ratooning. Sugarcane control practices include manual, mechanical and chemical methods, and present practices are described in detail. A combination of cultural and chemical methods is recommended by two of the country's leading sugarcane experiment stations. Cost-reducing and income-adding practices like intercropping with rice and grain legumes are also being practiced and recommended.

CAB (WA 29-3657) A

Southeast Asia; sugarcane; timing; novel systems; intercropping

54202

MATHUR, P.S. Weed control in sugar cane in North India. Technical Bulletin, Indian Institute of Sugarcane Research (1965), No. 2, 22 pp. [Indian Inst. Sugarcane Res., Lucknow, India].

Common weeds of sugarcane are listed and special weed problems are discussed. Methods of weed control, including hand-weeding and interculture, burning, flooding, field preparation, rotation of crops, green-manuring with Crotalaria juncea, Sesbania aculeata, Cyamopsis psoralioides, and Vigna catiang, fallowing, and mulching, are described, including photographs of many operations. A number of tools, including khurpi, kassi, spades, and

various hoes and cultivators are presently used for weeding: those such as khurpi (a local short-handled weeding hoe or fork), which do not disturb the soil, help conserve precious soil moisture, but are less effective in controlling weeds and require frequent weeding operations. The use of the IISR-developed weeder-mulcher (see no. 52416) is suggested, and a weeding schedule for North Indian sugarcane is outlined. Trash mulching conserves soil moisture, suppresses weeds and gives yields comparable to those from other weed control methods with a great saving in labour. The 'deep-furrow cum trash-vein' system, a modification of the trash-mulching system developed at the Lucknow Institute, is outlined. In this system, furrows about 20 cm deep are opened by a bullock-drawn ridger and the cane planted in these furrows. When germination is complete, the furrows are clean-weeded and trash is packed into the furrows. Irrigations are given only in the furrows, leaving the ridges dry; these are periodically weeded by inter-culture. This system saves trash, reduces weed growth on the ridges due to lack of water, and ultimately increases yields. Chemical control of weeds is also discussed.

CAB (WA 18-2233) JAFC

Indian subcontinent; sugarcane; hand tools; animal-drawn implements; herbicides; water management; novel systems; land preparation; mulching; planting techniques; timing; irrigated crops; crop rotation; imported mulches

54203

MATHUR, P.S.; SAKSENA, M.M. On the utility of trash mulch in sugarcane ratoons. Indian Sugarcane Journal (1965), 10(1):24-27 [Indian Inst. Sugarcane Res., Lucknow, India].

In trials, trash mulch 15-30 cm thick packed into the furrows between the stubble rows up to ridge level after the sugarcane harvest, without dismantling the ridges, suppressed weeds, conserved soil moisture, reduced early shoot borer infestation and ultimately gave yields of ratoon comparable to or better than those obtained with the normal method of weed control of dismantling the ridges followed by 5 hoeings. Trash from the previous crop, remaining in the field, is sufficient to mulch about half the ratoon crop. About eight to ten person-days are required to spread trash in one hectare of ratoon field, at about one tenth the cost of the normal weed control practice.

WRO JAFC

Indian subcontinent; sugarcane; mulching; economic analysis; imported mulches

54204

LALL, M. Weed management can raise yields in sugarcane. Indian Farming (1977), 26 (12):25+ [Central Plant Protection Training Inst., Hyderabad, India].

Current and recommended weed control practices in sugarcane in India are discussed. Farmers weed postemergence with local tools - Kudali, Kutta or Khurpi. Hoeing starts the week after planting in the north, and continues up to four months at frequent intervals. In the south, weeding starts at the emergence of the mother shoots and continues until the completion of the second earthing-up. Normally earthing-up is done at 45 and 90 days after planting in ridges. Farmers often weed more frequently than is necessary - 3 to 4 weedings at 3 to 4 week intervals from the time of emergence of the mother shoots up to 12 weeks after crop emergence should be adequate. A trash mulch of dried sugarcane leaves about 10 cm thick gives good weed control, but may increase infestations of termites, rats and Sclerotium. Intercropping with grain, cowpea, soyabean and chickpea suppresses weed growth. Deep ploughing in summer helps desiccate perennial weeds. Burning the trash in the ratoon crop after harvest reduces subsequent weed infestations. Herbicides suitable for sole crop and intercropped cane are discussed.

