ETHIOPIAN WEED SCIENCE COMMITTEE (EWSC)

PROCEEDINGS OF THE FIRST ETHIOPIAN
WEED SCIENCE WORKSHOP

Problems and Priorities For Weed Science in Ethiopia

14-15 MAY 1987

ADDIS ABABA, ETHIOPIA

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WEED SCIENCE WORKSHOP

PROBLEMS AND PRIORITIES FOR WEED SCIENCE IN ETHIOPIA

14 - 15 May 1987, Addis Abeba, Ethiopia

Organized by
ETHIOPIAN WEED SCIENCE COMMITTEE
AND
INSTITUTE OF AGRICULTURAL RESEARCH

Edited by
Ahmed M. Sherif, Chris Parker, Ann Stroud
and Rezene Fessehaie

Addis Abeba, 1989

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ACKNOWLEDGEMENT

The Organizing Committee of the First Ethiopian Weed Science Workshop gratefully thanks all agricultural scientists who served as chairpersons and rapporteurs during the workshop. The committee is also indebted to the Institute of Agricultural Research (IAR) for its unreserved assistance in providing all the necessary facilities to make the workshop a success. Thanks is also due to all participants of the work-shop a success. Thanks is also due to all participants of the workshop as well as Ethiopian Weed Science Committee (EWSC) members who assisted in the organization of the workshop. Many thanks also to the Ministry of Coffee and Tea Development (MCTD) for allowing its conference hall and other services. Last but not least, sincere thanks to the commercial companies who funded the workshop: Agro-industrial Inputs International, Ciba Geigy, Hoechst and May and Baker, and AgriService, Ethiopia for printing this volume.

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Chairman : Ato Birhanu Kinfe

Rapporteur : Dr. Mesfin Tadesse

WELCOME ADDRESS

Ahmed M. Sherif
Organizing Committee Chairman

Comrade Dr. Seme Debela, General Manager of IAR,
Honoured Guests,
Ethiopian Weed Science Committee (EWSC) Members,
Comrades,

On behalf of the Organizing Committee and myself, I welcome you all to the First Ethiopian Weed Science Workshop, organized by the EWSC in collaboration with the Institute of Agricultural Research (IAR).

Starting from the first meeting of the founding members of the EWSC in 1982, the idea of organizing workshops on a regular basis had always been mentioned on every occasion. Due to inconveniences encountered, none could come true until the First Ethiopian Crop Protection Symposium gave us the impetus to think about it more seriously. The objective of the workshop is to consider and thoroughly discuss the ways in which weed research can most effectively contribute to the Ethiopian agriculture with particular attention to the differing needs of the different classes of agricultural sector: individual peasants, producer cooperatives and state farms.

The theme of the workshop, as indicated on the program, is to discuss the existing weed problems facing farmers and state farms: control methods of weeds practiced, aspects of land preparation in view of weed control, economics of herbicide use in the existing farming situation in the country, the situation of manpower and the need for its development, and other aspects pertaining to weed control.

Although the use of herbicides by farmers is long overdue, the timely consideration of importing limited amount to be used in the excess-producing weredas shall also be discussed. The use of high yielding improved varieties with constant application of fertilizers and pesticides, other than herbicides, may not give the expected result, since introduction of modern technology necessarily includes integration of herbicides as a component.

The outcome of the workshop, we believe, will indicate the areas where more attention is needed and will be a driving force for sound and practical work to be carried out both in weed research and development. It will also indicate the role we, the Ethiopian Weed Science Committee members, should play in the "Self-sufficiency in Food Crops" program laid down by the Workers Party of Ethiopia (WPE).

In this workshop, 11 papers will be presented, and most of them are short background statements which will lead into the longer sessions alloted for structured discussions. We, therefore, hope that you will actively participate in the

PRESIDENT'S ADDRESS

Birhanu Kinfe
President of the Ethiopian Weed Science Committee (EWSC)

Comrade Dr. Seme Debela, General Manager of IAR,
Dear EWSC Members and Invited Guests,

It is a great pleasure to address the First Ethiopian Weed Science Workshop, organized by EWSC in collaboration with the Institute of Agricultural Research (IAR).

Dear Participants!

I want to bring to your attention that the idea of forming EWSC was initiated by seven persons involved in Weed Science activities in August 1982 to strengthen the field of crop protection with the cooperation of other sister disciplines (Ethiopian Phytopathological Committee and Committee of Ethiopian Entomologists) which were established earlier. The founding members of EWSC drafted a constitution and the committee was legally recognized by the Ethiopian Science and Technology Commission (ESTC) as a professional, nonprofit-making committee effective from December 1982.

The committee was formed with the following objectives:

(a) To promote a more united approach among weed scientists to solve weed problems in agricultural production

(b) To promote professional concern and understanding among weed scientists for the development and application of weed science throughout Ethiopia

(c) To efficiently disseminate information to farmers and consult other agricultural organizations on weed problems and methods of control employed

(d) To facilitate better professional contacts for exchange of information and experience in the area of weed science among weed scientists who are engaged in research, teaching, extension work and state farm services by means of conferences, seminars, workshops and exchange of publications

(e) To properly document weed science work, summarize research results and make information available to users

(f) To formulate policies to be enacted by recommending areas of research priorities, promoting manpower development, coordinating the existing resources, etc

(g) To promote the art and the science of weeds and to raise the conciousness of the public on the importance of weeds in agricultural production

In the first 2 years the number of members who were actively involved in the activities of EWSC was very low. However, the initiators of the committee have made a great effort to increase the number of members by contacting, agitating and registering persons involved in weed science activity in different agricultural organizations. The weed management workshop organized with the cooperation of the Ministry of Agriculture (MOA) and FAO in May 1985 also contributed much in raising the number of interested members in the committee.

In July 1985 a special meeting was called to discuss ways of strengthening the committee. During this meeting, a resolution was passed to form three subcommittees, namely Publication and Training (P & T) Subcommittee, Parasitic Weeds Subcommittee and Aquatic Weeds Subcommittee. Each subcommittee has its own coordinator, and reports the activities it performed during the annual meeting of EWSC. This strategy had increased the participation and contribution of the members in the committee. Later, National Standing Committee for Parasitic Weed Control was established, and terms of references as well as short- and long-term work programs were proposed through dedication of few EWSC members.

The initiation of EWSC Newsletter was found to be an important forum of communication among members of the committee and professional weed scientists in different countries and for the dissemination of information on weed science to users. The Newsletter has reached EWSC members in all administrative regions and many known libraries in Ethiopia. It is also internationally recognized that upon request copies were sent to Nigeria, Sudan, Thailand, Federal Republic of Germany and USA. Moreover, EWSC has become an affiliate member of the International Weed Science Society (IWSS), and has developed a favorable relationship with Weed Science Society for Eastern Africa (WSSEA), Asian Pacific Weed Science Society (APWSS) in Philipines and International Plant Protection Center (IPPC) in USA.

These international communications have given the Committee a great deal of experience which could help to strengthen EWSC and weed science activities at national level. Hence, at this juncture, on behalf of EWSC executive committee members, I request unreserved cooperation of the management offices of the different agricultural organizations in giving permission for their employee whenever invited to attend conferences, workshops, seminars, symposium, etc. on weed science in the country and abroad. Also, I want to acknowledge the cooperation of IDRC for sponsoring EWSC representatives to attend the 10th and 11th WSSEA conferences, CIMMYT and CIBA - GEIGY chemical company for sponsoring one EWSC member to participate in the short-term weed management training course held in IPPC, Oregon State University.

Dear Participants!

We, Ethiopian Weed Science Committee members do not boast to have met with our commitments; we rather believe that to make the objectives of our committee practical and to improve agricultural production, greater efforts and sacrifices in time, money, material and moral are expected from us.

I sincerely hope that the outcome of this workhop would help us identify the weed problems, proper weed management system, research priorities and extension work in weed control and give us the opportunity to express our unity with other disciplines and consequently improve agricultural production in the country. Lastly, on behalf of EWSC members and myself, I want to acknowledge the contributions of IAR management, Ministry of Coffee and Tea Development (MCTD), and chemical importing agencies who made monetary assistance to the workshop and the unreserved efforts and sacrifices of the Organizing Committee in making this workshop possible. May I invite Dr. Seme Debela, General Manager of IAR, to formally open this workshop.

Thank you.

OPENING ADDRESS

Dr Seme Debela
General Manager of IAR

Mr. Chairman,
Invited Guests, and
Conference Participants,

To begin with, I would like to express my appreciation to the Organizing Committee for giving me this unique privilege of opening the First Ethiopian Weed Science Workshop.

This workshop comes at a time when the national need for improved agricultural technologies is very apparent. The country's agricultural production is severely constrained by a myriad of man-made and natural problems. As a result, our production is much below our national need for food and feed crops. Our rapidly increasing population is swallowing up whatever small gain we are achieving. Natural disasters such as drought are aggravating the already difficult production conditions. Mismanagement of agricultural and forest lands are driving conditions from bad to worse. In short, we are in a most difficult situation.

In some ways, this can be considered as a blessing in disguise. These catastrophic situations have become major instruments for reexamining the national status of agricultural production. Beginning with the disastrous drought of 1974, the government has been giving serious attention to agriculture as a main activity for raising the national economy. This is reinforced by the declaration of the Ten-year Indicative Plan which clearly shows agriculture as the main national focus for investment.

As part of the national strategy for raising agricultural productivity, the government has assigned a high priority to agricultural research. As a result, IAR has embarked upon an ambitious plan to strengthen and expand its research activities across the major agro-ecological zones of the country. There is also a major effort to make the research programs even more relevant to the needs and priorities of the farming community.

As we all know, the preponderant portion of our national agricultural production comes from the peasant sector, where the average crop productivity is less than 10 q/ha. The main reason for such low productivity is the use of traditional agricultural technologies, although there are also other important constraints. The limiting technologies come in many forms such as inefficient agricultural tools and implements, low-yielding varieties, poor pest management systems, defficient storage structures.

It is the task of the agricultural research to develop technologies as well as systems that help raise our agriculture from its current low technological base. This important task, however, can not be left only to the research institutions, although admittedly they play the major role. Professional societies could and should assume a central role in investigating the development of appropriate agricultural technologies.

Encouraging and supporting professional committees or societies like EWSC is a policy IAR strongly endorses. We have keenly observed the development EWSC has attained in the last 5 years, and we are encouraged by the progress it has made. The need for such professional committees to serve as a focus for spearheading research and development in this country is very great.

As we all know, developing appropriate agricultural technologies is only half of the game, as far as the task of raising the national agricultural productivity is concerned.

Such technologies must be transfered to the farming community in the shortest time possible. This requires a very close link between research and extension. Unfortunately, this has not been our strong point in the past. But, current trends seem to be encouraging, although there is still a wide room for improvement.

Finally, Mr. Chairman, I would once again thank the Organizing Committee for giving me this honor and I would now declare this First Ethiopian Weed Science Workshop open!

Thank you.

Proceedings First EWSC Workshop: Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987.

THE STRUCTURE OF FARMING IN ETHIOPIA: THE STATE FARM SUB-SECTOR

Dereje Ashagari[1/]

ABSTRACT

The origin, structure and organization of the state farm sector and the current cropping patterns on its some 200,000 ha are described. Weed problems are noted as an important constraint on productivity, often because of the predominant practice of mono-cropping. Suggestions are made on how these problems may be reduced by an integrated approach.

INTRODUCTION

Agriculture has been and is the mainstay of the Ethiopian economy. It contributes about 45% of the GDP of the export earnings and provides a livelihood for about 85% of the population.

Today there are three distinct modes of agricultural production in Ethiopia:

1. Private farming which comprises sedentary and pastoral farmings and currently encompasses 5.9 millions of the annually cultivated and almost 100% of the pastoral lands.

2. Collective farming which comprises the producers cooperatives and settlement farms.

3. State farms which are owned by the government and encompass about 200,000 ha and produce close to 5 million quintals of various types of crop produce.

State farms came into existence when the privately owned commercial farms were expropriated and put under public or government ownership as a result of the March 1975 Land Proclamation Number 31/75. The total area at the time of nationalization was about 67,000 ha and was

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[1/] Ministry of State Farm Development, P.O.Box 5765, Addis Abeba.

administered first by the short-lived Ministry of National Resources and later by the then Ministry of Agriculture and Settlement.

As the need for further strengthening of the agricultural sector of the economy was found pressing, the Ministry of State Farm Development (MSFD) proper was established on May 1979 with the following aims and objectives.

- To alleviate the country's food problems
- To produce adequate raw materials for the industry
- To expand output for foreign exchange earning
- To expand the establishment of agro-industries
- To create employment opportunities
- To serve as a model for the producers cooperatives

ORGANIZATIONAL STRUCTURE

In order to fulfil its aims and objectives, MSFD is organized with the following hierarchies and functions.

1. The Ministry:

   A policy-making and supervising body over the corporations and enterprises.

2. The Corporations:

   Management and/or service bodies over enterprises.

3. The Enterprises:

   Regional operating and supervising bodies over state farms.

4. The State Farms:

   The lowest management and operational entities at the actual location of production activites. Ideally, the size of a state farm is 6,000 ha for rainfed farms, 4,000 and 2,000 ha for irrigated cotton and horticultural crops, respectively.

On the basis of the organizational hierarchy, MSFD has seven corporations reporting directly to it. Each corporation normally has more than one enterprise under its supervision. In turn each enterprise supervises and coordinates the activities of several state farms within given administrative regions or within certain defined geographical areas. Currently MSFD administers 7 corporations, 16 enterprises, 82 state farms and 15 processing plants. These include both the crop and livestock state farms.

The seven corporations are grouped into three categories: regional, specialized and service-giving corporations.

The regional corporations are organized on a regional basis to operate in more than one administrative region that have similar ecological characteristics. This group includes Northwestern, South, and Awash Agricultural Development corporations which are engaged mainly in the production of cereal, oil and fiber crops.

The second group encompasses specialized corporations which are entrusted with specialized production, processing and marketing functions. These functions are carried out by the Livestock Development and Meat Corporation, the Horticulture Development Corporation, and the Ethiopian Seed Corporation.

The third group is the Agricultural Equipment and Technical Service Corporation which provides technical services such as importing and distributing agricultural machineries, equipment, spare parts and chemicals; maintaining agricultural machinery; surveying, designing, and constructing land development work; and renting heavy equipment, and data processing.

PRESENT RANGES OF CROP PRODUCTION AND FUTURE TRENDS

During the 1986/87 crop season, 203,161 ha of land was cultivated and about 4.8 million quintals of crop was harvested. The types of crops, areas planted and amount of production are given in Table 1. Of the total hectarage, 71.6% was covered by cereals, 1.6% by pulses, 1.9% by oil crops, 19.4% by fiber crops, 0.4% by stimulant crops, 3.5% by horticultural crops and 1.5% by others.

In the past, state farms were developed following the cropping patterns of the prenationalized commercial farms and the dictates of the economic environment that prevailed in the country. At present the short-and long-term objectives of the farms are being redefined to meet the changing priority of Ethiopian agriculture. Although state farms will continue to supplement and complement the production of the peasant sector in general, there will be gradual emphasis on the production of industrial and cash crops and on the processing of the output thereof. In general it is understood that efforts will be made on intensive production programs and that expansion in area would be limited to a manageable size in the future. In fact, according to the Ten-Year Perspective Development Plan, it is understood that by the end of the planning period, the total cultivated area of state farms will be close to 470,000 ha out of which about 114,000 ha would be under irrigation. During this period production is also anticipated to be 16.5 million quintals. Of the total production, 27.7% will be directly used for food, 54.5% for food industry, 6.7% for other industry, 10.3% for export and 1.8% for seed.

IMPORTANCE AND METHODS OF CONTROL OF WEEDS IN STATE FARMS

Currently, excluding the very small hectarage covered by some pulse and oil crops, the main cropping schemes that are successively followed year after year include wheat and barley in Arsi and Bale regions; maize and sorghum in Welega, Gojam, and Awasa - Billito areas; and cotton in Awash and Lower Rift Valleys. Lack of suitable alternate crops, appropriate technologies, appropriate implement and other as inputs (emphasis given to produce only perticular crops), etc. are cited as the main reasons for this monocropping pattern.

This monocropping practice, as it has been expected, has created several soil and crop protection-related problems. If one considers only the weed problems, although most of the broadleaf weeds are relatively better controlled by the presently used selective herbicides, weeds such as *Avena* spp., *Snowdenia polystachya*, *Setaria* spp., *Bromus pectinatus* , and *Cyperus* spp. have become very problematic in Arsi and Bale state farms. *Rottboellia cochinchinensis* has become a very serious problem in the maize-and sorghum-growing state farms. The parasitic weed *Striga* spp. is also on the increase in these same cropping areas. Another parasitic weed, *Orobanche* spp. is becoming a limiting factor in some of the horticultural crop state farms.

Weed control practices in state farms include manual, mechanical and chemical means of control as will be described by my colleagues in other papers at this workshop.

SUGGESTED OUTLINES FOR BETTER WEED CONTROL

The total economic improtance of weed must be measured not only by the actual damage they cause but also by the costs of control measures and by the limitations they sometimes impose on the types of crops such as the limiting effect of *Striga* spp. on maize and sorghum and *Orobanche* spp. on solanaceous and some oil crops. The intensification of plant production and the employment of various types of control measures require a detailed knowledge of the life history and population dynamics of weed species the losses they cause and the possible control measures. Although some progress has been made in the past few years, the knowledge of weeds and their control methods are yet at an early stage of development.

Efforts should be made to devise effective and economical control measures against the destructive weed species. Of course, since single control measure rarely proves effective for the wide range of weed problems, the aim should be at developing an integrated approach which is the skillful blending of many types of control measures. Methods of an integrated approach should include:

- Preparation of proper seedbed,
- maintenance of appropriate plant population and spacing,
- removal of weeds manually and mechanically,
- control of weeds chemically, and
- use of tolerant or resistant crop types, especially for the parasitic weeds.

The outlines suggested for better weed control will materialize only when we intensify our efforts and increase our efficiency in utilizing them. One requirement is steady and continuous research in weeds and control measures geared at solving immediate problems on the one hand and to a building up of basic knowledge that will be used in solving problems of the future on the other hand. Another requirement is to make the information readily available to users. A third requirement is that, although many great discoveries are made by inspired individuals, we should be aware of the fact that more and important complex weed problems can be solved only through cooperative efforts and sharing facilities.

