Zambezia (1990), XVII (ii).

WEED SCIENCE TECHNOLOGICAL NEEDS FOR THE COMMUNAL AREAS OF ZIMBABWE

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IN ZIMBABWE THE agricultural sector is divided into three levels existing side by side: a relatively small number of large-scale commercial farmers numbering about 6 000; a larger number of small-scale commercial farmers numbering about 8 600; and a very large number of small-scale non-commercial farmers, also known as communal area farmers, numbering about 4,3 million (Zimbabwe, 1985, 132). For the purposes of this article the small-scale commercial farming sector will not be considered as its crop production cannot be clearly distinguished as being either commercial or communal in nature. There is a considerable difference between the contributions of the large-scale commercial farmer and the communal area farmer to crop production in the national economy. The communal area farmers comprised about 77 per cent of the population in 1982 (Zimbabwe, 1984), but they produce enough food crops to feed the rural population only if there is no drought; and their contribution to marketed produce is only between 1 and 42 per cent depending on the crop (Grain Marketing Board, 1987). On the other hand, large-scale commercial farmers, whose arable lands average 2 200 hectares in size (including planted pastures but excluding natural pastures) (Zimbabwe, 1985, 132), produce between 58 and 98 per cent of marketed crops (ibid., 139–51).

The differences in farm size and contribution to marketed produce reflect the different technologies in weed management which in the large-scale commercial sector has led to a 30 per cent increase in crop yield since the early 1960s (Tattersfield, 1982). The methods of weed control currently being used depend on the land's physical features, soil conditions, and economic, technical and human resources at the disposal of the farmer.

Research specifically in weed technology improvement started in 1965 with the formation of the Weed Research Team at Henderson Research Station (Henderson Research Station, 1967). However, most of the work done there was oriented towards the needs of the large-scale commercial farmers with only a few elements applicable to the communal area farming sector. (One such example is the ox-drawn cultivator, originally meant for the large-scale commercial farming sector before the use of tractors, which eventually reached the communal area farmer.) This orientation is shown by the type of research programmes described in the Annual Reports of the Weed Research Team issued from 1969 to 1983 which were published by the Department of Research and Specialist Services of the

Ministry of Agriculture. During this period there were great advances in weed technology such as the use of sophisticated tractor-mount weeders, herbicide spraying booms and aerial spraying equipment. Consequently weed technology for the large-scale commercial farmer is now very good, but the communal area farmer lags behind and so this article deals with the needs of this sector and focuses upon the following: the status and effectiveness of weed management strategies; the main problems in current weed management strategies; and current and future research needs.

HAND-WEEDING OR HOEING

This is the most widely used method of weed control practised by the communal area farming sector. Weeds close to the crop plants are hand-pulled, while weeds further from the crop plants are removed by hoes with iron blades attached to a wooden or iron handle. These hoes are often used while sitting or squatting and slowly moving ahead, but ones with longer wooden handles are used while stooping. The efficiency of these operations is low, requiring 200–400 man hours per hectare (Gill, 1982). The choice of a big or small hoe is governed by the wetness of the soil, soil type, the type of weed, the growth stage of weeds and crops and the type of crop. For example, groundnuts (*Arachis hypogea*) need a small hoe while cotton (*Gossypium hirsutum*) and maize (*Zea mays*) need a bigger hoe.

This method is slow, labour intensive, cumbersome and inefficient. Chemical weed control is 20–30 per cent more efficient in controlling weeds compared to hoeing or weeding by hand (Gill, 1982). In most cases timely weed control is rarely achieved. Delaying weeding until weeds have already inflicted adverse effects on the growth and development of the crop plant is a wasteful operation. Due to untimely weeding operations and the low efficiency of this method of weed control there are yield losses and in some cases total loss of yield. Weeding frequency varies from one ecological region to another depending on rainfall distribution, soil type and fertility, the condition of land preparation at planting the crop and the weed flora. Most crops need at least two weedings.