CAB (WA 27-717) JAFC

Indian subcontinent; sugarcane; traditional systems; timing; mulching; intercropping; Vigna; soyabean; grain legumes; weed seed source reduction

54301

MOODY, K. Weed control in Asian soybeans using non-chemical methods. In: Expanding Use of Soybeans. Proceedings of a conference held at Chiang Mai, Thailand, February 1976 (INTSOY Series, International Soybean Program, No. 10) (1976), 69-73 [Int. Rice Res. Inst., P.O. Box 933, Manila, Philippines].

A review of weed control methods including the growing of competitive soyabean varieties, sowing density, land preparation, manual and mechanical weeding and mulching. Narrow row spacing (30 cm) decreases weed growth but also increases the risk of crop lodging. Rice straw from a previous crop, scattered over the field before dibbling soyabean seeds, reduced the need for weeding and increased yields of unweeded plots.

CAB (WA 28-1184) WA

Southeast Asia; Far East; soyabean; cultivar selection; planting techniques; land preparation; inter-row cultivation; mulching; crop rotation

54302

MOODY, K. Weed control in mungbean. In: 1st International Mungbean Symposium, Tainan, Taiwan; Asian Vegetable Research and Development Center (1978), 132-136 [Dep. Agron., Int. Rice Res. Inst., Los Baños, Laguna, Philippines].

Despite high losses due to weeds, weeding of mung bean (Vigna radiata) in many parts of Asia is the exception rather than the rule, as current cultivars are low yielding and the economic return to weeding is low. The author reviews the literature on weed competition and control in mung bean, and makes suggestions for control measures which would greatly increase yield in return for a low input from the farmer. Herbicides are presently uneconomic for use in mung bean and trials in the Philippines failed to reveal sufficiently selective herbicides. A single timely weeding can increase yields considerably - this should be within a few weeks from emergence. Inter-row cultivation is less time- consuming than handweeding, but demands row planting of the crop and can reduce yields, probably due to root damage. Mulching has considerable potential, provided the residues from previous crops are used in situ. In contrast to soyabean and cowpeas, weed growth and yield reductions were not significantly affected by row width. Maize-mung bean intercrops compete very successfully with weeds, and other crop combinations are possible. Mung bean cultivars vary greatly in their ability to compete with weeds, and more competitive ones could be selected by the farmer. It is also suggested that plant breeders could select new cultivars in the presence of weeds.

CAB (WA 29-1617) WA/JAFC

Southeast Asia; Vigna; timing; inter-row cultivation; mulching; intercropping; maize; cultivar selection

54303

DUMAS, R.E.; AUSAN, S. Research results and practical experiences regarding weed control in peanuts in Suriname. In: Proceedings of the Caribbean Food Crops Society (Suriname) Symposium on Maize and Peanut, Paramaribo, Suriname, 1978 (1978), Agricultural Experiment Station, Paramaribo, Suriname, Vol. 15, 272-287 [Agric. Exp. Stat., Paramaribo, Suriname].

Crop information relevant to weed control and prevalent weeds are mentioned, followed by a discussion of possible preplanting and postplanting weed control measures. It was demonstrated that labour requirements for the traditional methods of land preparation, weeding and hilling could be reduced from 700 to 80-100 man hours/ha through the introduction of small machines and herbicides. Among herbicides tested, a pre-emergence application of alachlor (1.7-2.6 kg active ingredient/ha) proved the most satisfactory.

ATA (6-32689) ATA

northern South America; groundnut; traditional systems; motor-powered implements; herbicides; economic analysis

54304

PAYNE, H. The appropriateness of specific packages of technological practices for weed control in peanut cultivation in Jamaica. In: Proceedings of the Caribbean Food Crops Society (Suriname) Symposium on Maize and Peanut, Paramaribo, Suriname, 1978 (1978), Agricultural

yield by 10-15%, giving an additional income of 100 rupees/acre. This technique might also benefit subsistence farmers by reducing labour requirement at a peak period.