Table 1. Crop production in state farms during the 1986/87 crop season

Crop	Hectares planted	Total yield ('000 quintals)	Yield/hectare (quintals)
Maize	61498	1706.1	27.7
Sorghum	8938	57.1	6.4
Wheat	63149	1291.3	20.4
Barley	11425	199.4	17.5
Tef	549	2.7	5.0
Haricot bean	1973	11.7	6.0
Soybean	1295	6.2	4.8
Sunflower	819	6.4	7.8
Rapeseed	2391	23.3	9.7
Groundnut	599	6.4	10.7
Cotton	38462	925.6	24.1
Kenaf	1026	5.8	5.7
Tobacco	835	8.2	9.8
Fruits	3270	265.2	81.1
Vegetables	1877	228.1	121.5
Pepper	1884	14.0	7.4
Flowers	159	11.8	74.0
Broomcorn	1360	5.6	4.1
Others	1652	29.8	-
TOTAL	203161	4806.4	

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THE BOTANICAL NATURE OF WEED PROBLEMS IN ETHIOPIA

Ahmed M. Sherif 1/

ABSTRACT

The diversity of weed species is parallel to the diversity of climatic conditions in Ethiopia. This paper deals with the botanical nature of weeds regarding growth habits, means of seed dispersal, importance based on the difficulty of controlling weeds; and abundance in farms and suitability of the country for the growth of weeds internationally recognized at worst weeds such as Cyperus rotundus and Striga hermonthica. The information was gathered from surveys made in different administrative regions and partly from literature.

INTRODUCTION

The simplest definition of the term "weed" is "any plant growing where it is not wanted." This statement clearly indicates that the idea about weeds is generally in terms of human activities or in direct relation to his interest in the environment. Since the beginning of the recorded history, weeds have exhibited some distinctive characteristics and growth habits that have interfered with human activities in different ways (Roberts 1978). Although the list of characteristics of weeds can be very long, it includes the ability to survive and to produce seeds in poor conditions, the ability to grow and establish seed rapidly, the quality to adapt to both short and long distance dispersals, the power to make vegetative reproduction and ability to regenerate when divided into fragments, and ability to germinate after variable and often long periods of dormancy of the seeds (Hill 1977).

1/ Institute of Agricultural Research, Melkassa Research Center, P.O.Box 2003, Addis Abeba.

CLASSIFICATION OF WEEDS

Broadly speaking, weeds can be classified as annual and perennial weeds which include a wide spectrum of species with broadleaves or narrow leaves in both categories. Weeds are found in diverse conditions: growing together with crop plants and competing for all their growth requirements, relying on other plants for their essentials needs as parasites, or living in water-saturated habitats as aquatic weeds. All these forms exist in large populations where environmental conditions are favorable, as in Ethiopia. Annual weeds which mostly rely on a high output of seeds or have distinct mechanisms, such as tuft of hairs on the seeds or hooks or sticky material for dispersal, mostly exist in habitats disturbed by cultivation. Perennial weeds are most serious in those habitats where soil disturbance is minimal (Hill 1977), like in plantation crops such as coffee and citrus orchards.

PROBLEMATIC WEEDS IN ETHIOPIA

Ethiopia, which has diverse climatic conditions, can be called a botanic garden because of its immense wealth of plant species. From a weed science view point, many of the most important weed species found in the world exist in Ethiopia. The sedges, Cyperus rotundus and Cyperus esculentus, which have very extensive underground system can grow vertically downwards upto 0.5 m and laterally upto 90 m. Cyperus rotundus has tubers that can tolerate dry as well as saturated soil moisture for a long time. The grass weeds Digitaria abyssinica (=D. scalarum) and Cynodon dactylon also have extensive underground rhizome systems that make them very difficult to control by mechanical and chemical means. A broad-leaved composite, Launea cornuta, is also a perennial weed that has become very important in the last 10 - 15 years in Ethiopia. Like the above-mentioned species, Launea also has an extensive and deep underground system, as well as a large number of seeds, distributed by wind. These perennial species require repeated cultivation or deep plowing to reach their extensive underground parts. And also most herbicides do not control them because of the difficulty of translocation to all underground buds.

Annual weeds have the ability to grow fast and some have broad leaves, like Guizotia scabra, which compete for light and shade the crop. Annual grass weeds similar to cereals like Avena spp. are difficult to identify at the seedling stage for manual weeding and for chemical selectivity. There are also fleshy weeds such as Portulaca spp. which tend to regrow after cultivation.

Parasitic weeds such as Striga, Orobanche and Cuscuta are distinct group of weeds that parasitize a wide range of plants. Striga and Orobanche are nearly impossible for farmers to control effectively because the damage to the host crop is done before the parasites emerge. In the case of Cuscuta spp., which are shoot parasites that entangle the host plant with their fiber-like stems, are impossible to remove without either seriously damaging or taking off the host as well.

Although most weeds are not host-specific, the parasitic ones usually parasitize specific families of plants. However, all weeds are not serious problems in all climatic regions. Hence, the weed groups in a decending order of importance in this country are (1) parasitic weeds, especially Striga which is threatening sorghum production in many regions, (2) perennial weeds, and (3) annual weeds.

Very Important Weed Species in Ethiopia

Although the list of important weed species can be very long, the following are selected on the basis of the difficulty to control them and/or their abundance.

I. Parasitic weeds	Distribution
Cuscuta campestris	- Shewa, Welega, Kefa, Gonder
Cuscuta epilinum	- Shewa
Orobanche cernua	- Shewa
Orobanche minor	- Shewa
Orobanche ramosa	- Shewa, Harerge, Sidamo, Gojam
Striga asiatica	- Harerge, Gamo Gofa
Striga hermonthica	- Shewa, Harerge, Gojam, Gamo Gofa, Welo, Tigrai, Eritrea, Gonder, Welega
Striga latericea	- Shewa

II: Annual weeds	Distribution
Ageratum conyzoides	- Kefa, Welega, Illubabor, Sidamo
Amaranthus hybridus	- Shewa, Gojam, Arsi, Harerge, Sidamo, Kefa, Welega, Illubabor, Welo, Tigrai, Eritrea, Gonder
Argemone mexicana	- Welo, Tigrai, Eritrea, Gonder, Harerge, Shewa, Sidamo

Avena vaviloviana	-	Shewa, Gojam, Arsi, Sidamo, Harerge
Datura stramonium	-	Kefa, Welega, Sidamo, Illubabor, Shewa
Eleusine indica	-	Sidamo, Kefa, Illubabor, Gonder, Welega
Flaveria trinervia	-	Welo, Tigrai, Eritrea, Gonder, Shewa, Harerge
Galinsoga parviflora and Guizotia scabra	-	Shewa, Gojam, Welega, Kefa, Illubabor, Welo, Tigrai, Eritrea, Gonder, Sidamo
Nicandra physalodes	-	Kefa, Welega, Sidamo, Illubabor, Shewa, Welo, Tigrai, Eritrea, Gamo Gofa
Phalaris paradoxa	-	Shewa, Gojam, Arsi, Harerge, Sidamo, Tigrai
Plantago lanceolata	-	Shewa, Gojam, Welega, Kefa, Illubabor, Tigrai
Portulaca oleracea	-	Shewa, Gonder, Welo, Harerge, Eritrea, Sidamo
Rottboellia cochinchinensis	-	Gojam, Welega, Eritrea
Setaria pumila (=S. pallide-fusca)	-	Shewa, Welega, Gojam, Arsi, Harerge, Sidamo, Illubabor, Kefa
Setaria verticillata	-	Shewa, Arsi, Sidamo, Harerge, Welo, Eritrea, Bale
Snowdenia polystachya	-	Shewa, Gojam, Harerge, Arsi, Bale, Sidamo, Welo, Tigrai, Eritrea, Bale
Xanthium spinosum	-	Shewa, Gonder, Welo, Tigrai, Eritrea, Bale, Harerge, Gamo Gofa

III. Perennial weeds

Perennial weeds		Distribution
Convolvulus arvensis	-	Shewa, Gojam, Welo,
Cynodon spp.	-	Gonder, Welo, Harerge, Bale, Shewa
Cyperus esculentus	-	Welega, Sidamo, Gojam, Kefa, Shewa
Cyperus rotundus	-	Shewa, Gojam, Kefa, Welega, Illubabor, Welo, Harerge, Eritrea, Bale
Digitaria abyssinica (=D. scalarum)	-	Shewa, Kefa, Welega, Illubabor, Harerge, Welo, Tigrai, Eritrea, Gonder

Eichhornia crassipes	-	Illubabor, Shewa, Welega, Gonder, Welo, Harerge, Eritrea, Shewa
Rumex abyssinicus	-	Shewa, Gojam, Sidamo

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SESSION II A

THE FARMER'S PROBLEMS AND PRACTICES

Chairman : Dr. Taye Teferedegn

Rapporteur : Ato Teshome Regassa

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SMALLHOLDER FARMERS WEED PROBLEMS AND WEED CONTROL PRACTICES IN ETHIOPIA

Steven Franzel, Mulugeta Mekuria, Chilot Yirga[1/]

ABSTRACT

This paper examines small farmers' weed problems and weed control practices in selected areas of Ethiopia. Most of the data are from farming systems surveys conducted by the Agricultural Economics and Farming Systems Research Department (AEFSRD) of the Institute of Agricultural Research (IAR). First the AEFSRD program is described and the survey methods used are presented. Next, case studies on weed problems and practices from four areas of Ethiopia are examined. The principal conclusions are as follows:

1. In many areas of Ethiopia, the farmers's predominant weed control system, hand weeding by family labor, is not sufficient to complete weeding in a timely manner. The overlapping of activities over many different enterprises prevents the farmer from adequately weeding his crops.

2. The more varied are the farmer's options for exploiting different ecological circumstances and growing different crops, the less likely it is that weeding will be an important problem.

3. In Central Shoa, farmers have found herbicides to be an effective weed control measure.

4. In Western Ethiopia, the farmer practice of "shilshallo", or oxen cultivation, should be the mainstay of any improved weed control system.

1/ Institute of Agricultural Research, P.O.Box 2003, Addis Abeba.

INTRODUCTION

Research Program of AEFSRD

The Department of Agricultural Economics and Farming Systems Research (DAEFSR) currently has research programs under way in seven major centers. The earlier programs started at Holetta, and Bako, and later extended to Nazret and Awasa. Since 1986, the program coverage included Jima and the newly established centers of Adet and Sinana. In terms of manpower the department has one farming systems research advisor (expatriate) two research officers, eleven assistant research officers (of these two are farming systems research agronomists), and eight technical assistants.

As our paper deals with smallholder farmers weed problems, it is worth outlining the FSR approach used by IAR and its usefulness in the following sections.

The Problem Setting

In most developing countries the generation of new technology alone has not provided solutions for helping farmers increase agricultural productivity and achieve higher level of living. The constraints on adoption of new technology appear to be more complicated than were conceived by researchers earlier.

Explanations for poor technology adoption include farmers' unwillingness, inefficient extension service, inadequate credit facilities, poor input supply, and inappropriate technology generated by research institutions. Let us consider the last factor, i.e., technology generation, as it can be addressed by research scientists. Technology is developed on research stations under conditions quite different from those of the smallholder farmers. Therefore, in many instances the technology is not feasible or acceptable to the farmers for whom it was intended.

The problem of generating technologies that are not adopted by smallholder farmers can be attributed to the lack of understanding the conditions under which these farmers operate. This has resulted from a fundamentally top-down approach to agricultural research and development. After studying problems of agricultural technology generation and transfer for the last two decades in Eastern and Southern Africa Collinson (1982), concluded that the fundamental problem in the research/ extension sequence followed in Africa is the failure to use a systems perspective in the understanding and identifying farmer problems and the development of farmer recommendations. In many countries research and extension staff remain skeptical that smallholder farmers are managers in any accepted sense of the world. Such skepticism leads to the *feeling* that "we know what is best for you". This inhibits the extension service from understanding smallholder farmers and gathering feedback on key problems to research.

Today there is a significant change in the attitude of the scientific community towards smallholder farmers. The presence of several new perceptions of the small farm situation resulted in the development of the farming systems research approach (Sands 1985).

Farming Systems Research: Methodology

Farming systems research is defined as an applied interdisciplinary approach to agricultural research to generate improved agricultural technology for farmer target groups. In FSR, teams of researchers and extension staff conduct surveys to identify farmers fields, aimed at solving these problems and increasing agricultural productivity.

Farming systems research evolved in the postgreen revolution era with the growing perception of the failure of the agricultural research and extension institutions to generate and disseminate technologies adopted on a wide scale by peasant farmers.

The FSR approach to agricultural research has been adopted by many developing countries in Asia, Latin America and recently in Africa. FSR has the following major characteristics. It is farmer-based, problem-solving, comprehensive, multidisciplinary, complementary with commodity and disciplinary research, iterative, dynamic and responsible to society (Shaner 1982). Most FSR projects have the stages of description and diagnosis, planning on-farm research, on-farm research and assessment, and recommendation and extension. In these stages, FSR projects attempt to achieve the following specific objectives (CGIAR, 1978):

(a) To understand the resource context and evaluate the existing farming system as operated by the farmers.

(b) To improve problem identification for better research programs.

(c) To conduct research on new or improved practices for possible testing on farms.

(d) To enhance the capacity of research organizations to conduct research on priority farming systems problems.

(e) To evaluate new or improved practices, assess their benefits, and obtain information on the impact they have on smallholder farmers and the problems faced.

With these rationale, IAR initiated the FSR approach as a major program. The program initially started in 1976/77 with demonstrations and later evolved as a package-testing program. In the 1984/85 season, the approach was refined and diagnostic surveys and on-farm experiments were initiated. Both informal and formal surveys were carried out in 1985 at Bako and Nazret, and relevant on-farm trials were designed. In 1985/86, similar work was started at Holetta and Awasa, while in 1986/87, Jima, Sinana and Adet FSR teams conducted their informal surveys. They are now preparing to launch formal surveys.

These diagnostic surveys were conducted with the active participation of researchers, local extension personnel, key local informants and the farmers. The contribution of agronomists in such diagnostic work is crucial. Because of the lack of agronomists at some of the sites where surveys were conducted, the survey results sometimes lack detailed coverage of agronomic practices.

Another problem is that some of the surveys were carried out when some of the crops were not in the field and it was difficult to get a complete picture of crop husbandry practices.

WEED PROBLEMS AND WEED CONTROL PRACTICES: CASE STUDIES FROM SMALL CEREAL-BASED FARMING SYSTEMS

The four case studies examined in this paper and the sources of information on each are shown below. The first three case studies are from small cereal areas, whereas the fourth is from a maize area.

1. Dendi zone: Dendi woreda and part of Addis Alem woreda, Shewa Region (Hailu 1986).

2. Wolmera zone: Wolmera and part of Addis Alem woreda, Shewa Region (Hailu 1986).

3. Adet zone: Adet woreda, Gojam Region (Aleligne and Franzel, 1987).

4. Bako zone: Bakotibe, Gudeyabilla, Gobaseyo, Sibusire, and Wayutuka woredas; Welega and Shewa regions (Legesse, et. al., 1987).

The first three areas are primarily tef-producing areas; Dendi zone is primarily a vertisol (black soils) area and Wolmera zone is dominated by nitosols and mollisols (red soils). Adet is a mixed zone; red soils predominate with many black patches; many farmers cultivate some of each soil type.

Dendi Zone

Table 1 summarizes background information and information on weeding practices in Dendi zone. The zone's altitude is 2200 to 2500 m with an average annual rainfall of 1100 mm, falling primarily between June and September. Vertisols predominate and the principal crops are tef, wheat, barley, noug and chickpea. Over 75% of the farmers own two or more oxen.

Table 1. Dendi and Wolmera zone survey results, 1985

	Dendi black soil zone	Wolmera red soil zone
Background information		
Altitude	2200 - 2500 m	2200 - 2500 m
Rainfall	1100 mm June - September	1100 mm June - September
Primary crops	tef wheat noug chickpea barley	tef wheat barley faba bean
Area cultivated	2.5 ha	2.5 ha
Busy period	September - July	June - August
Weeding		
Principal weeds	*Snowdenia polystachya* *Phalaris paradoxa*	*Bidens* spp. *Snowdenia polystachya* *Medicago polymorpha* *Phalaris paradoxa* *Rumex* spp.
Herbicide use	30% of farmers	88% of farmers
Crops	tef, wheat, barley	tef, wheat, barley
Type	2,4-D	2,4-D
Hand weeding practice	70% of farmers tef weeded twice, wheat, chickpea once	12% of farmers tef weeded twice wheat once only 20% weed faba beans
Overlap between weeding period and busiest time	yes, for tef, wheat noug no for chickpea	yes
Weeds: a high priority constraint	no	no

(Source: Hailu, 1986)

In the black soil areas, tef and wheat are plowed three times each, while noug and chickpea are plowed once each. Figure 1 shows the crop calendar for the Holetta area. Noug is planted in May, tef in July and wheat and chickpea in September. The average area cultivated is 2.5 ha and rotations, usually involving a cereal with an oilseed or pulse, are practiced. Noug is well known among farmers for its ability to suppress weeds in the crop which follows it.

In the black soil areas, the principal weeds are Snowdenia polystachya and Phalaris paradoxa. Approximately 70% of the farmers rely solely on hand weeding for weed control, whereas 30% use herbicides. Tef is weeded twice and each of wheat and chickpeas are weeded once. Tef weeding, the most time-consuming weeding activity, usually begins at 40 to 60 days after planting. Farmers wait this long to begin weeding because they claim that the soil is so wet that moving through the field will cause mechanical damage to the crop.

Farmer's busiest period is from late August through September, the period of tef weeding. Other activites during the same period are the planting of wheat and chickpeas.

About 30% of the farmers used herbicides during 1985. In all instances 2, 4-D was used and it was applied to tef, wheat, and barley. Applications are estimated at 0.4 to 0.8 l 2, 4-D/ha, mixed with 200 l of water. The recommended level is 1 l/ha, mixed with 240 l of water. Prices ranged from Birr 13 to 35/l and most of it was purchased from private shops in Addis Abeba.

The importance of the peak season labor bottleneck at weeding time is shown in Table 2. The table shows that relying on hand weeding experience, the most critical labor peak of highland vertisol systems in central zone is in September (Agricultural Development Division 1986). Labor use in September is about 44 man-days, 45% higher than in the next highest month. The report shows that 58% of the labor used in September is for weeding tef, and 35% is for weeding wheat and faba bean.