Most communal area farmers use family labour, and when it is insufficient they hire labour. However, hired labour may be unavailable when needed at a critical time, such as the November–January period when the planting of late crops and weeding of early planted crops is taking place. For those farmers with heavy soils excessively wet conditions may not permit efficient weeding to be done resulting in long periods of crop–weed competition and yield reduction (Table I). Another problem with weeding and hoeing by hand is that there are morphological similarities of some weeds with certain crops. Finger millet (*Eleusine coracana*) and rapoko

Table I

MEAN SEED COTTON YIELDS AT HENDERSON RESEARCH STATION

	Yields (kg per ha)	
	1967/8 Drier season	*1968/9 Wetter season*
Weed-free full season	2 852	2 991
Weed-free first 2 weeks only	2 783	3 188
Weed-free first 6 weeks only	2 733	888
Weed-free first 4 weeks only	2 444	99
Weed-free first 2 weeks only	Nil	35
Weedy full season	Nil	Nil
Weedy first 8 weeks only	680	2 043
Weedy first 6 weeks only	1 590	2 507
Weedy first 4 weeks only	2 142	3 387
Weedy first 2 weeks only	3 074	2 909
Least significant difference (5%)	596	737

Source: Abridged from Schwerzel and Thomas (1971).

grass (*E. indica*) are very similar and difficult to distinguish particularly at the early stages of growth before flowering; other examples are Shamva grass (*Rottboellia cochinchinensis*) in maize and stockrose (*Hibisus* spp.) in cotton. Because of such similarities these weeds commonly escape removal. Another problem with this method of controlling weeds is that it cannot deal effectively with parasitic perennial and annual weeds which reproduce vegetatively. *Striga* spp. comprise the most common group of parasitic weeds causing considerable economic crop damage to maize and pearl millet (*Pennisetum typhoides*). The haustoria of parasitic weeds penetrate the food conduction tissues of the roots of the crop plants, and it is impossible to relieve the crop plants from such an intimate and damaging relationship by weeding or hoeing.

The most troublesome perennial weeds are *Cyperus esculentus, C. rotundus, Cynodon dactylon* and *Imperata cylindrica*. They are very persistent and difficult to control because they propagate by underground rhizomes, stolons and tubers. They readily regrow after hoeing from depths beyond the reach of conventional hand tools. Other methods are needed for their effective control.

MECHANICAL WEED CONTROL

Mechanical weed control has been improved by the introduction of the plough, the spike-tooth harrow and the animal-drawn tyne cultivator. The plough is used primarily for land preparation, tilling land to depths greater than 15 cm from the soil surface. Spike-tooth harrows are used as secondary tillage equipment tilling land to not deeper than 15 cm. In addition to land preparation these two implements also control weeds. The tyne cultivator is more specifically used for controlling weeds. The main constraint to the use of animal-drawn cultivators is their availability and, to a lesser extent, draft-power problems.

The tyne cultivator is very efficient at removing weeds, particularly when they are below 15 cm tall, but its main disadvantage is that it is rather heavy for the draft animals. This is particularly so early in the summer when animals are in poor condition because of the lack of grazing pasture during the dry months. As a result some farmers opt for the less efficient but lighter plough with its shear removed.

Weed control by tillage equipment has several disadvantages (Tattersfield and Cronin, 1958; Chivinge, 1984), notably about 5 per cent crop damage each time any implement passes through the land, especially when the animals are not well trained; the failure to remove intra-row weeds; the near impossibility of adequately controlling some weeds bigger than 15 cm; and the inability to employ mechanical implements when crops are about 60 cm tall for fear of crop damage. On the other hand, mechanical weed control is comparatively faster and less labour intensive than hand-hoeing.

CROP ROTATION

By and large very little crop rotation is practised in the communal areas because of the big maize or cereal–legume rotation ratio. Most farmers do not grow many legumes any more or if they grow them the proportion is extremely small. The only legumes commonly grown are groundnuts and some cowpea (*Vigna angulata*). Allied to the limited crop rotation has been the use of more or less the same system of weed control. This has resulted in ecological shifts in the weed species in response to those approaches which relied heavily on a single method of control. This limited crop rotation has led to some weeds becoming more widespread and persistent; examples are rapoko grass, upright starbur (*Acanthospermum hispidum* D.C.), pigweed (*Amaranthus hybridus* L.), witchweed (*Striga* spp.) and the wandering jew (*Commelina benghalensis* L.).

CULTURAL WEED CONTROL

This involves the use of clean certified crop seeds, optimum plant populations and plant arrangement, crop cultivars adapted to the ecological region, optimum planting dates, maintenance of sufficient soil fertility, availability of adequate moisture, and use of competitive crops. The communal area farmer has problems in putting some of these methods into practice. Optimum planting dates are difficult to attain because rainfall may be delayed. There might be enough moisture to encourage weed but not crop germination. The result is that some weeds germinate before the crop and yet the farmer might not be in a position to remove these weeds before planting the crop. Adequate moisture may also be difficult to maintain because of mid-season droughts. As there are no irrigation facilities the crop may suffer while the weeds, which are mostly C4 plants,* survive relatively well under those conditions. Optimum planting populations are rarely achieved. In fact most farmers use about half of the recommended plant populations (Agronomy Institute, 1985).