CAB (WA 17-1047) JAFC

Indian subcontinent; cotton; irrigated crops; inter-row cultivation; timing; animal-drawn implements

5.45 Perennial crops

54501

NIGERIAN INSTITUTE FOR OIL-PALM RESEARCH (NIFOR). Establishment of leguminous cover crops in oil palm plantations. NIFOR Advisory Sheet No. 17, 2 pp. [NIFOR, Benin, Nigeria].

Pueraria phaseoloides, Calopogonium mucunoides and Centrosperma pubescens are recommended cover crops for use in oil palm, except in areas with a prolonged dry season where they would compete for water with the crop. A mixture of species is recommended to take advantage of the early and quick establishment of C. mucanoides and the greater persistence of C. pubescens and P. phaseoloides. Practical advice on seed mixture, scarification of seed, sowing and the management of newly-established cover crops is given.

WRO JAFC

humid tropics; perennial crops; cover crops; West Africa

54502

NIGERIAN INSTITUTE FOR OIL-PALM RESEARCH (NIFOR). Care of young oil palms. NIFOR Advisory Sheet No. 18, 2 pp. [NIFOR, Benin, Nigeria].

The following weed control practices are recommended in young oil palm plantations:

(1) Intercropping with food and cash crops for the first two years, followed by establishment of a legume cover crop.

(2) Slashing to prevent the cover crop smothering the palms.

(3) Mulching in areas with a dry season longer than 4 months: this can be with vebetable material from the surrounding area or bunch refuse; black 150-g age polythene in newly-burnt areas where vegetation is not available, to be covered with vegetable mulch when the polythene tatters in about 18 months; or, in drier areas where cover crops are not recommended, the area can be hoed 2-3 inches deep at the beginning of the dry season to destroy weeds and create a 'dust mulch.'

(4) Ring weeding to 3-5 ft. radius around the palm bases, depending on palm age, by hand with a cutlass or machete (2-3 times a year, requiring about 1 man-day per acre for each operation), or using herbicides. Sources of recommended herbicides and sprayers are given for Nigeria.

WRO JAFC

West Africa; humid tropics; perennial crops; cover crops; mulching; imported mulches; slashing

54503

HOVE, J. VAN DEN. [The use of cattle for the control of grasses in oil palm plantations in Colombia]. Oléagineux (1966), 21(4):207-209 [Fr, es] [IRHO/Société Industrial Agraria La Palma].

Young oil palm fields of a plantation in Colombia were heavily invaded by pasture grasses, in particular by Panicum maximum, Hyparrhenia rufa, Pennisetum purpureum and Brachiaria purpurascens. Frequent handweeding or disc harrowing followed by ploughing and sowing of pueraria (Pueraria sp.) proved ineffective. A trial showed that cattle could be used more effectively. The vegetative aspect and growth of the palms rapidly improved and the pueraria cover was re-established after 4-6 months' grazing. If stocking-rate is too high, palm leaves may be attacked and vegetative cover may disappear due to excessive trampling. The use of cattle is recommended in plantations at least 8 months old at a stocking-rate not exceeding 1 head per 2 ha.

CAB (WA 15-1587) TA

humid tropics; northern South America; perennial crops; grazing

5.46 Vegetable crops

54601

PALLER, E.C.; VALENTE, F.V.; SAN GABRIEL, R. Field evaluation of different weed control approaches in transplanted tomatoes. In: University of the Philippines at Los Baños, College of Agriculture, Department of Agronomy. Weed Science Report 1978-1979 (1980), 76-79 [Weed Sci. Sect., Dep. Agron., College Agric., Univ. of the Philippines at Los Baños, BioScience Building, College, Laguna, Philippines].

A rice straw mulch stopped most weeds except Cyperus rotundus, but handweeding 30 days after transplanting controlled surviving weeds. However, handweeding at 30 days after transplanting did not increase yields of mulched tomatoes, showing that the abundant surviving plants of C. rotundus did not compete. Off-barring (moving soil away from the crop row), followed by earthing-up combined with mulching with rice straw, significantly reduced C. rotundus populations and other weeds for up to 30 days, and provided adequate control until harvest.

WRO JAFC

irrigated crops; vegetable crops; Southeast Asia; mulching; imported mulches; perennial problem weeds; inter-row cultivation

54602

BALTAZAR, A.M.; PALLER, E.C.; VALENTE, F.V. Weed control in cabbage. In: University of the Philippines at Los Baños, College of Agriculture, Department of Agronomy. Weed Science Report 1978-1979 (1980), 80-91 [Weed Sci. Sect., Dep. Agron., College Agric., Univ. Philippines at Los Baños, BioScience Building, College, Laguna, Philippines].