Figure 1: Crop Calendar for Dendi and Wolmera zones

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan	Feb.
Dendi black soil zone														
Tef		LP					P		W		H			
Wheat		LP							P	W			H	
Noug		LP			P					H				
Chickpea		LP							P	W				H
Busy period								XXXXX	XXXXX					
Wolmera red soil zone														
Tef		LP			LP		P		W			H		
Wheat		LP			P		W				H			
Barley		LP			P		W			H				
Faba bean		LP			P		W		H					
Busy period					XXXXXX	XXXXXX	XXXXXX							

Source : Hailu, 1986

LP - Land preparation
P - Planting
W - Weeding
H - Harvesting

Table 2. Highland vertisol areas of central zone labor use by crop (man-days/month)

Crop	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	TOTAL
Wheat	11.5	12.2	2.2	5.8	0.0	1.4	0.0	1.4	10.8	9.4	0.0	0.0	54.7
Tef	10.7	1.3	0.0	5.0	0.0	3.8	2.5	6.3	25.2	6.3	10.1	11.3	82.5
Faba bean	0.0	0.0	0.0	2.7	0.0	0.7	0.7	1.4	4.1	0.0	5.8	4.4	19.7
Chickpeas	2.5	0.2	0.0	1.8	0.0	0.0	0.0	0.0	1.81	0.0	1.8	3.9	12.2
Vetch	2.6	0.4	0.0	0.9	0.0	0.0	0.0	0.0	0.9	0.0	0.0	1.2	6.1
Lentils	2.3	0.4	0.0	0.9	0.0	0.0	0.0	0.0	0.9	0.0	0.0	1.1	5.6
Noug	0.3	0.0	0.0	0.9	0.2	0.2	0.0	0.0	0.0	0.0	0.0	2.0	3.6
Total (-F)	30.0	14.6	2.0	18.0	0.2	6.1	3.2	9.1	43.7	15.7	17.7	24.0	184.5
Total (+F)	34.6	19.3	4.3	18.0	0.2	6.1	3.2	9.1	43.7	15.7	19.1	27.1	200.4

Source : Agricultural Development Division, 1986

F = Fertilizer

Herbicides play an important role in alleviating this bottleneck, permitting weeding to be done on a timely basis and permitting the farmer to attend to other activities, including planting chickpea, vetch, lentil, and noug; and hand weeding faba bean. The greatest benefit is probably in permitting weeds to be controlled on a timely basis; the labor peak is so skewed as to suggest that weeds are an important problem constraining production in the hand weeding system. Moreover, even if labor is available during the first 45 days after emergence, the soil is so wet that moving about in the field will cause mechanical damage to the crop.

Farmers farming on black soils did not consider weeds to be one of their priority problems limiting production. The high-moisture retention capacity of the soils limits weed growth, and those farmers experiencing labor shortages used herbicide. However, farmers experienced problems in finding herbicides and also complained about the rapidly rising prices. During 1987 these problems became even more acute, and it is likely that herbicide use declined.

Wolmera Zone

Table 1 summarizes background information and information on weeding practices in Wolmera zone. The zone's altitude is 2200 to 2500 m and the average annual rainfall is 1100 mm, falling primarily between June and September. Nitosols and mollisols, both red-brown, predominate and the principal crops are tef, wheat, barley, and faba bean. Over 75% of the farmers own two or more oxen.

Tef is plowed four times, wheat and barley three times each, and faba bean 0 - 1 time. Figure 1 shows that wheat, faba bean and barley are planted in June, while tef is planted in July. Approximate area cultivated is 2.5 ha, and rotations, usually involving a cereal with a pulse, are practiced.

From June through August is the busiest time of the year. Tef planting in July coincides with the weeding of other crops. Soon after, in August, tef needs to be weeded. Principal weed species include *Bidens* spp., *Snowdenia polystachya*, *Medicago polymorpha*, *Phalaris paradoxa*, and *Rumex* spp.

Approximately 88% of the farmers use herbicides to help solve their weed problem. Figure 1 shows that the weeding of all the principal crops coincides with the farmers busiest time of the year. Herbicides play an important role in alleviating the labor bottleneck by helping farmers complete land preparation and planting and weeding operations on the four major crops on a timely basis.

Weed infestation is more severe on red than black soils; this explains the higher use of herbicides. 2, 4-D is applied to wheat, tef, and barley at the same rate, 0.15 l mixed with 80 litre of water. Farmers use hand weeding to control grass weeds.

Farmers do not consider weeds to be a serious production constraint as long as herbicides are available. However, during 1987, prices increased and shortages were common, causing serious weed infestation problems for the farmers.

Adet Area

Background information and information on weed problems and weeding practices for the Adet area are shown in Table 3. The altitude ranges from 2000 to 2600 m and the average rainfall average is about 1470 mm, falling from May to October. All farmers cultivate on red soils and many also have plots on the black soils. The principal crops on the red soils are tef, barley, maize, and faba bean; tef, rough pea, chickpea and barley predominate on the black soils. Farmers rotate cereals with pulses on both soil types and the average farm size is 2.1 ha. Half of the farmers have two or more oxen; less than 10% have none.

The farming system is considerably more complicated than those Holetta's because of the fact that farmers cultivate on both red and black soils. Figure 2 presents the crop calendar for the Adet area. On the red soils, barley and maize are planted in May, faba bean in June, and tef in July. On the black soils, tef is planted in July and chickpea, rough pea, and wheat in September. In Adet minor crops are also more important in the system than in Holetta; a substantial number of farmers also grow finger millet and field pea on red soils and barley and fenugreek on black soils.

Weed problems are significantly more severe on the red soils, where Guizotia scabra, Galinsoga spp., and Plantago lanceolata infest tef, and Snowdenia polystachya hampers maize. On the black soils, Guizotia scabra on tef and Trifolium spp. on barley are important.

Tef is weeded once, 30 to 60 days after planting, on both soil types. Barley, faba bean, and late-planted crops such as wheat and chickpea are usually not weeded; farmers claim that weeding is not necessary. Maize is cultivated with ox-plow approximately 30 days after planting, and is hand weeded about 60 days after planting. Slashing of weeds is done about 3 months after planting.

The major weeding operation for farmers is tef weeding which takes place in September, the busiest month for farm families (Figure 2). According to the results of the survey,

Table 3. Adet area survey results, 1985

	Black soil		Red soil
Background information			
Altitude		2000-2600 m	
Rainfall		1470 mm May-Oct.	
Primary crops	tef roughpea chickpea wheat		tef barley maize faba bean
Cultivated area		2.1 ha	
Busy period		September	
Weeding			
Principal weeds	*Guizotia scabra* (tef)		*Snowdenia polystachya* (maize) *Guizotia scabra* (tef) *Galinsoga* spp. (tef) *Plantago lanceolata* (tef)
Herbicide used		None	
Hand weeding	Tef weeded once, 30 - 60 days after planting. Wheat, roughpea, chickpea not weeded.		Tef weeded once, 30-60 days after planting. Barley and faba bean not weeded. Maize is cultivated after 30 days, weeded after 60 days, and slashed 90 days after.
Overlap between weeding period and the busiest time	No		Yes for barley, maize, faba bean. No for tef.
Weeds: a high priority constraint	No		No

Source: Aleligne and Franzel, 1987.

however, weeds are not a high priority constraint limiting production. This suggests that farmers generally have sufficient time to weed their tef.

Weeding Labor Requirements in Small Cereal Systems

Data on weeding labor requirements are useful for assessing the degree to which labor is constraining at weeding time and for using in partial budgets to assess the profitability of alternative weeding practices such as herbicides. Unfortunately, labor data are highly variable and unreliable for three reasons. First, the efficiency of labor varies widely from individual to individual. Second, weeding requirements vary significantly both within an area and between areas, depending on soil type, moisture, and farm management such as land preparation and rotation. Third, available data are based on farmers' own estimates, which may be inaccurate and biased. Measuring labor inputs directly is also subject to bias. Labor inputs of research station laborers may be biased upwards or downwards, depending on the level of supervision, physical fitness of the laborers and the nature of their contract. Measuring farmer's own labor inputs is also subject to bias because the farmer knows the researcher is observing him.

Figure 2. Crop calendar for Adet survey area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
Black soils													
Tef			----	----	LP	----	P	----	W	----	----	H	
Roughpea						----	LP	----	P	----	----	----	H
Chickpea						----	LP	----	P	----	----	----	H
Wheat						----	LP	P	----	----	W	----	H
Red soils													
Tef	----	----	LP	----	----	----	P	----	W	----	H	----	LP
Barley	----	----	LP	----	P	----	----	----	H	----	----	----	LP
Maize	----	----	LP	----	P	C	W	----	S	H	H		
Faba bean					LP	P	----	----	----	H			
Busy period for Adet farmers						xxxxx	xxxxx	xxxxx					

Source: Aleligne and 1, 1987

Notes :
- LP - Land Preparation
- W - Weeding
- S - Slashing
- P - Planting
- C - Ox-cultivation
- H - Harvesting

With all of these reservations in mind, data on weeding requirements from three sources are presented in Table 4. The data show that tef requires the greatest weeding levels, 2 to 3 times that of wheat, 2 to 4 times that of barley, and 3 to 9 times that of faba bean. Data for Adet are 2 to 3 times higher than those for Holetta. Weeding at Adet is likely to be higher since rainfall is higher, though the ratio between the two areas is probably exaggerated. Data for black soils in the central zone highlands from ADD (1986) are higher than the Adet data and lower than the Holetta data. Data for tef weeding on the red soils are double those on the black soils; for wheat the ratio is three to one.

WEED PROBLEMS AND WEED CONTROL PRACTICES: CASE STUDY FROM A MAIZE-BASED FARMING SYSTEM

Table 5 summarizes information from the Bako mixed farming systems zone. The Bako zone is at an altitude of 1500 to 2000 m, and received 1200 mm of rainfall, most of which fall from May to September. The topography is undulating, and nitosols predominate. Major crops are maize, tef, noug, and pepper; and the average cultivated area in 1985 was 1.5 ha/family. Maize is the primary staple food and the most important crop in the system. Two-thirds of the farmers own one or more oxen, which are used for land preparation and weeding.

Maize fields are plowed three times, and tef and pepper fields three to four times each. Figure 3 shows that maize is planted in April/May, pepper in June, noug in June/July, and tef in July and August. The busiest period of the year is June through August. This coincides with periods of maize and pepper weeding.

The favorable growth condition of the area encourages weed growth in farmers' fields. This is exacerbated by poor land preparation and inefficient weeding practices which results in frequent weeding of maize. The implements used are all traditional, including _gasso_ a local hoe used for the first maize weeding; _maresha_, an ox-plow used for the second weeding; and the sickle for slashing. Important weeds include: _Guizotia scabra_ (_tufo_, _mech_) _Snowdenia_ sp. (_muja_) _Bidens_ spp. (_kelo_, _adey abeba_) and _Nicandra_ sp.

Table 5 shows intervals between various maize weeding operations. The first weeding which starts 18 - 25 days after planting is hoeing, done mainly by women and children. The men take care of the operations done by ox-power, including planting the remaining maize fields and preparing land for the other crops.

Table 4. Hand labor weeding requirements (man-day/ha)

Crop	Holetta (1)	Adet (2)	Central zone black soils	Highlands red soils
Tef	40	80	60	138
Wheat	20	-	26	75
Faba bean	8	24*	16	15
Barley	20	48*	-	30

All data are from informal interviews with farmers

Source : (1) Hailu, 1986

(2) Aleligne and Franzel, 1986

(3) Agricultural Development Division, 1986

*These crops are usually not weeded in Adet area.

Table 5. Bako mixed farming systems zone

Background information	
Altitude	1500 - 2000 m
Rainfall	1200 mm May through September
Soils	nitosols
Primary crops	maize, tef, noug, pepper
Cultivated area per farm	1.5 ha
Busy period	June - August
Weeding	
Principal weeds	*Guizotia scabra* *Snowdenia* sp. *Bidens* sp. *Nicandra* sp.
Herbicide used	none
Weeding practice : maize	1st weeding: 18 - 25 days after planting, by hoe 2nd weeding: 35 - 42 days after planting, by oxen cultivation 3rd weeding: 52 - 59 days, pulling weeds missed by oxen cultivation 4th weeding: 80 - 85 days, slashing weeds with sickle
Weeding practice: other crops	tef weeded once at early tillering stage noug is not weeded. Pepper weeded four times, at 15-day interval by local hoe
Overlap between weeding period and busiest time	yes, for maize and pepper
Weeds: a perceived constraint by farmers	yes

Source : Legesse, *et. al.*, 1987.

Figure 3. Bako area crop calendar

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Maize		L		P	W	O	W	W			H	
Tef						L		P	W		H	
Noug					L	P					H	
Pepper	L					P	W W	W W				H
Busy period						xxxx	xxxxxx	xxxxx				

Source : Legesse, *et. al.*, 1987

LP - Land preparation
P - Planting
W - Weeding
O - Oxen cultivation
H - Harvesting

The second weeding, which is ox-cultivation, is carried out about 35 to 42 days after planting, when the plants are about knee-high. Maize taller than knee-high is difficult for ox-cultivation, and practicing it results in plant breakage. In cases of extreme labor shortage, farmers practice two ox-cultivations instead of one hoeing and one ox-cultivation; the first weeding is delayed until the crop attains a height that will prevent it from being buried by the ox-cultivation.

Besides weeding, ox-cultivation has several other purposes. It is a means of thinning, which is especially important for two-thirds of the farmers who broadcast their maize. It is also a means of reducing lodging; farmers believe that the root disturbance from ox-cultivation helps resist lodging by initiating strong root development and firm stalks. In between-row ox-cultivation, the increase in lodging resistance is mainly as a result of ridging.

The third weeding carried out 52 to 59 days after planting is complementary to the ox-cultivation. Mainly done by bare hands supplemented with sickle, it is for pulling up the remaining weeds and filling furrows from ox-cultivation. Slashing, which is the fourth weeding operation on maize, is done from silking up to soft dough stage. Carried out 40 days after pulling, it prevents the weeds from seeding and makes harvesting easier.

The farmers' weeding practices appear to be in rough agreement with the station's recommended weeding times of 25 - 30 and 55 - 60 days after planting (Dawit 1985, personal communication). Each of the farmers' weeding operations extends over a long period, mainly because of the extended planting of maize. An on-farm experiment comparing the station's weeding recommendations, two hand weedings, with the farmers method, as stated above, was conducted for two seasons, 1985 - 1986. There was no significant yield difference between the two treatments, but the farmers' method required much less labor during their busiest period. They thus rejected the station's recommendation (Bako Agricultural Research Center, 1987).

Tef around Bako is mostly weeded once: 86% weed once while only few, 11%, weed twice. The second weeding is only in case of high weed infestation. When the preceding crop is noug the fields are less weedy than if it is maize or sorghum. The weeding starts from early tillering and extends to postheading.

Noug does not usually require any weeding according to the farmers. Dodder (Cuscuta sp.), a parasitic weed, which is very serious in the western part of Welega Administrative Region, also causes some problem in some parts of the survey area. Pepper weeding is a very labor-intensive operation with a close weeding interval of 15 days. Four weedings are done manually using gesso, the local hoe.

According to the farmers, weeds are important constraint on farm productivity. The overlapping activities during the June through August period are the weeding of maize and pepper, the plowing and planting of tef, and the transplanting of pepper and planting of noug. About 10% of the farmers use hired labor for weeding maize during this period, but most rely on family labor which is insufficient for completing the weeding operations on the timely basis.

Data on weeding labor requirements are highly variable and subject to the same biases as mentioned for weeding labor requirements in small cereal systems. Table 6 shows data averaged from 20 farms (5 farms at each of four sites) in the Bako zone. These data were collected by enumerators who measured field sizes and monitored farmers closely during the weeding period. Hoeing inputs, the first weeding operation, vary from 10 to 47 man-days among the sites. Similarly, hand pulling ranges from 4 to 33 days and slashing from 7 to 33 days. Total man-days spent on weeding average 65 man-days, ranging from a low of 24 to a high of 102.

Table 6. Labor data for weeding, Bako zone

Operation	location				
	Chari	Wollanso	Werego	Tibe	Average
	Man-days/ha				
Hoeing	32	47	31	10	30
Oxen cultivation	3	2	1	2	2
Hand pulling	-	33	4	5	14
Slashing	15	20	33	7	19
Total	50	102	69	24	65

Source : Bako Agricultural Research Center, 1987. Data at each site are averages of data from five farms. Data was collected through a frequent visit-farm survey.

CONCLUSIONS

The four case studies presented in this paper highlight the high degree of variation in weed circumstances, problems, and control measures in Ethiopia. Nevertheless, several important conclusions can be drawn:

1. In many areas of Ethiopia, the farmer's predominant weed control system, hand weeding by family labor, is simply not sufficient to complete weeding in a timely manner.

2. The principal reasons why farmer's weed control measures do not suffice are not laziness or lack of knowledge about the importance or correct time for weeding. Rather, the overlapping of activities over many different enterprises prevents the farmer from managing any single enterprise in the technically optimal way. In three of the four case studies examined, weeding of the major crop coincided with farmers busiest period of the year doing mechanical damage to the crop, especially when grown on black soil.

The implications of these findings are that researchers have to assist farmers to find new ways to tackle their weed problems. Experiments to instruct farmers as to when to hand-weed their crops are simply not useful. Rather, researchers should explore new technologies such as improved rotations, chemical control, improved land preparation, or changing the length of crop cycle or modifying planting dates to avoid the overlapping of activities.

3. The more varied are the farmer's options for exploiting different ecological circumstances and growing different crops, the less likely it is that weeding will be an important problem. Thus, in Adet, where farmers cultivate both red and black soils, they are able to spread their labor among a great number of enterprises. Weeds, relatively speaking, are not an important problem. In the Wolmera red soil zone, where few crops are grown and all are planted at about the same time, hand weeding cannot prevent important reductions in yield.

4. In Central Shewa, farmers have found herbicides to be an effective weed control measure. Available data suggests that a principal advantage of herbicides is that they permit farmers to control weeds on a more timely basis, thus increasing yields. They also permit the farmer to transfer labor from weeding his major crops to weeding other crops, such as faba bean, and preparing land for and planting tef, which is planted during the weeding period for wheat and barley.