Most communal farmers do not use the optimum amount of fertilizer for their soil, largely because of lack of soil analysis and shortage of cash. Some farmers do not fertilize their crops at all. Farmers prefer to fertilize cotton and maize, but sunflower (*Helianthus annus*), sorghum (*Sorghum bicolor*), finger millet and pearl millet rarely get fertilized. Despite this lack of fertilization the weeds always grow very vigorously, depriving the crop of the necessary growth resources.

The only common cultural practice is the use of clean certified seed and recommended cultivars. Maize and cotton are the two main crops grown with clean seed by farmers. Certified seed for other crops such as groundnuts are available but are not widely used.

Because of these constraints most crops are not vigorous enough to compete with the weeds for limited nutrients. Cultural methods of weed control are not being utilized to maximum effect and yields are depressed.

CHEMICAL WEED CONTROL

Herbicide usage in Zimbabwe started in the early 1950s (Tattersfield and Cronin, 1958). By 1955 yield increase in maize due to chemical weed control, particularly with 2,4–D (2,4-dichlorophen-oxyacetic acid), had been noted in large-scale commercial farms; but communal area farmers have not yet caught up with herbicide usage (Table II). The advantages and disadvantages of using herbicides by communal area farmers have been categorized as follows (Sharman, 1970; Parker, 1972; Hammerton, 1974; Chivinge, 1984):

Advantages

- Elimination of early crop-weed competition leading to higher yields.
- Reduction of time spent on weeding, thus giving time for other family duties.

* C4 plants produce the first products of photosynthesis with two 4-carbon compounds which makes them more efficient under conditions of high temperature and strong light.

- Can be used under wet conditions.
- Reduced tillage system.
- Flexibility in the crops grown.

Disadvantages

- They may be costly.
- The availability of spraying equipment might be a problem.
- Sufficient technical knowledge is needed.
- Herbicides with a wide safety margin may be limited.

Table II

HERBICIDE SALES IN ZIMBABWE, 1979–1986

Season	*Sales (%)*			
	Large-scale commercial farms	*Peasant farmers*	*Others*	*Total*
1979/80	98,23	0,74	1,03	100
1980/1	98,42	0,95	0,63	100
1981/2	97,48	1,08	1,44	100
1982/3	98,16	1,41	0,43	100
1983/4	98,00	1,10	0,90	100
1984/5	98,03	1,15	0,82	100
1985/6	97,80	1,35	0,85	100
Average	98,02	1,11	0,87	100

Source: From information supplied by agro-chemical companies.

INTEGRATED WEED CONTROL

This involves combining two or more methods to control weeds, such as removal of inter-row weeds by a tyne cultivator followed by hand or hoe removal of intra-row weeds. However, the impact of this practice on the improvement of crop yields is doubtful as intra-row weeds may not be removed soon enough to prevent competition with crop plants.

CURRENT RESEARCH

Research aimed specifically at the needs of the communal area farmer started in 1982. The programmes included: weed surveys in communal areas; research into weeding systems which would fit into communal area farming systems; research into herbicide carry-over problems in crop rotations; surveys of soil types found in communal areas; and screening herbicides specifically for use in sandy soils which are typical of most communal areas. Up to now the main problem with the current research is that of applicability, as problems such as low rainfall and socio-economic constraints which are found in the communal areas are not found on Henderson Research Station where most of the research is concentrated.

RESEARCH NEEDS FOR THE COMMUNAL AREA FARMER

About 75 per cent of the rural population spends more time battling with weeds than with any other operation from mid-December to mid-February. These farmers have not adopted chemical weed control to any significant extent. Over a period of seven years herbicide usage by the communal farmer has averaged 1,11 per cent compared to 98,02 per cent for the large-scale commercial farming sectors (Table II). The Table on its own does not explain why there is such a disparity. However, Chivinge (1984) indicated that the scale of operation and the lack of cash, technical know-how, equipment and herbicides were some of the reasons why herbicide technology is not implemented in communal areas. These explanations are not exhaustive and other constraints more important than these might be responsible for the poor adoption of chemical weed control in these areas.

Table III compares the cost of herbicides and hand weeding in cotton and maize. This Table shows that it is economically viable to use herbicides but certain considerations involving a farmer's choice have not been taken into account; these include: yield levels to be attained; the element of risk of crop failure; application equipment problems; whether the labour force is technically competent; and the socio-economic conditions of the farmer concerned. Only after considering all these factors can the use of herbicides be considered economic or not. It has been reported that the use of herbicides has resulted in yield increases of up to 55 per cent in maize and 75 per cent in cotton under Zimbabwean communal farming conditions (Anon., 1984) and yet the use of herbicides is still very low.