Rice straw and rice hull mulches 2.5-7.5 cm deep, herbicides, and herbicide-mulch-cultivation treatments were compared in transplanted cabbage. Rice hulls gave better control of grasses, while rice straw provided better control of broad-leaved weeds 20 days after transplanting (DAT). Handweeding was carried out at 30 DAT to remove Rottboellia exaltata and Cyperus rotundus. The 7.5 cm deep mulches gave higher yields than 2-3 handweedings. Highest yields in the herbicide trials were given by the local practice of hand hoeing and earthing-up combined with 3 handweedings.

WRO JAFC

Southeast Asia; irrigated crops; vegetable crops; perennial problem weeds; annual problem weeds; mulching; imported mulches; timing

54603

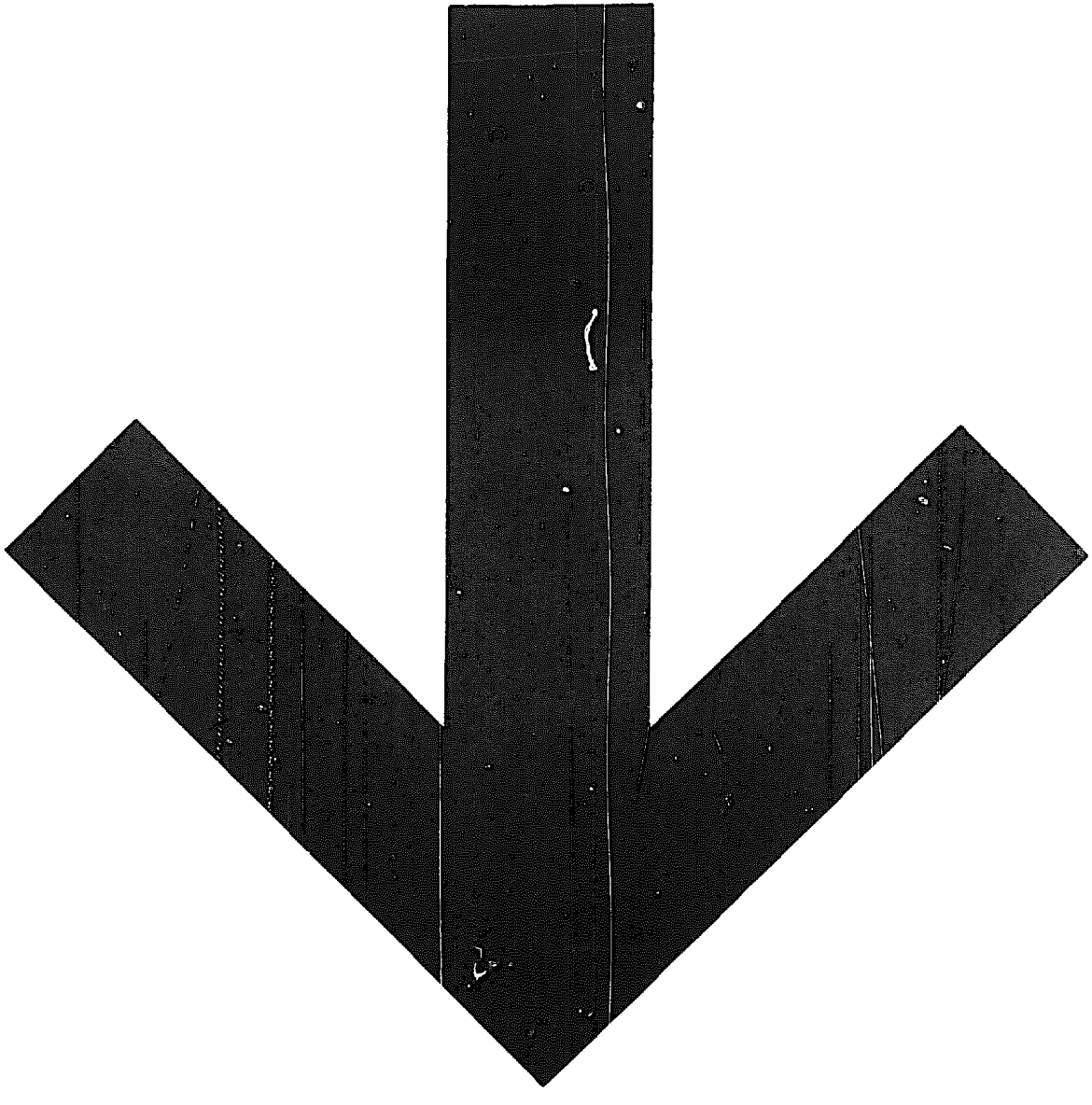
YIP, S.M. A survey of the common weed species found in vegetable fields and weed control methods adopted by farmers in Hong Kong. Agriculture Hong Kong (1976), 1(5):434-445 [Dep. Agric. Fish., 393 Canton Road, Kowloon, Hong Kong].