5. In the high rainfall areas of Western Ethiopia, farmers have developed a complex system for controlling weeds, including hoeing, oxen cultivation, hand-pulling,

and slashing. On farm trials have shown that farmers strongly prefer their own weeding method over the station's recommended method two hand weedings. In fact, there was no significant yield difference between the two methods and the recommended method required much more labor during the farmers' busiest period. Therefore, efforts to improve on farmers weed control methods should build on a basis of better understanding current farmer practices. Oxen cultivation, which is low in labor requirements and has added benefits of thinning and ridging to improve lodging resistance, should be the mainstay of any improved weeding system.

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D I S C U S S I O N

Ann Stroud: Your survey information is very useful to extension. I want to know what the Department of FSR and Agricultural Economics is planning to do on future survey?

Mulugeta Mekuria: We go on generating information and identify the farmer's problems as perceived by the farmer. For identified priority problems, if there are informations available from on-station research, we continue carrying out on-farm verification and adaptation trials. Through this process, feed-back is channelled towards the research center for future programming. As far as collaboration with other organizations such as MOA is concerned, there are forums for discussion.

Ann Stroud: In your surveys, how do you uncover the amount of time farmers spend in and out of farm activities such as marketing?

Mulugeta Mekuria: Labor surveys are difficult. But attempts have been made to get realistic profile of the farm labor. As to the survey, most farm labor goes to farm activities.

Asnakew W/Ab: Do we have information on the residual effect of herbicide on the soil physical properties and soil micro-organisms?

Ermias Kebede: There is no study made so far. Repeated herbicide application and monocropping is said to cause problem to soil micro-organisms and this results in deterioration in soil physical properties. Repeated herbicide application is also suspected that weeds develop resistance.

Chris Parker: The chemicals currently used in Ethiopia do not have this sort of threat. As far as the soil condition is concerned, there is no long term effect. But there may be indirect effect by reducing the underground biomass.

Dereje Ashagari: Before any herbicide is imported and adopted, all available information regarding the herbicide should be sought. It is necessary to confirm whether the chemicals will have residual effect.

Hailu Gebre: How is the life cycle of problematic grass weeds such as Rottboellia of cereals in the state farms and does this affect the management?

Chris Parker: The difficulties with those weeds is that they don't have weedy characteristics to be identified, they have long dormancy periods and they cannot be identified from the crop at early stage.

Birhanu Kinfe: These weeds reproduce by seed and produce a large number of seed. They usually germinate with the crops and cannot be identified to be weeded. By the time they can be identified, they had already inflicted damage to the crop and reached maturity.

Ermias Kebede: These weeds produce seeds more than once every year and there are no specialized chemicals to control them.

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

THE NATURE OF THE WEED PROBLEMS, CONTROL METHODS AND FUTURE RESEARCH STRATEGIES ON THE STATE FARMS

Ermias Kebede[1/]

ABSTRACT

The nature of weed problems on the State Farms and the range of different manual, mechanical and chemical methods used for their control is reviewed. The extent to which these methods are successful is evaluated. Outstanding unsolved weed problems and the research in progress is also discussed in this paper.

INTRODUCTION

Weeds have always been a problem in agricultural systems. Despite the wide-spread use of herbicides they still cause serious crop losses in agriculture throughout the world. Social and economic pressures have made it increasingly important to consider other methods in addition to chemical control for the eradication of weeds.

Since the establishment of the State Farms, mechanized large scale farming has increased at a very fast rate. Various crops are being produced for feeding the population and supplying raw materials for local industries. In the process of producing these crops, numerous factors such as mechanization and different cultural practices play an enormous role.

Insects, diseases, weeds and vertebrate pests cause severe damage to the crops. Various control measures are devised in order to keep them below the economic threshold levels. Hence, pest management is one of the most expensive and laborious tasks in crop production of

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the State Farms. This paper deals exclusively with the weed management practices on the State Farms.

WEED MANAGEMENT PRACTICES

Both parasitic and non-parasitic weeds are causing serious crop damage to many crops in the State Farms (Table 1 and 2).

Table 1. Prevalent weed species in wheat and barley

Grass and sedge weeds	Broad-leaved
Snowdenia polystachya	Amaranthus spp.
Avena spp.	Galium spurium
Lolium temulentum	Guizotia scabra
Bromus pectinatus	Polygonum spp.
Setaria spp.	Chenopodium spp.
Phalaris paradoxa	Galinsoga parviflora
Eleusine indica	Anagallis arvensis
Cynodon dactylon	Oxalis latifolia
Digitaria abyssinica	Rumex spp.
Cyperus spp.	Commelina benghalensis

Table 2. Prevalent weed species in maize and sorghum

Grass and sedge weeds	Broad-leaved
Rottboellia cochinchinensis	Nicandra physalodes
Sorghum arundinaceum	Tagetes minuta
Setaria spp.	Launaea cornuta
Eleusine indica	Amaranthus spp.
Brachiara spp.	Galinsoga parviflora
Digitaria spp.	Achyranthes aspera
Cynodon spp.	Datura stramonium
Cyperus spp.	Solanum nigrum
	Portulaca oleracea
	Striga spp.

Mechanical Weed Control

In the process of seedbed preparation using different implements, the majority of the weed population is destroyed. After early rain, the fields are ploughed by heavy duty machines such as the disc plough and mouldboard plough. These implements incorporate the stubble and weed seeds into the soil. The disturbance of the soil and availability of moisture stimulates the weeds to flush. After a certain period of time just before planting, the fields are disced for the second time either by heavy duty disc harrow (DIA) or by light disc harrow (RDMD) depending on the weed situation. After broadcast seeding or drill planting the seed covering is done by light disc harrow or the spike-tooth harrow.

In cotton growing areas, weed control is achieved by pre-irrigation. At the time of seedbed preparation the fields are irrigated to enhance weed germination. Some time later there is a flush of weed germination and these are left to grow up to the 2 leaf stage before being disced or ploughed-under. This operation incorporates the weeds into the soil and exposes the roots to desiccate. There is no herbicide application involved in this type of land preparation.

In row planted crops such as maize, sorghum, sunflower, haricot bean and cotton inter-row cultivation is done by rotary or Lilleston cultivators to control weed seedlings.

Although the above stated operations are the major mechanical weed management practices, their success is not adequate in some areas because of the fluctuating weather conditions from year to year.

Manual Weed Control

Because of time constraints, machinery shortage and weather fluctuations in relation to very large hectarages, there is an overlap of operations and difficulty in preparing ideal seedbeds particularly in rainfed areas. This situation encourages the infestation of fields by weeds which finally require manual weeding both before and after seeding. The purpose of manual weeding in the State Farms is:

a) To remove established (Tsedeke arem) weeds. These are weeds which are left untouched at the time of ploughing, discing and seed covering. Unless these weeds are removed they interfere with herbicide application on the newly germinating weeds because they make a canopy and hinder the penetration of spray droplets to the target weed. Although this kind of

Table 3. Crop production in the State Farms during the 1986/87 crop season (after Dereje 1987)

Crop	Farm land (ha)	Yield q/ha
Maize	61,498	27.7
Sorghum	8,938	6.4
Wheat	63,149	20.4
Barley	11,425	17.5
Tef	549	5.0
Cotton	38,462	24.1
Fruits	3,270	81.1
Vegetables	1,877	121.1

Aerial application of herbicides is widely practiced, particularly on wheat and cotton. About 80,506 hectares of land has been sprayed by air every year in the last five years. The cost of aerial application for herbicides is Birr 14.80/ha. The State Farms annual expenditure for herbicide purchase is about Birr 4.6 million (Table 4).

Table 4. Herbicide purchase of the State Farms for the years 1983 - 1987

Years	1983	1984	1985	1986	1987
Purchase (Mill. Birr)	3.02	5.22	4.26	6.12	6.31

In the State Farms, when the purchase of pesticides is analysed, the highest expenditure goes for insecticides followed by herbicides, then fungicides and rodenticides. In world market, in terms of value, in 1985 herbicides constituted 44% of the total as compared to 31% for insecticides and 18% for fungicides (Holly, 1986). Thus, it is apparent that herbicides have now become dominant in terms of usage in other parts of the world.

weeding can be done in a short time, labour shortage often delays the operation and creates delay in timely application of herbicides. A similar operation, which is roguing, is done to clean the fields just before harvesting in order to ease the harvesting mechanization. These types of manual weeding are not pre-planned and budgeted but are done in emergency cases because of poor seedbed preparation.

b) Normal Hand Weeding: This type of manual weeding is practiced where no herbicide application is recommended or where the topography of the fields does not allow herbicide application by different machinery. This is the most tedious, time consuming and uneconomical method of weeding in large scale farming. Although it is a pre-planned and budgeted operation, labour shortage, time constraints, weather conditions, social and economical problems do not always allow proper execution of hand weeding. In the State Farms 10 man days per hectare are allocated for one hand weeding, but in actuality it happens that hand weeding is often done 2 - 3 times which inflates the cost of weeding to 20 - 50 man days/ha.

Chemical Weed Control

Weed control by chemical is a technology of the 20th century. There is no shortage of interest in the possibility of an alternative to laborious hand or mechanical weeding. The concept of competition between plants for light, water and nutrients is familiar to both small scale and large scale farmers, as also is the interference of weeds with harvesting and other farming operations. Demands for increased food production from reduced labour forces have led to enhanced interest in the selective control of weeds by herbicides.

At present, in the State Farms effective weed control through herbicide use has transformed levels of yield in the major crops like wheat, barley, maize and horticultural crops (Table 3). It has removed some of the restrictions on cultivation practices of the State Farms. Some non-selective herbicides, such as glyphosate and paraquat are being used widely to support minimum tillage practices and also by controlling problematic weeds such as *Digitaria abyssinica* and *Snowdenia polystachya* which are identified to be the bottlenecks of the State Farms productivity.

UNRESOLVED WEED PROBLEMS AND RESEARCH

There is a great potential for plants not now regarded as weeds to enter that classification because of changes in cultural practices and in the type of crops grown. For example, there has been an increase in population in recent years of Snowdenia polystachya, Bromus pectinatus and Avena spp. in wheat and barley; Rottoboellia cochinchinensis and Striga spp. in maize and sorghum; Orobanche spp. in tomato, tobacco, cut and export flowers and other vegetable crops.

It has been found to be difficult to introduce crop rotation in the tens-of-thousands of hectares of the State Farms. Because of continuous monocropping, the weed problem is increasing from year to year. In most cases, herbicides have been applied for the control of broadleaf weed and satisfactory control has been achieved. As a result, it seems that the balance of the nature of the weeds has been disturbed and grass weeds are becoming dominant (Table 1, 2).

RESEARCH ON THE STATE FARMS

As for research in progress, MSFD has a plan to carry out a crash trial programme for the control of Rottoboellia cochinchinensis. IAR/MSFD collaborative trials for the control of Striga spp. and Orobanche spp. are in progress. Still the above stated major weed species need urgent solutions and recommendations for their control measures. Thus the research priorities and emphasis will be geared towards their control in the future.

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SESSION II B

LAND PREPARATION AND OTHER CULTIVATIONS

Chairman : Dr. Hailu Gebre

Rapporteur : Ato Dawit Mulugeta

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

A REVIEW OF MINIMUM TILLAGE RESEARCH IN ETHIOPIA

Getachew Alem[1/]

ABSTRACT

The research work on minimum tillage at Awasa, Bako, Holetta and Mekele IAR farms are reviewed. At Holetta a one year preliminary study on tillage frequency showed that 1 - 2 plowings for faba bean, tef, and linseed gave nearly as high yields as 3 or 4 plowings. In Awasa, one year's data gave significantly higher yield in zero tillage relative to conventional tillage (numerous ploughing). In Bako, five years' data showed that conventional tillage was superior to zero tillage in terms of grain yield. The efficacy of herbicides, paraquat and glyphosate was tested in zero tillage plots. However, there was no significant yield difference between the herbicides used.

INTRODUCTION

Several workers (Lal., 1979, Russel, 1973) have defined tillage as mechanical, chemical or biological soil manipulation for optimizing conditions for seed germination, emergence, and seedling establishment while maintaining a long-term objective of optimizing sustained land and crop productivity. Traditionally it is done mainly to control weeds; however, this remains as a short term objective.

In the temperate and humid areas continuous and intensive tillage operations to repress weed competetion have resulted in land deterioration and a decline in crop productivity, largely due to soil erosion. Excessive tillage was blamed for such conditions, and for the first time U.S. and European researchers and farmers attempted to study and use reduced tillage practices in the early 1950's. In an effort to minimize the soil losses by water erosion, the number of tillage operations were

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proposed to be reduced. Gradually, no-till or zero tillage systems in which conventional tillage (mechanical) for weed control has been replaced by non-selective herbicides have come into effective use in many parts of Europe and North America. The development of suitable implements has accelerated its use and encouraging results have been achieved in controlling erosion, in saving energy consumption and time of field operations, in temperate areas.

Recently, many other countries have adopted this technology. The International Institute of Tropical Agriculture (IITA) centered at Ibadan, Nigeria, has studied the suitability of this practice for the humid tropics, particularly in the rain forest areas of West Africa. In 1980, a team of Ethiopian experts (of which the author was a member) was sent to IITA to assess the relevance and importance of minimum tillage to Ethiopian agriculture. Research projects were then initiated along this line, and work has been carried out at Awasa, Bako Mekele, and Holetta Research Farms.

This paper attempts to review research findings on minimum compared to conventional tillage practices in Ethiopia.

LITERATURE REVIEW

The different tillage systems that are used to date are (i) conventional (numerous ploughing) (ii) reduced (minimized number of ploughings) and (iii) no-till or zero tillage (Lal, 1979). All refer to the method of seedbed preparation. In reduced tillage, the number of frequency of field operations is lesser than conventional tillage. Zero tillage is a system of seedbed preparation whereby seeds are planted or drilled into the untilled soil. In these systems, mechanical weed control is replaced by the use of non-selective herbicides.

The type of tillage system chosen depends on crop, soil and climate (Lal, 1979 and 1980; Van Doren and Triplett, 1979). Other factors that influence tillage include days available and time requirement for total land preparation operations the type of equipment required, and availability of animals or machinery. A cultural practice survey in Ethiopia (Pathak, 1987) showed that the greater the number of weedings, the greater the frequency of plowing. This has also been found to vary with the type of crop, soil type, and agro-ecology of the area. Reduced and zero tillage are not new to some areas in Ethiopia. In the central highlands, farmers used 1 - 2 ploughings for faba bean compared to 5 - 6 for wheat, 4 - 10 for tef and 3 - 4 for maize (Pathak, 1987). In Gojam, lupin (gibto) is produced under a zero tillage system.

Many factors contribute to increased crop yield; however, the importance of good seedbed preparation cannot underestimated. Crop requirements for water, nutrients and support come from the soil. The manipulation and use of the soil therefore plays a significant role in increasing crop productivity. The effect of tillage on crop growth has been reported by various workers (Lal, 1979, Maurya and Lal, 1979, Nangju, 1979; Russel 1973). Tillage changes the edaphic environment; alters soil physical conditions, loosens a few centimeters of topsoil resulting in temporary increase in infiltration, gas exchange, soil temperature, reduces weed population and competition and influences erosion and drainage conditions (Van Doren and Triplett, 1979). It also affects the soil surface environment through the disposition of crop residues. Insects and diseases associated with the residues are also affected by tillage operations.

Experimental results elsewhere (primarily in temperate areas) have shown that reduced tillage has the advantage in saving energy, labor, time and hence can reduce the cost of production (Couper, et al., 1979). Other advantages include reducing soil erosion and improving soil physical conditions (Lal, 1976 & 1979, Van Doren and Triplatt, 1979). In higher rainfall areas, conventional tillage using a mouldboard plough increased run-off (Lal, 1976). Soil loss of 57 and 36 tons/ha from no-till in Central Ohio and Nigeria (Russel, 1973). Such an advantage was attributed to the presence of sufficient crop residue mulch and improved soil physical conditions in the no-till system which increased infiltration and water holding capacity of the soil. Couper et al. (1979) reported increased maize yield due to zero tillage compared to conventional tillage. However, this yield increase was achieved over 3 - 4 years of continuous use of zero tillage. Moreover, it was observed that crop vigor, root penetration and grain yield with zero tillage may not always be greater than with conventional tillage in the humid tropics (Lal, 1979). The advantage comes largely from the energy, time and labor saving, and reduced soil and water losses and thereby the maintenance of sustained land productivity.

MATERIALS AND METHODS

Experiments on minimum tillage were carried out at four IAR Farms; Bako, Holetta, Awasa and Mekele. Preliminary observations on a cooperative basis were also conducted at Diksis State Farm and at Kulumsa in Arsi region.

Awasa and Bako

Awasa and Bako sites are located at an altitude of 1700 and 1650 meters both experiencing a humid tropical climate with 22 and 11 years mean annual rainfall of 1150 and 1225 mm, respectively. The soils at Awasa are alluval having a loam to clay loam texture, while Bako has a deep red clay soil classified as a nitosol. The major crop grown in both areas is maize.

The treatments compared at both sites were no-till (zero tillage) and conventional tillage. Three herbicides; paraquat (Gramoxone), glyphosate (Roundup) and atrazine + metolachlor (Primagram) were used. Paraquat and glyphosate at 3.5 and 4.5 liters product/ha, respectively, were applied to control weeds in no-till plots. Primagram, 500 FW at 2.0 kg a.i/ha was used on both no-till and conventional plots. Fertilizer (N-P) rates of 0-0, 60-26, and 90-39 kg/ha of urea and triple super phosphate (TSP), respectively were broadcast as sub-plot treatments. Direct seeding for no-till was done manually using a sharpened stick to a 5-10 cm depth; while land preparation for conventional tillage was performed using a tractor and planting was done in rows. The crop used at both locations was maize, varieties Awasa 511 and Bako composite, respectively (IAR, 1984).

Holetta

Holetta Research Farm is located at an altitude of 2390 meters. It has a highland or Dega (2300 meters a.s.l.) environment with a relatively cool and dry winter, and warm and wet growing season. It has a bimodal rainfall pattern; Belg (short rain) in March-April and Mehere (long rain) in June-September. It has a mean annual rainfall of over 1102 mm. Nearly 75% of the rainfall occurs during the Mehere season.

There are two soil types: the red soil classified as a nitosol, and deep black clays known as vertisols. Nitosols are the most predominant soil type and have a friable soil structure. Vertisols have a high water holding capacity swelling when wet and producing large cracks when dry. Seedbed preparation is difficult with vertisols due to these properties.