In spite of the apparent 'economic benefit', the communal area farmer does not seem eager to adopt herbicide technology. This implies that there is either something wrong with the technology or the way it is being introduced. It is not currently known whether it is the appropriate technology for these farmers. Herbicide technology has been introduced to the communal area farming sector in the same manner as in the large-scale commercial farming sector and this is perhaps partly why it seems to be failing. Blackie (1982) has pointed out that Zimbabwean farmers will adopt any technology which is suitable to their farming system. Freeman (1983) and Vega (1983) have reported that small-scale farmers (communal area farmers) adopt new technologies when: they are aware of the technologies; the technologies are useful to them; they are reasonably certain of the efficacy of the technologies; the technologies are economically

Table III

A COMPARISON BETWEEN THE COST OF HERBICIDE USAGE AND HAND-WEEDING IN MAIZE AND COTTON USING THE 1986 COST OF HERBICIDES

	Pack size (litres)	*Cost per pack (Z$)*	*Dosage (litres per ha)*	*Cost per ha (Z$)*
Maize				
Gardomil 500FW	5	67,60	3	40,56
+ one hand-weeding				15,00
				55,56
Gesagram 500FW	5	91,35	3	54,81
+ one hand-weeding				37,50
				92,31
Two hand-weedings				125,00
Cotton				
Cotogard 500FW	5	143,95	3	86,37
+ Dual 750EC	5	163,20	1	32,64
+ one hand-weeding				37,50
				156,51
Three hand-weedings				212,00

Source: Weeding figures are based on a recent survey carried out in Murewa by the author as follows: (1) An average of two weedings for maize and three for cotton. (2) Herbicide-treated lands have less weed pressure and so are charged Z$37,50 per ha. Untreated lands with heavy weed pressure are charged Z$62,50 per ha.

feasible; they are sure of securing technical assistance, the necessary credits, and a sufficient supply of herbicides.

Work done in other developing countries on herbicide technology for the communal area farmer may give some idea as to why the introduction of herbicides seems to fail in Zimbabwe. In Central America it has been shown that herbicides can only supplement and not replace labour (Hammerton, 1974). Work done in Ghana, Nigeria and Zambia (Carson, 1979; Akobundu, 1980; Parker and Vernon, 1982) has shown that herbicides are cheaper than labour yet up to now the use of herbicides by the small-scale farmer in these countries is very limited. The main reason is that the small-scale farmer needs a systems or holistic approach in the introduction of any technology. Consideration should be given to the farmer's human and financial resources, his yield goal, the climatic and edaphic constraints, the impact that the new technology will have on the whole society and the feasibility of adopting the technology. The farmer's decision as to whether or not to adopt herbicide technology will depend on these factors. As these factors differ from one group of people to another, there is a need to devise weed science technologies suitable for each group.

One of the biggest weaknesses in weed science technology for the communal area farmer in Zimbabwe is that the weed spectrum and its impact on crop production is not known. There has been no weed survey in the peasant farming sector until recently yet at least four have been carried out in large-scale commercial farms (Soane and Waister, 1963; Thomas, 1970; Budd, 1976; Chivinge, 1983). It is not known how competitive weeds are under the farmer's level of management, climatic and edaphic conditions. Nobody has explained why farmers are using the methods of weed control in current practice and whether these need modification or changing. Table IV shows maize and groundnut yields in Chibi and Mangwende Communal Lands. The two districts are in different ecological regions which is reflected in the yields. Their cultural practices in crop production are also different. The question is: should one recommend the same weed science technology to the two rural areas or not? It is most likely that we would need a different package for each area and this can be done only after studying the weed management component in addition to the whole farming system, that is, by adopting a systems approach.

Table IV

MAIZE AND GROUNDNUT YIELDS IN TWO DIFFERENT ECOLOGICAL REGIONS

Crop	*Yields (tonnes per ha)*			
	Chibi (Region IV)		*Mangwende (Region IIa)*	
	With cattle	*No cattle*	*With cattle*	*No cattle*
Maize	1,90	0,95	3,24	2,10
Groundnuts	0,16	0,15	0,74	0,54

Source: Modified from Shumba (1984).

CONCLUSION

The communal areas of Zimbabwe have seen very little change in weed science technology. Most of the research done in the past does not seem to have had any useful impact on improving weeding efficiency or increasing crop yields in these areas. Consequently there is a need to undertake research which has direct relevance and applicability to these farmers. If

Zimbabwe is to make noticeable improvements in weed science technology for this group of farmers, a systems or holistic approach is needed. Investing in research, particularly with herbicides, without first of all understanding the constraints of the communal area farmer is a waste of time, money, effort and human resources.