Weed surveys were carried out in July-August 1974 to determine the main weeds of vegetable fields, the control methods used, and the extent of herbicide use, and to identify research needs; a total of 82 fields under a drybed system of irrigation were investigated.

The average density of weeds was 150/m^2 and 62 species belonging to 49 genera and 23 families were identified; these 62 are listed in order of index of relative importance in an appendix giving scientific name, common name in Chinese characters, and family. The 3 most important were Portulaca oleracea, Panicum repens and Cyperus iria. Weed control methods practised included the use of hand tools, hand pulling, rotary cultivation, burning and herbicides. The labour required for hand-weeding leaf vegetables in summer was 10 man-days/crop in drybed and 8 man-days/crop in furrow irrigated cultivation, or 25-33% of the total labour requirement. Only 8% of farmers with drybed cultivation and 3% of farmers with furrow irrigation used rotary cultivators for weeding. Flame guns were widely used after harvesting, being frequently preceded by the use of paraquat for desiccation. Paraquat was the most popular herbicide and that mostly in noncrop situations. Only 14% of farmers used pre-emergence herbicides and only 2 herbicides (nitrofen and alachlor) were used. It is concluded that the use of pre-emergence herbicides would be the solution, but that advisory/extension work was needed together with more research.

CAB (WA 27-3652) WA

Far East; traditional systems; herbicides; irrigated crops; vegetable crops; economic analysis