Minimum tillage experiments were carried out for three to four years on both soil types. The treatments included plowing one, two, three and four times. Fertilizer rate used was 60 kg/ha of N and 60 kg/ha of P_2O_5. Major crops of the area, wheat, barley, tef, faba bean and linseed, were tested. Land preparation was done by oxen and tractor in separate plots.

Mekele

This site is located in Tigrai Region at an altitude of 1970 meters. The rainfall, ranging between 300-800 mm, is erratic in distribution and is highly variable. There are two seasons: the short (Belg) in March-April, and long or main season (Kremt) in June-September with a dry spell in between. Eighty percent of the showers are light and constitute about 50% of the total rainfall (IAR, 1975). Seventy percent of the annual rainfall occurs in the main season. Tillage trials were carried out at two sites, Illala (main-center) and Kwiha (sub-center) approximately 12 km apart.

There are two major soil types: shallow dark clays classified as vertic cambisols (Illala), and eutric cambisols of Kwiha Series (Kwiha). The latter type is the most dominant soil types in Tigrai Region. Tillage trials were carried out in Illala and Kwiha for two consecutive years, 1981 and 1982. The treatments were plowing only during sowing, plowing once and sowing, plowing twice and sowing, plowing thrice and sowing. Fertilizer rates of 100 kg/ha of urea were used. The test crop was barley.

RESULTS AND DISCUSSION

Awasa

The results of the trial at Awasa are given in tables 1,2 and 3. A significant yield difference was obtained among seedbed preparations (no-till and conventional tillage) and fertilizer levels used in the 1981 trial. The grain yield ranges between 31 and 53 q/ha in no-till, and 22 and 28 q/ha in conventional plowed plots. The overall yield on no-till practice was greater than that obtained under conventional. It is clear how this was affected by weed competition. The response to fertilizer rates was also higher in terms of grain yield with zero till and glyphosate; there was very little or no fertilizer response with zero-till plus paraquat or in conventional tillage.

Table 1. Effect of zero and conventional tillage on maize grain yield at Awasa, 1981

Fertilizer (N-P) kg/ha	Tillage Methods			
	Zero		Mean	Conventional
	Glyphosate	Paraquat		
0 - 0	37.4	50.9	44.1	25.8
60 - 26	31.5	49.9	40.7	21.8
90 - 39	53.6	51.8	52.7	27.6
Mean	40.8	50.8	45.8	28.4

Table 2. Effect of paraquat and fertilizer rates on maize grain yield in n0-till field at Awasa, 1982

Fertilizer (N-P) kg/ha	Grain yield (Q/ha)
0 - 0	11.8
60 - 26	25.1
90 - 39	33.8
Mean	23.6

Table 3. Effect of glyphosate and fertilizer rates on maize grain yield in no-till field at Awasa, 1983

Fertilizer (N-P) kg/ha	Grain yield (Q/ha)
0 - 0	30.9
60 - 26	42.7
90 - 39	40.2
Mean	37.9

The effect of different herbicides on the grain yield was also assessed. In no-till practice grain yield has been found considerably higher with paraquat (Gramoxone) giving 50.8 q/ha compared to 40.8 q/ha with glyphosate. The perennial sedge (*Cyperus rotundus*) was reported to be the most prevalent weed observed. This is not controlled by paraquat but is by glyphosate; thus, the results are difficult to explain.

In 1982, no-till at different fertilizer rates was tested and grain yield was found increasing positively with increased fertilizer rates (Table 2). Only paraquat was used during this experiment. The overall yield was much lower in 1982 than in 1981.

A similar experiment was carried out in 1983 with glyphosate used in no-till. Maize grain yield was much higher in 1983 than 1982 and ranged between 31 and 43 q/ha.

Bako

The results of maize response to different tillage methods, no-till and conventional, are given in Figures 1 and 2. In 1981, mean grain yield ranges between 7.7 q/ha and 26.5 q/ha, and 20 and 34.2 q/ha for the respective tillage practices. The response to fertilizer was considerably higher than in Awasa in both tillages: It seems that crop response to fertilizer is much higher in no-till than conventional tillage. Higher grain yield was obtained from the highest fertilizer rate (N-P of 90-39 kg/ha) in both tillage practices. Generally, conventional tillage was found superior in grain yield to no-till practice. Similar trends were observed in 1982, 1983, 1984 and 1986 with maize grain yield ranging between 15 and 28 q/ha, 4 and 18 q/ha, 8.5 and 20.8 q/ha, and 9 and 33 q/ha in zero tillage compared to 36 and 42 q/ha, 14.5 and 28 q/ha, 19 and 28.5 and 22 and 43.5 q/ha for conventional tillage, for the respective years. Yield in 1983 and 1984 was relatively lower compared to other years, being due to drought during these seasons.

Overall, no significant grain yield differences were observed to the preplanting application of glyphosate and paraquat in the zero-till plots.

Holetta

The effect of frequency of plowings on grain yield were tested on several crops; wheat, barley, tef, faba bean and linseed on red and black soils using tractor and oxen for one year, 1982. The results are shown in Fig. 3 and 4 for faba bean and linseed and Fig. 5 and 6 and Table 4 for wheat, barley and tef. Response to fertilizer was significantly different in wheat, barley and faba bean, while tef and linseed yields did not differ significantly on either soil types, under tractor or oxen plowing. There was no significant yield difference between frequency of plowings in wheat (in either soil types or under tractor plow), tef (in either soil under tractor plowing), faba bean (in either soil type under either tractor or oxen plowing) and linseed. However, increase in yield has been observed with higher frequency of plowings (four times) for wheat (under tractor and oxen plowings), barley and tef (under tractor plow only) in fertilized red soil. In black soil, grain yield has been nearly equal for all crops under the different frequency of plowings. Wheat yield under tractor plow showed an increase compared to barley, while others showed little increase with oxen plow. It is difficult to make a conclusion from these one year's results.

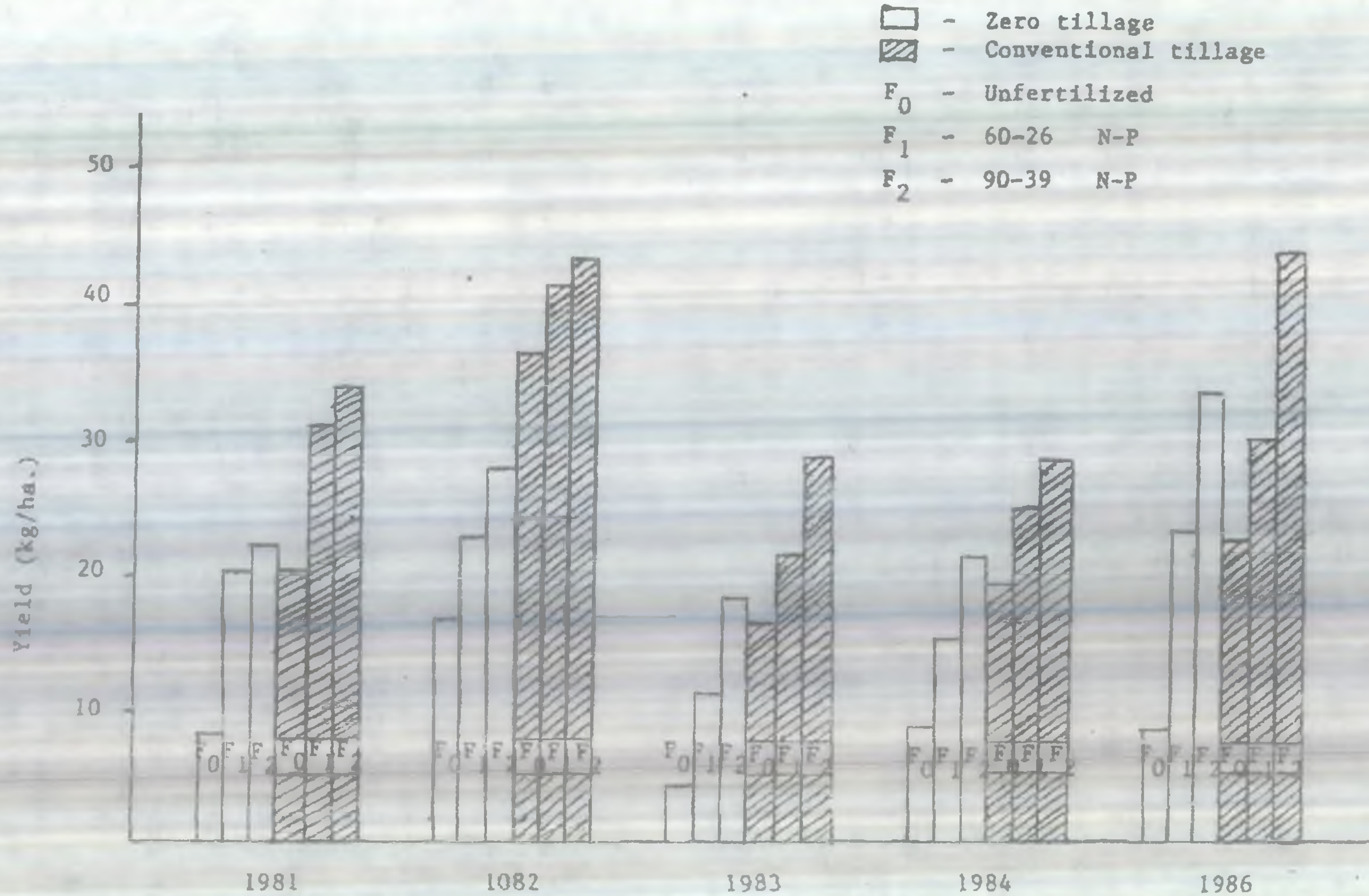


Figure 1: Effect of zero tillage and conventional tillage on the grain yield of maize at Bako

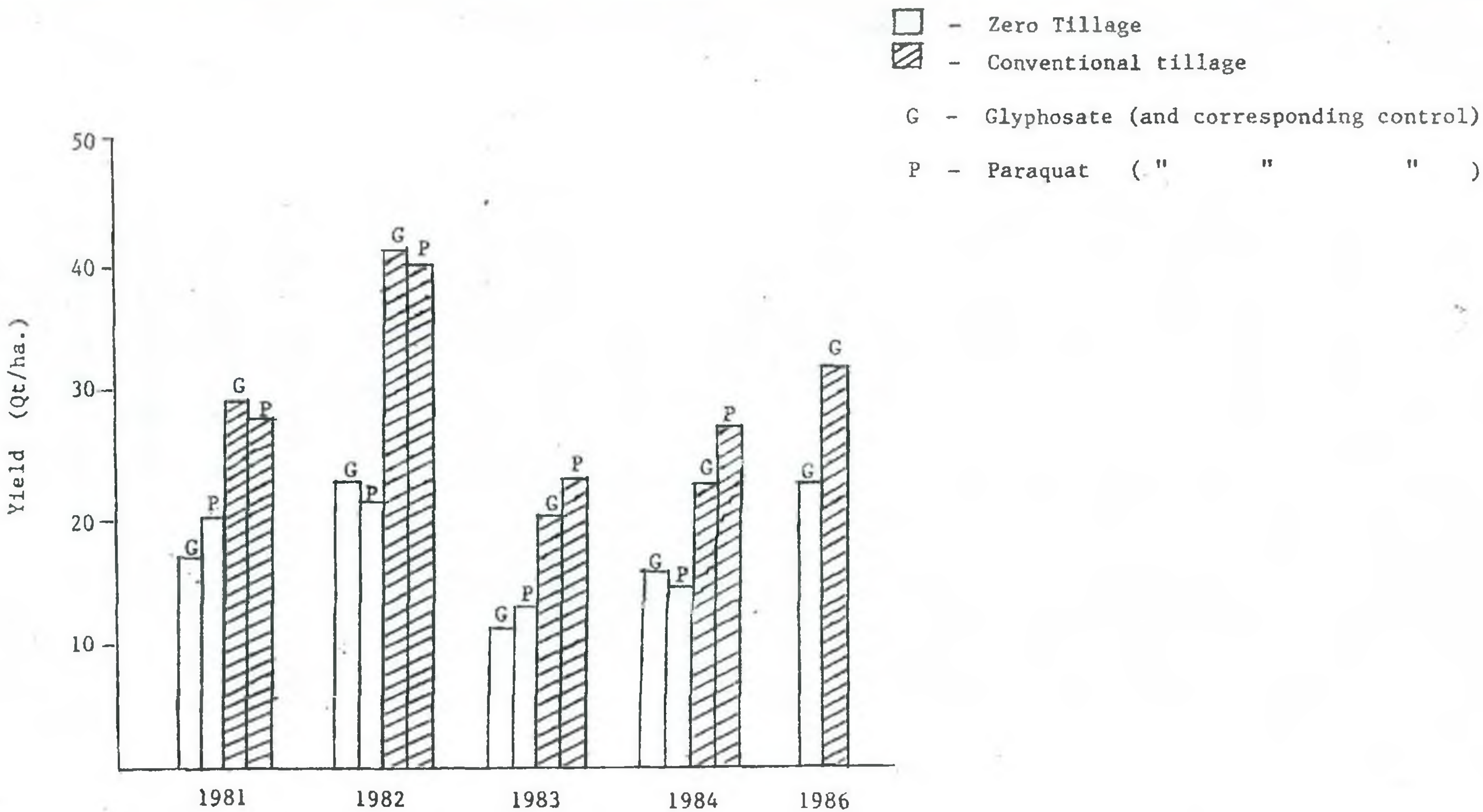


Figure 2: Effect of paraquat, and glyphosate on the grain yield of maize at Bako,

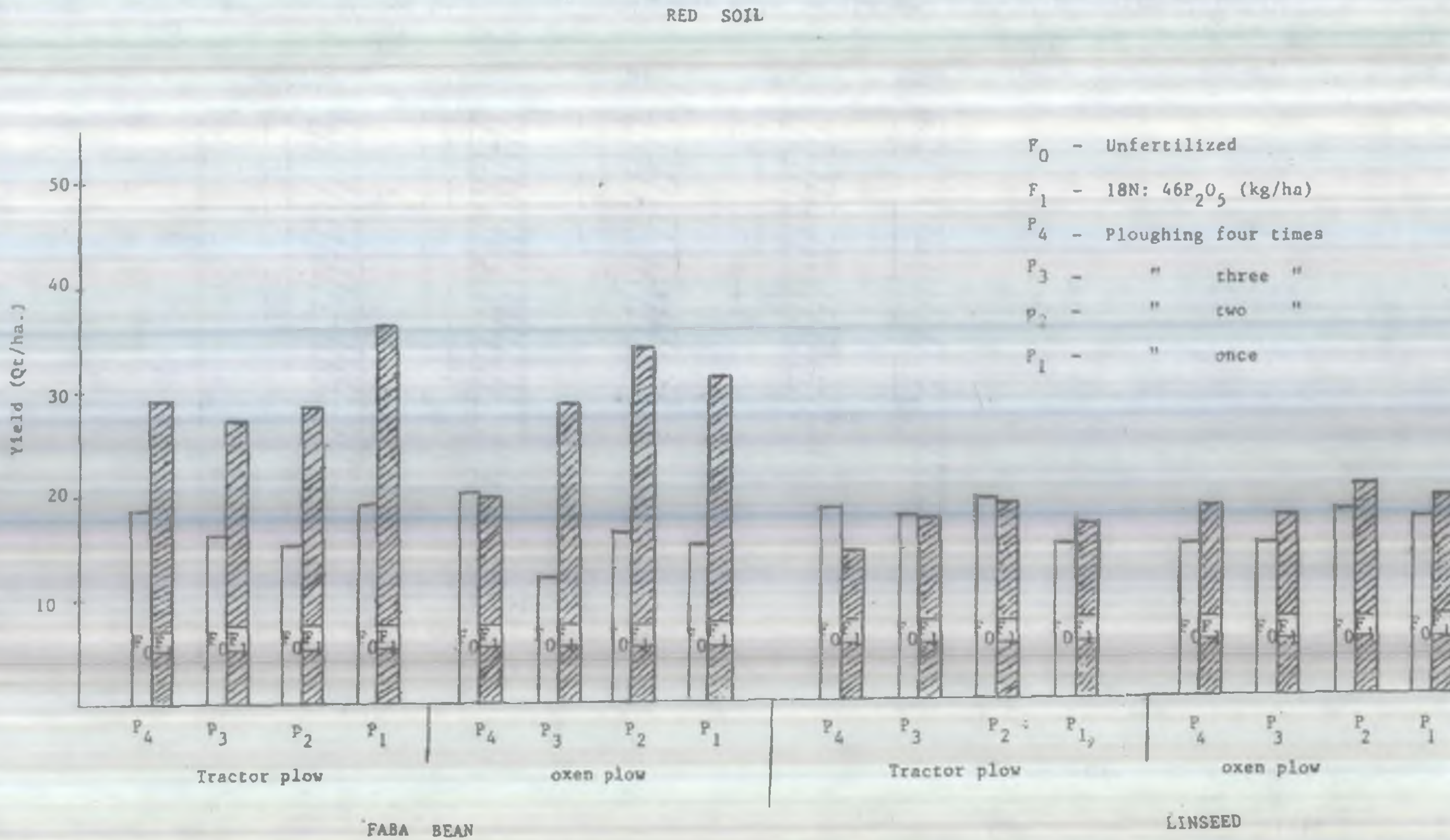


Figure 3: Effect of tillage method and NP - fertilizers on yield of faba bean and linseed 1982 Holetta