Acknowledgements

The author is grateful for the assistance given by Mr. C. Shumba for critically evaluating this article and Miss K. Wilsnagh for typing the manuscript.

References

AGRONOMY INSTITUTE 1985 *Annual Report: Summer 1984–5* (Harare, Ministry of Agriculture, Dept. of Research and Specialist Services), 14–41.

AKOBUNDU, I. O. 1980 'Economics of weed control in African tropics and sub-tropics', in *Proceedings of the 1980 British Crop Protection Conference on Weeds* (Nottingham, UK, Boots Pure Drug Company), 911–20.

ANON. 1984 *Kahwa Pakuru Newsletter* (Harare, Ciba-Geigy Zimbabwe).

BLACKIE, J. M. 1982 'A time to listen: A perspective on agricultural policy in Zimbabwe', *Zimbabwe Agricultural Journal*, LXXIX, 151–6.

BUDD, G. D. 1976 'The second survey of weeds of arable lands in Rhodesia', *Rhodesia Agricultural Journal*, LXXIII, 159–60.

CARSON, A. G. 1979 'Weed competition and control in maize (*Zea mays* L.)', *Ghana Journal of Agricultural Research*, IX, 161–7.

CHIVINGE. O. A. 1983 'A weed survey of arable lands in the commercial sector of Zimbabwe', *Zimbabwe Agricultural Journal*, LXXX, 139–41.

CHIVINGE, O. A. 1984 'The role of herbicide technology on the small scale farms of Zimbabwe', *Zimbabwe Agricultural Journal*, LXXXI, 97–102.

FREEMAN, D. M. 1983 'Technology transfer: Some strategic social organizational considerations with application to weed science', in *Communication of Weed Science Technologies in Developing Countries* (St Louis, Weed Science Society of America), 75–84.

GILL, H. S. 1982 'The role of hand and mechanical weeding in weed management in the advancing countries', in *Improving Weed Management: Proceedings of the FAO/IWSS Expert Consultation on Improving Weed Management in Developing Countries* (Rome, Food and Agriculture Organization), 17–22.

GRAIN MARKETING BOARD 1987 *Reports and Accounts for the Year Ended 31st March 1987* (Harare, The Board), 4–28.

HAMMERTON, J. L. 1974 'Problems of Herbicide Use in Peasant Farming' (Las Vegas, Paper presented at the Weed Science Society of America annual meeting).

HENDERSON RESEARCH STATION 1967 *Annual Report 1966/67* (Salisbury, Department of Research and Specialist Services).

PARKER, C. 1972 'The role of weed science in developing countries', *Weed Science*, XX, 404–12.

PARKER, J. M and VERNON, R. 1982 'Maize herbicides for small-scale farmers in Zambia', *Tropical Pest Management*, XXVIII, 259–65.

SOANE, C. M. and WAISTER, P. D. 1963 'A note on weeds of irrigated lands in the Sabi Valley', *Rhodesia Journal of Agricultural Research*, I, 47–52.

SCHWERZEL, P. J. and THOMAS, P. E. L. 1971 'Weed competition in cotton', *PANS: Pest Articles and News Summaries*, XVII, 30–4.

SHARMAN, C. 1970 'Herbicide development in peasant farming areas', in *Proceedings of the Tenth British Weed Control Conference* (Nottingham, Boots Pure Drug Company), 685–8.

SHUMBA, E. M. 1984 'Animals and the cropping sustems in communal areas', *Zimbabwe Science News*, XVIII, 99–102.

TATTERSFIELD, J. R. 1982 'The role of research in increasing food crop potential in Zimbabwe', *Zimbabwe Science News*, XVI, 6–10, 24.

TATTERSFIELD, J. R. and CRONIN, C. H. 1958 'Weed Control in Maize in Southern Rhodesia with Special Reference to Use of Herbicides' (Victoria Falls, paper presented at the African Weed Control Conference), 56–65.

THOMAS P. E. L. 1970 'A survey of the weeds of arable lands in Rhodesia', *Rhodesia Agricultural Journal*, LXVII, 34–5.

VEGA, M. R. 1983 'Constraints to weed science technology transfer in developing countries', in *Communication of Weed Science Technologies in Developing Countries* (St Louis, Weed Science Society of America), 93–104.

ZIMBABWE 1984 *1982 Population Census: A Preliminary Assessment* (Harare, Central Statistical Office), 8.

ZIMBABWE 1985 *Statistical Yearbook 1985* (Harare, Central Statistical Office).