V. Indexes

Index A - STRUCTURED LIST OF KEYWORDS

Index B - ALPHABETICAL, ITEM REFERENCED LIST OF KEYWORDS

Index C - ALPHABETICAL, ITEM REFERENCED LIST OF AUTHORS

Index D - ALPHABETICAL, ITEM REFERENCED LIST OF INSTITUTIONS

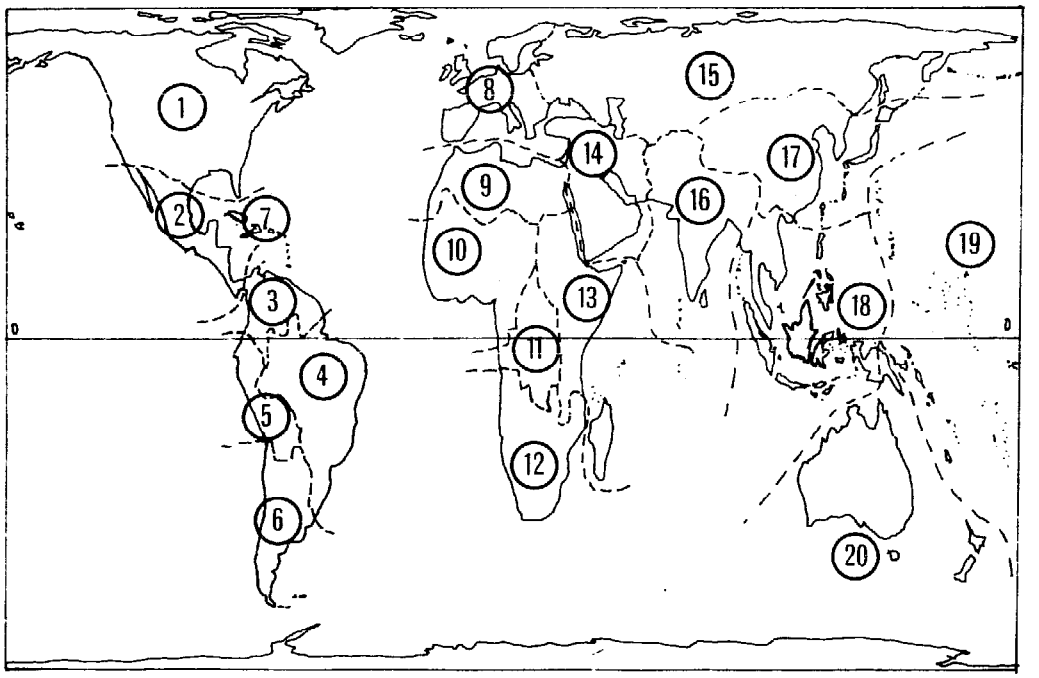


Figure 14.
GEOGRAPHICAL AREAS

Orthogonal World Map
Ref. Peters Projection,
Dr. Arno Peters
Univ. of Bremen

Key:

1	North America	
2	Central America	incl. Mexico and Panama
3	South America (northern)	incl. Colombia, Venezuela, Guyana, Surinam, Fr. Guiana
4	Brazil	
5	Andean Countries	Ecuador, Peru, Bolivia
6	South America (southern)	Paraquay, Argentina, Chile, Uruguay
7	Caribbean	
8	Europe	
9	North Africa	
10	West Africa	incl. Mauritania, Niger, Chad
11	Central Africa	Zaire, Central African Republic, Congo
12	Southern Africa	incl. Angola, Malawi, Mozambique, Zambia
13	East Africa	incl. Sudan, Ethiopia
14	Middle East	
15	USSR	
16	Indian sub-continent	incl. Afghanistan, Sri Lanka
17	Far East	China, Taiwan, Mongolia, Japan, Korea
18	Southeast Asia	
19	Pacific Islands	incl. Hawaii
20	Australasia	incl. Papua New Guinea

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STRUCTURED LIST OF KEYWORDS

CLIMATIC ZONES

Humid tropics
Semi-arid tropics
Highland and temperate zone

GEOGRAPHICAL REGIONS

Africa, North
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Africa, East
Africa, Southern
Africa, Central

South America, Northern
South America, Southern
Andean countries
Brazil Central America (includes Mexico)
North America
Caribbean

Europe
USSR
Middle East
Indian Subcontinent
Far East
Southeast Asia
Pacific Island
Australasia

CROPS

Irrigated crops

Cereals
Wheat
Maize
Sorghum
Rice, upland
Rice, paddy
Rice, deep-water
Millet, pearl
Cereals, local

Vegetable crops
Sugarcane

Grain legumes
Soyabean
Groundnut
Phaseolus
Vigna
Cajanus

Root and tuber crops
Cassava
Yam
Taro
Sweet potato

Fiber crops
Cotton
Jute

Perennial crops
Coffee
Tea
Cocoa
Rubber

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Oil Palm
Coconut

Tobacco
Pyrethrum
Sunflower

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Novel systems
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Minimum tillage
Sequential cropping
Crop rotation
Fallow
Intercropping

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Planting techniques
Inter-row cultivation
Slashing
Mulching
Mulches, imported
Cover crops
Timing (of weeding operations)
Utilisation (of 'weeds')
Water management
Weed seed source reduction (includes roguing, cleaning crop seed and field boundaries, etc.)
Cultivar selection

EQUIPMENT AND HERBICIDES

Hand tools
Implements, manual
Implements, animal-drawn
Implements, motor-powered
Herbicides
Herbicide application equipment
Herbicide application (low volume)
Herbicide application (high volume)
Herbicide application (granules)

PROBLEM WEEDS

Parasitic weeds
Annual problem weeds
Perennial problem weeds
Aquatic weeds

BIOLOGICAL CONTROL

Biological control
Herbivorous fish
Tadpole shrimp
Grazing
Allelopathy

MISCELLANEOUS

Economic analysis
Social analysis

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ALPHABETICAL, ITEM REFERENCED LIST OF KEYWORDS

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Ahmad, Ch. M.: 22602

Ahmad Faiz bin Md. Alif: 42101

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