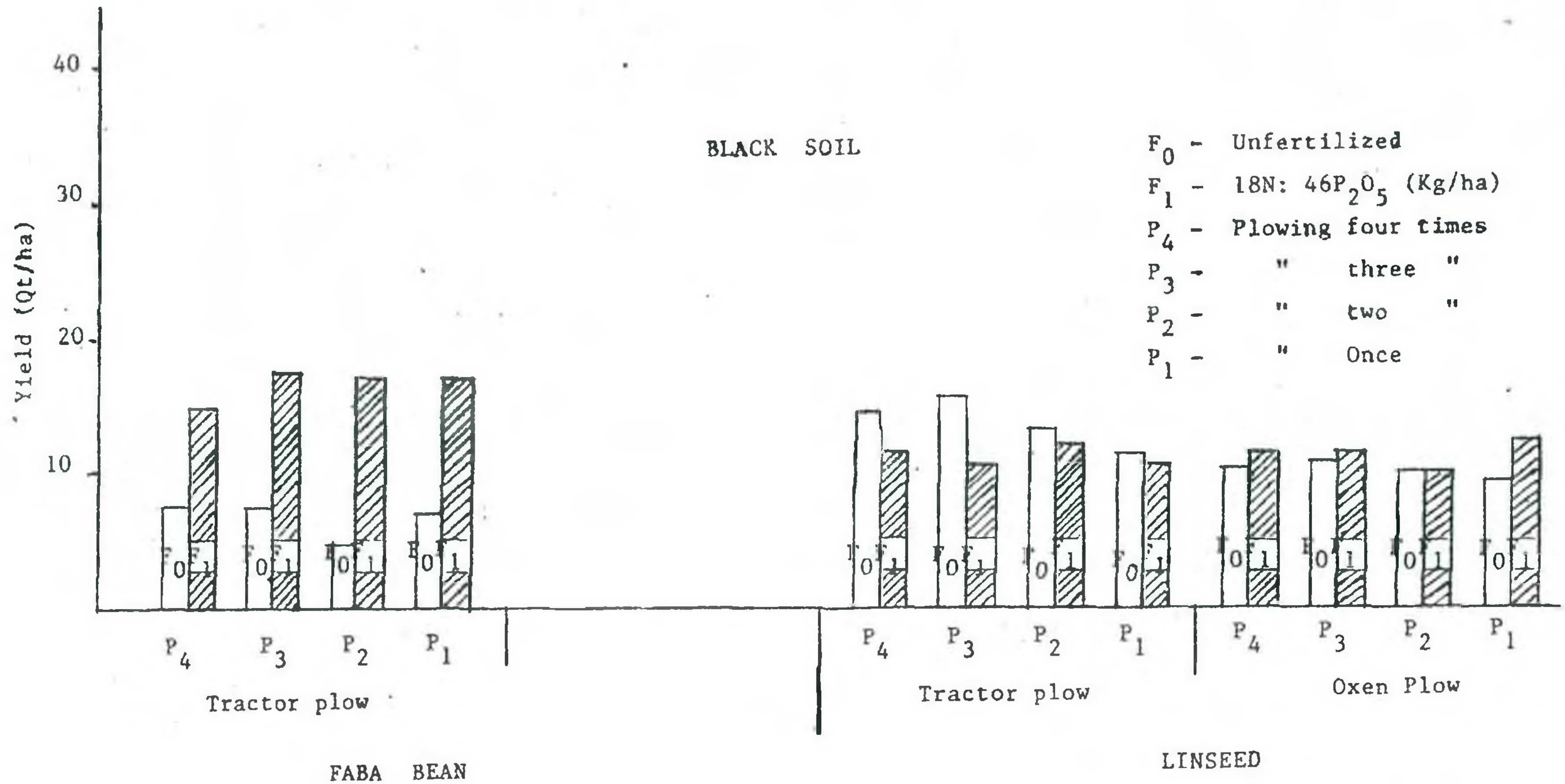


Figure 4: Effect of tillage method and NP-fertilizers on yield of faba bean and linseed 1982 Holetta

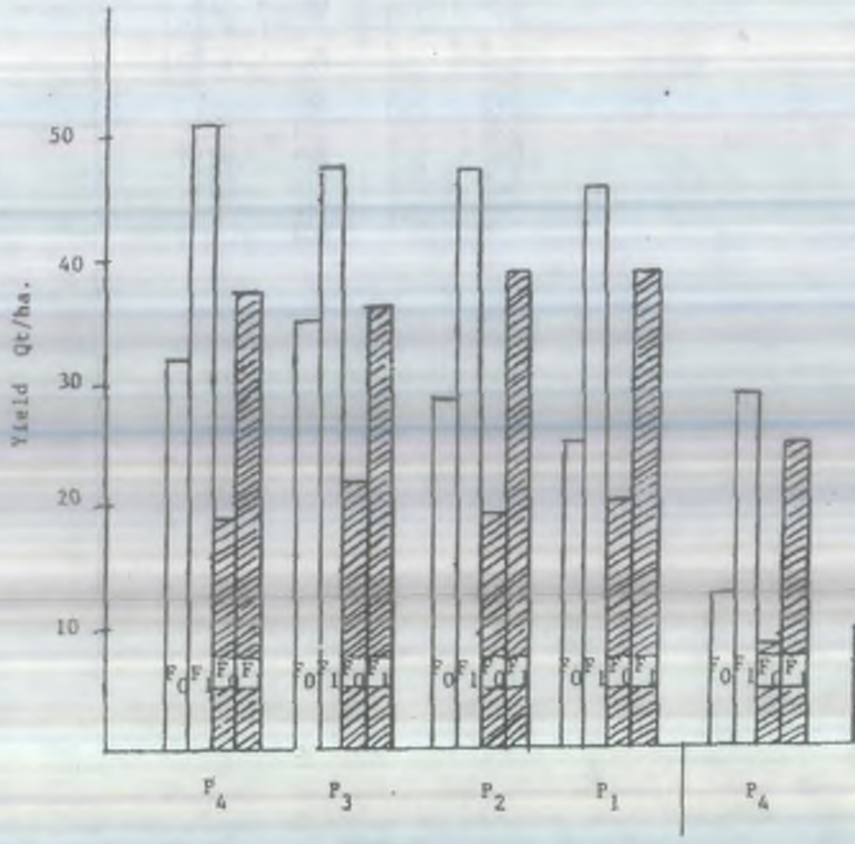
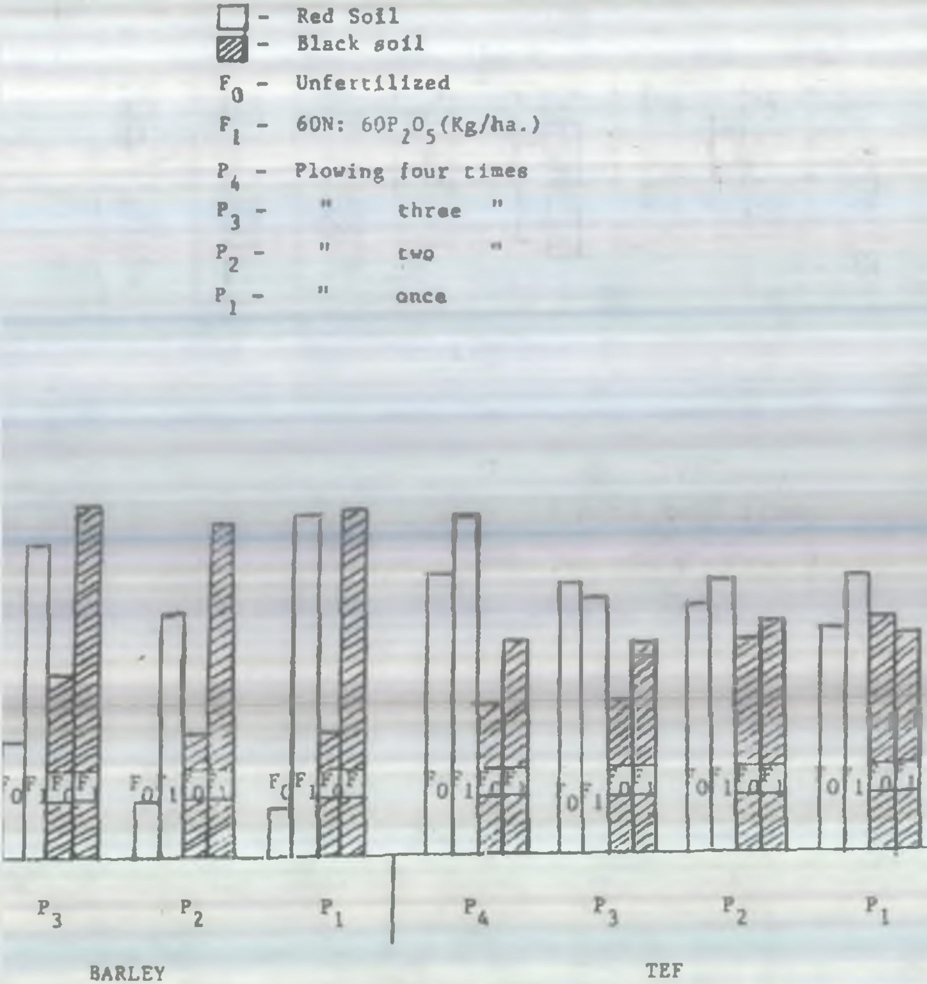


Figure 5: Effect of tillage method and NP-fertilizers
(tractor - plowed) at Holetta.



on yield of wheat, barley and tef

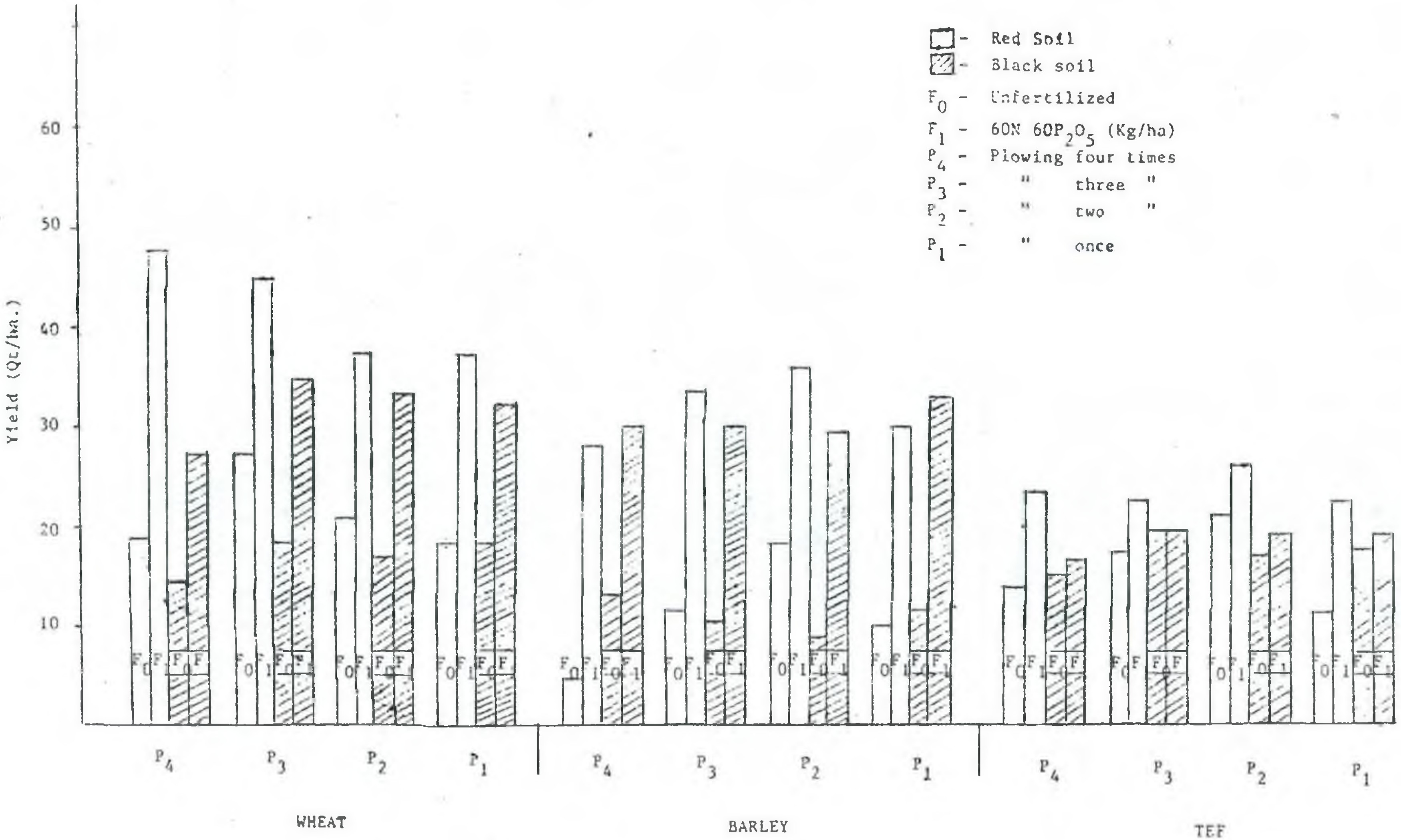


Figure 6: Effect of tillage method and NP - fertilizers on yield of wheat, barley and tef (oxen - plowed) at Holetta

Table 4. Effects of different tillage systems on the grain yield of wheat and barley (q/ha) at Holetta, 1982

Treatment	Black Soil		Red Soil	
	Wheat	Barley	Wheat	Barley
Zero tillage	35.84	30.39	33.89	32.45
Reduced tillage	39.15	27.25	37.34	28.11
Conventional tillage	39.80	19.29	43.88	31.57
Mean	38.26	25.64	38.37	30.71

<u>Mekele</u>

Grain yield among frequency of plowings were not significant at both locations, Illala and Kwiha in 1981 and 1982 (see tables 5 and 6). However, the yield at Kwiha (red soil) was relatively higher compared to that in Illala (black soil) in 1981. In 1982, yield was much lower compared to 1981. Generally, there was no consistent response to the different frequency of plowings. This may be due to low and arratic rainfall in the area.

Table 5. Effect of reduced tillage on the grain yield (kg/ha) of barley, at Mekele, 1981

Treatment	Location	
	Illala	Kwiha
Plowing only during sowing	912	1369
Plowing once and sowing	908	1375
Plowing twice and sowing	977	1382
Plowing thrice and sowing	911	1402
Mean	927	1382.5

Table 6. Effect of reduced tillage on the grain yield (kg/ha) of barley, at Mekele, 1982

Treatment	Location	
	Illala	Kwiha
Plowing only during sowing	947	466
Plowing once and sowing	892	420
Plowing twice and sowing	869	391
Plowing thrice and sowing	827	408
Mean	883.75	421.25

Other sites

In Kulumsa, higher yield was obtained in zero tillage compared to reduced (plowing or harrowing and planting) and conventional tillage (plowing, harrowing and planting) in 1983. Yield obtained from zero tillage at Diksis State Farm was lower compared to conventionally plowed plots largely due to water logging problems of the black clay soils (IAR, unpublished 1984).

CONCLUSION

One year preliminary studies on tillage frequencies in Holetta and Mekele showed that there was not any significant yield increase per se among the different plowing frequencies on wheat, barley, tef, faba bean and linseed production. Therefore, it appears to be possible to produce faba bean, tef and linseed after 1 - 2 plowings without sacrificing significant grain yield. There needs to be information gathered on costs of field operations and associated costs of production in order to determine whether the reduced tillage or lesser plowing frequency is economic. Soil measurements need to be made to see the effects of these practices on soil and water conservation as well.

In Awasa, zero tillage results were encouraging; however, the data generated were very limited. Plots used were too small to make conclusive assessment in terms of cost, and soil conservation benefits.

In Bako, five years of data showed that conventional tillage was always superior to zero tillage in terms of grain yield. Fertilizer response to both tillage methods was found interesting. Zero tillage seems to require more fertilizer than conventional tillage and this has been consistent throughout the trial periods. Economics were not calculated.

In almost all the sites, the approach to minimum tillage research appeared to aim at evaluating the efficacy of different herbicides while the major objectives of the study (soil conservation, energy and time saving) have not been studied. From the observations made at Bako the effect of herbicides on grain yield was significantly different. Herbicides should, therefore, be selected based on efficacy. economic benefits and any hazard associated with them. At Awasa, the results obtained concerning herbicides for three years (Table 1,2, and 3) were not conclusive. A detailed account of the weed population and flora in zero and conventional tillages has not been documented for most of the trial sites. In the future, replacing herbicides by a vegetative cover (live mulch) of useful species to repress weeds should be tested as a means. The adoption of this technology under situations where herbicides are not readily available and economical to the farmer may be useful.

Reduced and/or zero tillage results varied with sites, crops and soil types. This indicates the need for identifying sites and crops for minimum tillage practice.

Finally, the reviewed results indicated the potential for reduced tillage in the Ethiopian highlands and South western rainforest areas. This observation is similar to the observation made by Cloutier (1984). However, systematic studies need to be carried out in the future to assess not only yield but also the benefits from conserved soil, fuel (energy) and time.

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Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

THE SCOPE FOR INTRODUCTION OF IMPROVED IMPLEMENTS AND CULTIVATION METHODS IN ETHIOPIA

Araya Kebede[1/]

ABSTRACT

A study is described in which a package of improved implements and techniques was tested for land preparation in the middle Awash. It was shown that with such a package, a larger farm size, up to 3 ha or more could be cultivated. It is emphasised, however, that there could then be a problem of inadequate labour for post-planting operations, including weeding and harvesting. Hence research is continuing on the possibilities for improved implements for these further farm operations.

INTRODUCTION

Ethiopia is predominantly an agricultural country. Eighty five percent of the country's 42 million population derive their living from agriculture; 90% of the exports are agricultural based; 90% of the people live in rural areas. The country has a total area of 120 million hectares of which nearly 70 million hectares is cultivable. Out of the arable land, approximately 12 million hectares have been brought under cultivation, but not all this area is cropped every year. Ethiopia has a larger livestock population than any other country in Africa, having 27 million cattle, 24 million sheep, 18 million goats, 7 million horses, mules and donkeys and 1 million camels. Oxen are extensively used for draft purpose. Over 4 million traditional ploughs are used for cultivation with a matching number of oxen teams.

The topographic characteristics of Ethiopian agriculture favour the use of animal draft power. Moderate to steep slope of the cultivated land and the difficulty in mechanizing the cultivation of wet heavy clay soils in many regions has influenced the continuing dependence of the farmer on animal drawn equipment and hand tools.

1/ Institute of Agricultural Research, P.O.Box 2003, Addis Abeba.

The agricultural soils of Ethiopia are relatively fertile. The climatic conditions, on the whole, are favourable for intensive crop cultivation. A recently completed agro-climatic map of Ethiopia shows vast areas endowed with crop growing periods of 210 days or longer during the main rains, making it feasible to attain high intensities of cropping. However, the average yields of the major crops are low and not more than half of the 12 million hectares of land under agriculture is cultivated in any one year. Poor land preparation, delayed sowing, poor plant populations, spacing, low fertility and inadequate weed control are among the main reasons given for the low yields.

The limited capacity of draft animal power available to the Ethiopian farmer and the traditional ploughing practices are considered to be the main factors limiting the area cultivated in the main rainy season. The low crop yields and cropping intensity bring into focus the inefficiency of the prevalent implement draft animal power system. The commonly used wooden plough "Maresha" produces a seedbed of poor quality. In the absence of sowing equipment, seed broadcasting is widely practised, resulting in improper seed rate and unfavourable depth and spacing of seed. The crop stand is therefore generally unsatisfactory. Animal drawn or manually operated implements and tools for inter row-culture are not available and the weeding standards are low. Lastly, the inefficiency of wooden plow restricts the work put of a draft animal causing problems of timeliness in seedbed preparation and sowing. Because of the non-availability of appropriate tools and implements, the Ethiopian farmer is severely handicapped and is not able to take full benefit of the availability of 4 million pairs of draft cattle.

Therefore, in order to contribute effectively to the national endeavour to increase agricultural production, the Ethiopian farmer needs improved tools and implements to help him raise the standard of cultivation and crop care, to cultivate more land with the available draft animal power and to raise the intensity of cropping.

RESEARCH ON OX-DRAWN IMPLEMENTS

From 1977 to 1979 the agricultural engineering department of the Institute of Agricultural Research had carried out a study on the use of a package of animal-drawn implements at Melka Werer Research Center. This study gives some idea of the role and scope of improved implements and cultivation methods useful for anyone interested in developing agricultural production systems in peasant sector with minimum mechanization.

Objectives

The objective of the study was to identify a package of improved agricultural implements and mode of operations appropriate to Middle Awash Valley.

Methodology

The two year study used four oxen, two Barca from the Melka Werer herd and two other Zebu type bought from the market at Mieso, to pull the implement.

The implements used were:

- One mouldboard plough bought from ARDU
- One spike tooth harrow bought from ARDU
- One inter-row cultivator and ridger imported from England.

The first few months were spent in training the farmer on how to use the various implements and draft animals. The test crops were cotton and groundnut. These are among the more important crops in the Awash Valley. As far as variety, date of planting, irrigation interval and other agronomic parameters were concerened, the farm management procedures which had been established through repeated experimental work were adopted. The study was carried out on two hectares of land. The following parameters were recorded; time taken to complete an operation; assessment of quality of operation, and labour requirement for different field operations. Field operations included primary and secondary ploughing, harrowing, ridging and inter-row cultivations in order to reduce the amount of hand weeding required.

RESULTS AND DISCUSSION

Using improved implements and a pair of oxen it took 110.5 hours to prepare one hectare of land for planting (Table 1). If a peasant farmer works 6 hours a day for 5 days in a week it would take him about 4 weeks to prepare one hectare of land. If land is available for expansion, a single peasant farmer can prepare up to 3 hectares of land because he has adequate time between the harvesting and planting period to undertake this task.

Table 1. Field operation data per pair of oxen

Field Operation	Hours/ha	Projection to farm size	
		Hours/3ha	Hours/5ha
First ploughing	25.00	75.0	125.0
Second ploughing	20.0	60.0	100.0
Harrowing 2x	12.0	36.0	60.0
Ridging	9.5	28.5	47.5
Cultivation 2x	44.0	132.0	220.0
Total	110.5	331.5	552.5

(Source: IAR, Agricultural Bulletin No. 1, May 1979).

Table 2 indicates that weeding and thinning required 182 man days/hectare for cotton and 164 man days/hectare for groundnut. The task is too much to be carried out by a peasant farmer with his family (assuming family size of five persons). This clearly indicated the time constraint a peasant farmer faces for critical field operation such as weeding and planting. The same is true for harvesting. Therefore, the role of and need for improved implements come into picture when land expansion is contemplated under such conditions.

Table 2. Labour requirement for growing one hectare of cotton and one hectare of groundnut

Operations	Man-days	
	Cotton	Groundnut
Hand planting	26.0	42.0
Thinning & Weeding	182.0	164.0
Lifting	-	29.0
Picking (harvesting)	136.0	168.0
Chopping & Cleaning	36.0	-
Others 10%	38.0	40.0
Total	418.0	443.0

(Source: IAR, Agricultural Bulletin No. 1, May 1979).

Table 3 shows the total gross income a farmer can get by growing cotton and groundnut on two hectares of land. The minimal investment required on the identified package of implements and draft animals would not be excessive considering the possibility of the gross income per peasant family.

Table 3. Gross income (Birr) from one hectare of cotton and one hectare of groundnut

Specification	Cotton	Groundnut
Price per kg.	1.15	0.60
Yield kg/ha	2,915.00	3,087.00
Gross income (Birr)	3,352.25	1,852.20

(Source: IAR, Agricultural Bulletin No. 1, May 1979).

CONCLUSION

In Ethiopia farm families together with animals act as the main source of power for various agricultural field operations. Improved implements can reduce human drudgery and increase labor productivity per given time. Increase in yield could be realized through increasing size of land holdings and more timely land preparation and weeding. Minimum mechanization with improved tools and implements in the peasant farming sector has potentially no adverse effects on rural employment, but can help reallocate labor and/or reduce agricultural working hours. The saved time could be used for other useful employment.

In view of the above, the Institute of Agricultural Research through its Agricultural Implements Research and Improvement Centre, is undertaking extensive development, testing and evaluation programmes on animal drawn implements and hand operated tools required for land preparation, primary tillage, sowing, weeding threshing and transport of farm products.

A soil inverting primary tillage plow within the draft ability of the Ethiopian oxen has been developed and tested on research stations. A non-soil inverting plow, suitable for moisture stressed area, with very low draft requirement (about 60% of Maresha) has been developed and tested but its field capacity for a pair of oxen is low as compared to Maresha. A wheel hoe, having 400% field capacity as compared to hand weeding, is developed. A non-cleaning type cereal thresher has been developed and is being used extensively by farmers and IAR research stations. The thresher capacity is about 5 quintals per hour for wheat and barley. This thresher is also under further development for maize and sorghum crops. Donkey cart which are used around Alem Tena and Ziway area has been studied and modified to increase the pulling capacity of the donkey by 300%.

DISCUSSION

Ermias Kebede: There is no zero tillage on state farms, but reduced tillage using paraquat or glyphosate is used 15 to 20 days before final discing and sowing wheat and barley.

Wondimu Wolde-Hanna: Expressed concern that reduced tillage would encourage the deeper rooted weeds, and insect problems.

Birhanu Kinfe: It is a new concept worthy of more study but with particular attention to the costs.

Dereje Ashagari: Is it not possible to use reduced tillage without using herbicides?

Getachew Alem: Certainly tillage can be reduced without use of herbicide and is of great importance for soil conservation. Only zero tillage is completely dependant on herbicide. Insect problems can occur with either system and may need an integrated control approach.

Douglas Tanner: To what extent is the post-planting weeding requirement increased as a result of reduced pre-planting tillage? More information is needed on this aspect and on many others in this complicated subject.

SESSION III

STRUCTURED DISCUSSION

On the opportunities for agronomic approaches to improved weed control

Chairman : Ato Mulugetta Mekuria

Rapporteur : Mr. Chris Parker and
Ato Wendimu W. Hanna

STRUCTURED DISCUSSION

1. ABILITY OF FARMERS TO WEED ADEQUATELY

Ann Stroud: There is a general assumption sometimes that farmers do not weed adequately simply because they are lazy. Surely there is evidence now that this is not true.

Demissie G.Michael: I agree that this is totally unjustified and that there are genuine time constraints for the farmer. He could perhaps allocate his time more wisely, but needs guidance in doing this, and there is also some incentive problem.

Glyn Jones: There is clearly a need for much more information on the distribution of labor over different tasks over the cropping season.

Paulos Dubale: There is some tendency to laziness in coffee farmers when they can rely on the cash crop and are less dependent on their food crops. This is influenced to some extent by the extent of shade, as in SW districts where the shade reduces weeding needs, while in Hareree more weeding is necessary.

Hailu Gebre: Hand-weeding can never be the whole answer and farmers need help in developing alternatives.

Ann Stroud: A more holistic approach is needed, based on a sound understanding of all the constraints.

2. TECHNIQUES FOR MAKING WEEDING MORE EFFICIENT

Birhanu Kinfe: Hoes are widely used for sorghum and maize and also for cotton on state farms, but for small grains they are not practical.

Ermias Kebede: Hoes are of little use under really wet conditions, nor in broadcast crops.

Sebsibie Abebe: Hoes are particularly suitable on sandy soils as in Hareree and around Bako.

Teshome Regassa: Hoeing is effective in Hareree, but may take longer than hand-pulling?

Wondimu Wolde-Hanna: The value of hoeing depends on soil type and the weeds. Species such as <u>Commelina</u> and <u>Portulaca</u> may be encouraged, and a forked implement may be preferable.

Demissie G. Michael: Seed cleaning is an important aspect so that weeds are not sown with the crop.

Seifu Ketema: Agreed that seed cleaning should be emphasised, and other hygienic methods such as preventing the seeding of weeds in the field.

Taye Teferedegn: On a more general level, there is a need for the strengthening of IAR weed science capacity so that these different aspects can be more intensively studied.

Hailu Gebre: Row-planting and the broadbed and furrow techniques are highly advantageous in reducing the time needed for weeding.

Jemal Mohammed: Animal-drawn cultivators become possible with row-planting.

Ann Stroud: Farmers consider that row-planting takes too much time and that the plant populations are to low and do not provide enough thinnings which are valued as animal feed. They need to be convinced that additional time at planting will be compensated for in less time for weeding.

Douglas Tanner: Row-planting of wheat in Kenya has led to 40% increase in yield and is particularly popular in areas with limited land.

Paulos Dubale: The Welaita Agricultural Development Unit (WADU) uses row-planting and has very few weeds.

3. SCOPE FOR REDUCING TILLAGE

Glyn Jones: For tef, minimum tillage could be especially beneficial.

Getachew Alem: The possibilities have not yet been proven but there is certainly potential.

Ermias Kebede: There is a need for attention to the depth of ploughing, and the possibility of interactions between fertilizer use and tractor ploughing.

Birhanu Kinfe: The cost of glyphosate could be too expensive for widespread adoption?

Getachew Alem: Reduced numbers of tillage should be feasible and do not need herbicide in the same way as zero tillage.

4. RESEARCH NEEDS

Getachew Alem: There is a particular difficulty of convincing the farmer of the benefits of reducing tillage.

Wondimu Wolde-Hanna: Rottboellia is a particular problem species requiring extra research.

Hailu Gebre: There is a need for more study of the relationships of cultivations to the biology of individual weed species.

Ahmed Sherif: Agreed there is a need for more study of weed biology generally.

Abebe Menkir: Work on the seedling vigour of different crop varieties could be valuable, as it is observed that local landraces of sorghum are often stronger and compete better with weeds.

Douglas Tanner: There should at least be an avoidance of the most weed-susceptible varieties.

Hailu Gebre: Noug and buckwheat are well known for their ability to suppress weeds and are used to control Digitaria scalarum.

Ann Stroud: Especially in unweeded crops, the choice of variety may be critical (eg. in faba bean, peas and haricot bean) and broadcast-seeding may then also have advantages.

Sebsibie Abebie: More emphasis should be placed on crop rotation in relation to weed control.

SESSION IV

Economics of weed control

The status of herbicides in Ethiopia

Chairman : Dr. Hailu G. Mariam

Rapporteur : Ato Tsedeke Abate

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

CAN HERBICIDES BE ECONOMIC?

Chris Parker, Steven Franzel and Dawit Mulugeta[1/]

ABSTRACT

The economics of herbicide use are discussed in respect to the possibilities for replacig hired or family labor or for increasing crop yield. Simple diagrams are presented from which the acceptable cost of a herbicide treatment may be calculated, according to the amounts of hand labor replaced, or increased crop produced (allowing for different values of crop produce). These calculations are based on the assumption that only 75% of normal hand-labor is replaced, 25% being retained for supplementary weeding. When herbicide is used to replace family labor, a 100% return on investment is also allowed for. Although many of the commoner herbicides are likely to be economic as replacements for hired labor on large farms, only the cheaper ones can be justified for replacing family labor, unless there is also an increased yield. Such increased yield is shown to be possible in a number of crops, especially from the use of pre-emergence herbicides in situations where hand weeding is inefficient due to limited labor availability, or wet conditions. More studies are suggested, to confirm the potential of herbicides to increase yield under farm conditions, and hence generate evidence for their import substitution value.

INTRODUCTION

The answer to the question 'Can herbicides be economic?' basically depends on a) the cost of the herbicide, and b) the economic benefit from its use. Herbicides are not yet widely available in Ethiopia, so their costs are not yet established, other than 2,4-D which may cost as little as Birr 10-15 per ha. This is a minimum from which costs can be estimated to rise through Birr 40 to 50 for many of the more widely used compounds, to Birr 100 or more for the newest and most effective herbicides still under patent. In this paper we will avoid guessing at herbicide costs, but concentrate instead on the levels

1/ Institute of Agricultural Research, P.O.Box 2003, Addis Abeba.

of benefit which can be expected from their use, which will in turn provide a guide to the acceptable cost of herbicide for particular crops. As prices of crop produce also vary from year to year and market to market, this uncertainty is also allowed for.

POTENTIAL BENEFITS FROM HERBICIDE USE

Compared with traditional methods of weeding, the use of herbicide can be economically beneficial in any or all of three different ways; a) they may cost less, b) they may be more efficient and result in increased yield of the treated crop, or c) they may allow labor to be diverted to increase the production of other crops, especially by allowing a larger area of land to be cultivated.

Table 1. Hand-weeding requirements in different crops in Ethiopia

	Man-days of labor required for weeding: (and benefit/cost ratios calculated at the time or yield increase, q/ha)			
WHEAT	1 weeding	2 weedings	3 weedings	Source
Debre Zeit 1978	103 (0.5)	218 (2.0)		Ref 1 p40
Debre Zeit 1978	73 (4.5)			Ref 1 p44
Debre Zeit 1981	54 (2.6)	59 (6.4)		Ref 1 p51
Debre Zeit 1982	11 (25.1)	16 (2.9)	27 (6.8)	Ref 1 p61
Debre Zeit 1982	23 (10.7)	40 (5.8)	38 (4.6)	Ref 1 p67
Debre Zeit 1982		28 (7.4)		Ref 1 p73
Debre Zeit 1982	28 (26.9)	47 (12.1)		Ref 1 p80
TEFF				
Kulumsa 1969	29 (10.1)	43 (7.2)		Ref 2 p77
Kulumsa 1970	156 (3.4)	202 (2.8)		Ref 3 p74
Debre Zeit 1978	144 (1.4)	215 (1.7)		Ref 1 p47
Debre Zeit 1981	27 (2.1)	63 (0.5)		Ref 1 p54
Debre Zeit 1981	20 (2.6)			Ref 1 p57
Debre Zeit 1982	44 (1.3)	16 (0.4)	55 (0.[illegible])	Ref 1 p63
Debre Zeit 1982	32 (10.3)	58 (6.2)	85 (5.[illegible])	Ref 1 p69
MAIZE				
Awasa 1983	15 (+7.4q)	30 (+8.2q)		Ref 4 133
SORGHUM				
Bako 1983	1 (+13.7q)	82 (+11.5q)	104 (+[illegible]0.2)	Ref 4 131

Table 1 Cont'd

	Man-days of labor required for weeding: (and benefit/cost raitos calculated at the time or yield increase, q/ha)			
SUNFLOWER	1 weeding	2 weedings	3 weedings	Source
Awasa 1982	34 (+1.5q)	60 (+1.9q)		Ref 5 210
HARICOT BEAN				
Awasa 1984	76 (+20.1q)	106 (+22.6q)		Ref 6 118
FABA BEAN				
Holetta 1982	87 (+3.9q)	138 (+7.7q)		Ref 7 p76
Holetta 1982	160 (+4q)	269 (+1.5q)	449 (-3.3q)	Ref 4 136

Benefit/cost based on labor at Birr 2/day (except Birr 1/day in 1969/70) Prices of wheat Birr 60/q (1978), Birr 65/q (1981) and Birr 80/q (1982) Prices of tef Birr 25/q (1969/70), Birr 70/q (1978), Birr 80/q (1981), Birr 100/q (1982).

Sources: 1 = AAU, undated; 2 = CADU, 1969; 3 = CADU, 1971; 4 = IAR, 1985; 5 = IAR, 1984a; 6 = IAR, 1986; 7 = IAR, 1984b.

Replacement of hired labor

Where weeding is done by hired labor, the benefit to the farmer of replacing that labor can be readily calculated, and we may start by looking for information on the costs of weeding incurred in various crops and considering the likelihood that herbicide could lead to equivalent yields. In that case, the cost of herbicide can be directly compared with the cost of weeding. There is unfortunately little published information on the labor involved and hence the costs of weeding on the larger farms where labor is hired. But information is available from research trials by SPL, IAR, CADU and the University, and examples are shown in Table 1. Different timing and intensity of hand weeding were compared in a wide range of crops, and showed a substantial range of man-days required, varying from 15 man-days for one weeding in maize at Awasa in 1983, to 21 man-days in sorghum at Bako in 1983 and up to 160 man-days for a single weeding of faba bean at Holetta in 1983. Which of these figures represents what really happens on the farm is difficult to judge and more data are needed. One survey in the Kulumsa area in 1970 (Table 2) showed averages of 19 to 27 man-days per ha according to crop, while the figures for CADU trials were substantially higher. The data presented are therefore clearly influenced by a) a high variability in weed infestation, b) high variability in labor productivity among individuals and c) biases, both upward and downward involved in measuring labor inputs.

Table 2. Labor requirement for hand-weeding in Chilalo Awraja, 1970, based on 40 farmer interviews and on trial data.

	Man-days for weeding		
	On farms		In CADU trials
	Range	Mean	Mean
Wheat	10 - 36	22	42
Barley	3 - 33	19	NA
Teff	15 - 48	33	70
Faba bean	12 - 58	27	46

(from Engstrom 1974).

In Table 1, the benefit to cost ratios are those quoted in the original publications, and apart from the earliest data, from 1969 and 1970 when the labor rate was Birr 1 per day they are based on a labor rate of Birr 2 per day the government minimum wage which has now been constant for a number of years. In general, it can be seen that even these perhaps inflated labor inputs gave good benefit to cost ratio, and even with some decline in produce prices, these levels of hand weeding labor should still be economic. In the case of the faba bean example, however, it is not so certain that the large labor input was economic, and hence, it would not be valid to conclude that an equivalent cost of herbicide would be acceptable. In these examples a single figure has been used for the value of the crop, but this is an oversimplification at present, since official and market prices can vary quite widely.

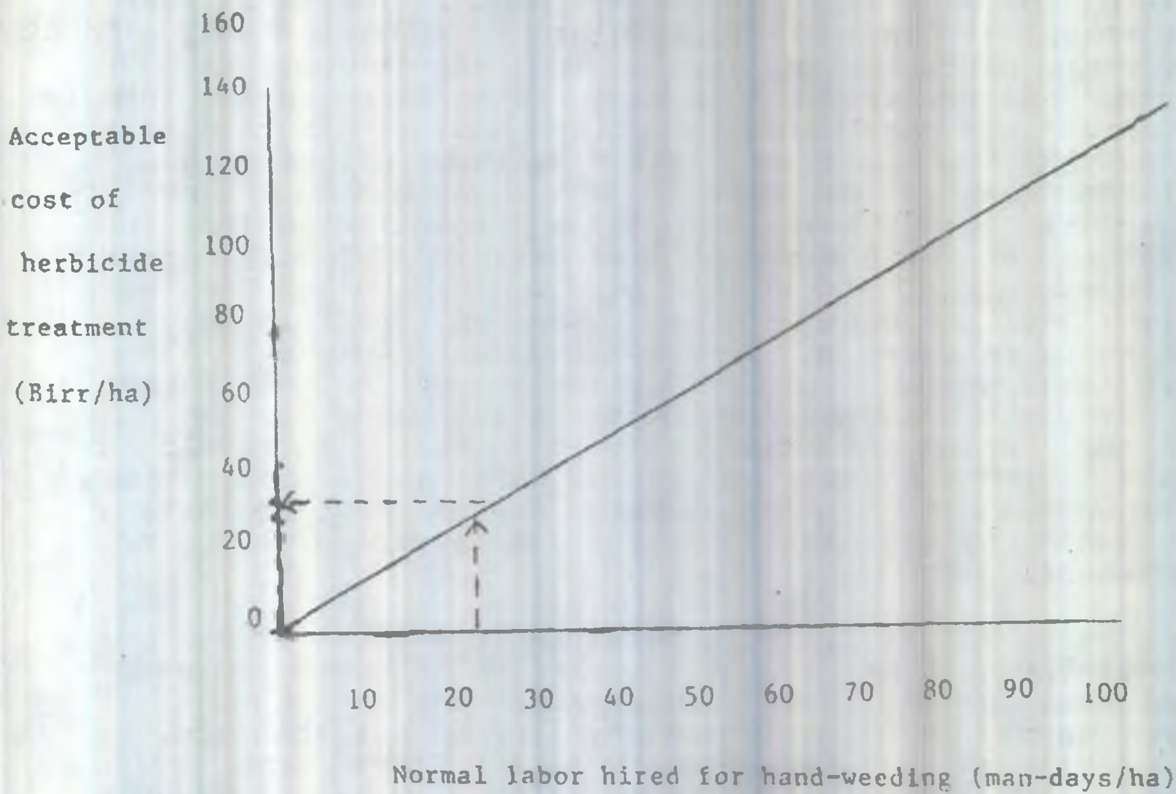
We could use the figures from Table 1 and assume that the herbicide would simply replace hand-weeding and give the same yield. We might then say that the cost of herbicide plus application must not exceed the amount normally spent on weeding. However, we do not believe that herbicide should be relied on to completely replace the weeding labor that has been previously used. In the case of some of the most effective herbicides, it is likely that equivalent yields could be obtained by herbicide use, without any other post-planting weed control operations. In most cases, however, it would be very unwise to encourage farmers to do without regular supplementary hand weeding, in order to prevent the almost inevitable build-up of herbicide tolerant weeds. Some cost of hand-weeding should therefore be written into the equation, as a precaution against such a development even where it does not at first sight appear to be essential. Hence in Figure 1, we have assumed that only 75% of the cost of hired labor can be safely saved, 25% being retained for supplementary hand weeding. (The term 'hand-weeding' in this paper is used for convenience to cover all non-herbicidal methods including hand-pulling, hoeing and inter-row cultivation.) It should be noted that the acceptable cost of herbicide treatment must include the cost of any labor for application, and also a proportion of the cost of purchase or hiring of spraying equipment.

Using Figure 1, it is possible to estimate the acceptable cost of herbicide replacing any measured or estimated current labor input, and it may be seen that if labor inputs of 20 to 50 man-days per ha are the norm, (as confirmed at this workshop for the State Farms, by Ermias, 1987) then herbicide costs of Birr 30 to 75 per ha are economically justified and still allow for some labor input for supplementary weeding.

Replacement of the farmer's own labor

On peasant farms, hired labor is not generally used, and it is the farmer's own time that is normally spent on weeding. To what extent can this labor be costed in the same way? If the farmer spends 20 days less time weeding a hectare of maize, can he really show a monetary gain of Birr 40 to offset against herbicide? It is quite possible that he could use that time to plant another crop at a more optimal time and thus produce more crop, and the 'opportunity cost' (value in alternative uses) of his labor might therefore be calculated at Birr 2 per day. It might even be that he could hire his labor out at this critical time of year for Birr 3 per day. Conversely it can be argued that the opportunity cost of his labor should only be estimated at a discounted level of perhaps Birr 1 per day. In Figure 2 therefore alternative estimates of 'acceptable cost' are indicated on each of these three assumptions. It will be seen, however, that even on the

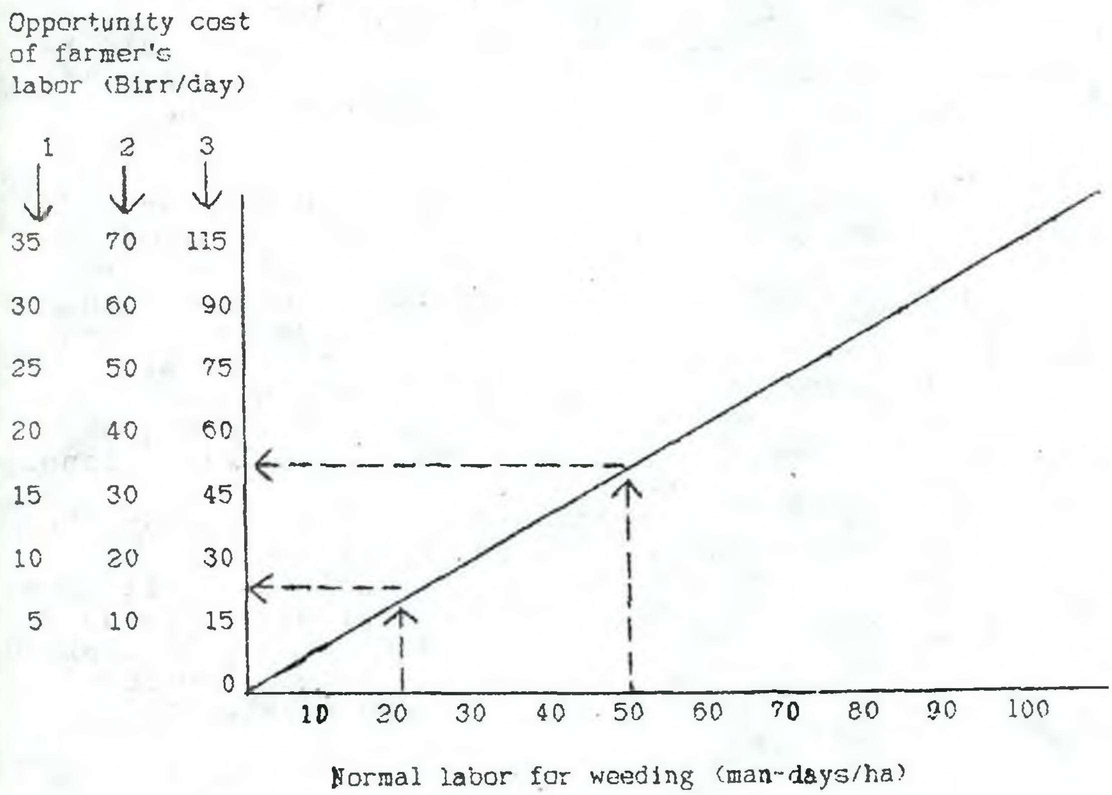
Figure 1: Calculation of acceptable cost of herbicide treatment replacing 75% of hired labor costs, assuming no change in crop yield, and labor cost Birr 2 per day*.



* Formula: Acceptable cost of herbicide = normal man-days/ha X % man-days saved X daily wage

eg. 30 = 20 X 75/100 X 2

Figure 2: Calculation of acceptable cost of herbicide treatment replacing 75% of the farmer's own labor, assuming no change in crop value, and 100% return on investment (at 3 levels of opportunity cost)*



* Formula: Acceptable cost of herbicide =

normal man-days/ha X % man-days saved X labor value X discount factor

e.g. 15 = 20 X 75% X 2 X 0.5

Birr 2 per day assumption the acceptable cost of herbicide is only half that in Figure 1. This is because the purchase of herbicide represents an extra investment (rather than simply diverting spending from hired labor to herbicide) and there must be some element of profit on that investment to cover the costs of capital, risk etc. (Perrin et al, 1976). The return on investment that we propose should be applied is the commonly suggested 100% return. Hence the net marginal benefit has to be twice the cost of the treatment.

Taking once again the norm of 20 to 50 man-days of labor, we see in Figure 2 that the acceptable cost of herbicide replacing the farmer's own labor will vary from Birr 7.5 to 50, depending on the opportunity cost placed on his labor. Only the relatively inexpensive herbicides are therefore likely to be justified where they merely replace the farmer's labor. But, for certain crops especially tef, the man-days often exceed 50 and higher investment could therefore be justified in some situations.

The possibilities for minimum or zero tillage have been discussed elsewhere in this workshop, and it may be emphasized that herbicide use could be justified if it helps to replace pre-planting labor. The concept of 25% labor being retained for supplementary weeding should be applied in this case also, as some labor may be needed to remove weeds before planting, which have not been completely destroyed by herbicide.

Increased crop yield

Some might argue that the farmer's own labor should not be costed at all, but this does not necessarily mean that herbicides cannot be economic for him, because if he does not have the time to weed adequately, he will be suffering crop loss which might be prevented by herbicide. And even if he has time to weed frequently, he may still not be obtaining optimum crop yield because:

a) wet conditions may mean weeds do not die and almost immediately regrow and compete again for light or nutrients, or

b) he may be damaging his crop in the process of weeding. The latter possibility is particularly apparent from Table 1 in which yields of faba bean were reduced by increased frequency of weeding, presumably because of mechanical damage and extra water-logging from soil compaction.

The inadequacy of hand weeding, even when done according to recommendation is strikingly shown in Table 3 where yields of maize were increased by many quintals per hectare, by the use of a good pre-emergence herbicide which prevented weed competition in the early stages, without crop damage.

The soundness of the standard recommendation to start hand-weeding at 30 days is also called seriously into question. It is almost certainly too late for maize and sorghum and many other crops too. It may now be argued that the farmers should in fact weed earlier and that the herbicide would not then show any advantage, but as already pointed out by Franzel et al (1987) at this workshop, the farmer has great pressures on his time during the main season for weeding and is very unlikely to be able to find the time to weed earlier. We believe therefore that, whilst the recommendation for weeding at 30 days (with or without a later weeding, depending on the crop and weed problem) is not the ideal for optimum crop yield, it is a target to which the farmer can realistically aim, but will not always be able to improve upon.

Table 3. Benefits from herbicide use in maize and sorghum

MAIZE at Bako, 1982-85 (from Dawit M. unpublished)

Treatment	Yield q/ha 1982	1984	1985	Mean	
Unweeded	13.3	11.7	53.2	32.4	
Weeded x 2	20.3	32.4	64.8	48.5	
Atrazine/metolachlor, at 2.0*	28.9	39.9	74.1	57.0	+17%
S.E.	3.6	3.8	5.4	4.7	

MAIZE at Bako, 1985 (unreplicated half-hectare plots, Dawit, M. unpublished)

Normal weeding	63.0	
Atrazine, at 2.0*	68.8	+9%

MAIZE at Ambo, 1982-85 (from SPL, 1986)

	1982	1983	1984	1985	Mean	
Weeded x 2	55.9	24.8	9.1	28.2	29.5	
Atrazine/metolachlor, at 2.0*	57.2	30.9	12.0	38.7	34.7	+18%

SORGHUM at Bako 1982-85 (from Dawit M., unpublished)

	1982	1983	1984	1985	Mean	
Unweeded	16.0	13.4	14.9	22.3	17.2	
Weeded	14.6	25.3	35.9	26.8	22.2	
Atrazine, at 1.75*	42.7	33.8	37.7	33.5	36.6	+65%
S.E.	6.1	6.4	1.8	3.6	2.8	

SORGHUM at Bako, 1982-85 (from Dawit, M. unpublished)

	1982	1984	1985	Mean	
Unweeded	7.8	16.9	20.9	15.2	
Weeded	20.3	35.9	40.2	32.1	
Atrazine, at 2.0*	34.5	34.7	38.7	36.0	+ 12%
S.E.	4.8	4.3	5.0		

* doses are all in kg a.i./ha

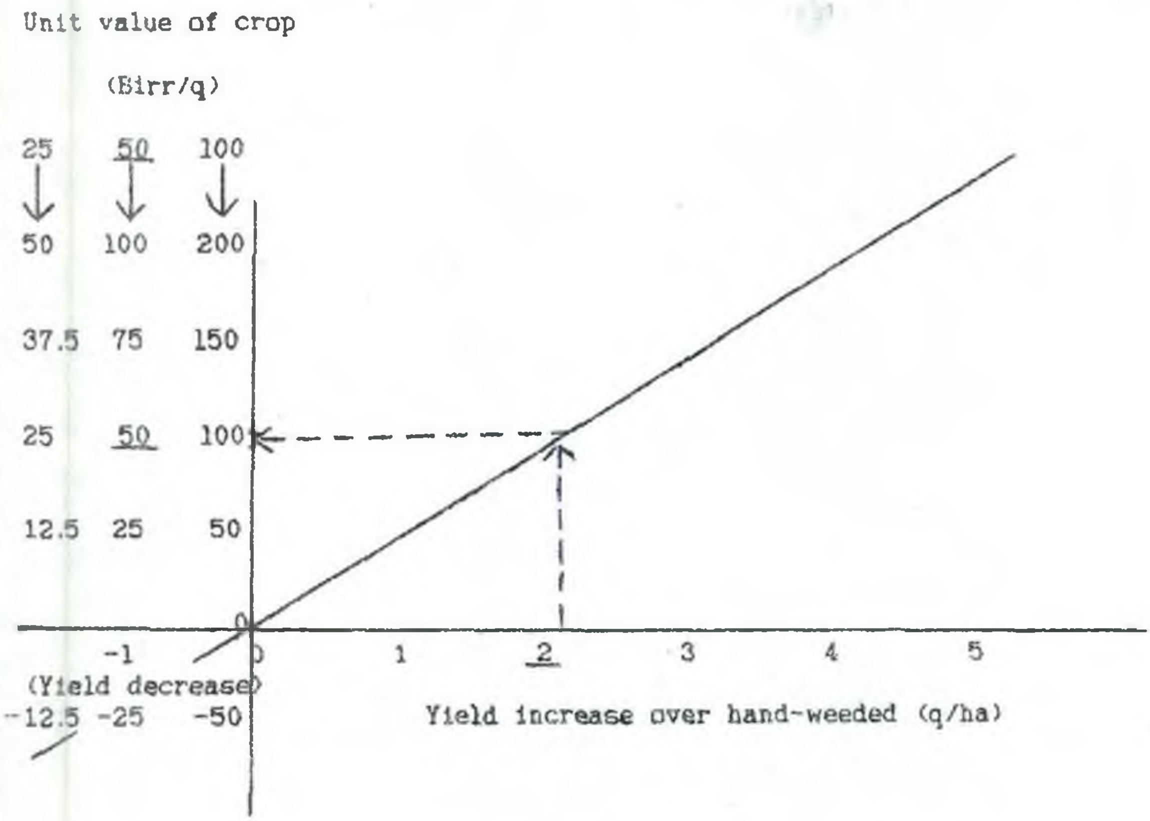
Hence we propose that the use of herbicides on peasant farms in Ethiopia may be justified in many situations on the basis of a clear and economic increase in yield, quite independently of any saving labor.

The acceptable cost of herbicide giving a yield increase will depend on the scale of the increase and the unit value of the crop, and Figure 3 gives these for yield increases on the assumption of three different crop produce prices. It again allows for a 100% return on a crop investment. For example a 1 q/ha yield increase in a crop with unit value Birr 25 per kg would justify only a Birr 12.5 investment in herbicide, on the basis of the yield increase only. If it is felt justified to cost an additional saving in labor, then that figure can be added. If the farmer normally spends 40 man-days weeding and we place a Birr 1 per day value on the opportunity cost of his labor, Figure 2 gives an additional 'acceptable cost' of Birr 15 per ha (40 days x 0.75 = 30 x 0.5 = 15) which may be added to the 12.5 to give 27.5. It will be noted that Figure 3 allows for a yield decrease due to herbicide. This is obviously not acceptable where only the benefit from crop yield is considered. It may, however, prove acceptable if the negative value of 'acceptable cost' is more than outweighed by an estimated 'acceptable cost' due to saving in labor. The negative value in Figure 3 would have to be deducted from any positive value deduced from Figure 2.

As most of the published information on crop yield response to weeding and herbicide use is expressed in % terms, an alternative Figure 4 has been prepared which allows calculation from those percentage data. A more detailed range of possible crop values are also included. This figure helps to emphasise how important it is to consider the absolute yield levels rather than just percentages when considering the likely economic benefit of herbicide use.. A 5% increase in a crop yielding 30 q/ha will justify a greater expenditure on herbicide than a 20% increase in a crop yielding 5 q/ha. Once again negative values are included to allow for perhaps an inexpensive herbicide giving slightly lower yield but resulting in a large saving in labor.

Table 4 shows that yield increases from herbicide use are not so often apparent with the small grain cereals in which mainly post-emergence herbicides are used. This is not too surprising, as there is not the removal of weed competition in the early weeks which contributes so importantly to the benefits from atrazine etc. in maize and sorghum. Where terbutryne was used pre-emergence, however, there have been good examples of yield increases in barley and wheat at Ambo, and the substantial yield increase in tef from use of the pre-planting herbicide 'Gesaten' shows how useful a good pre-emergence herbicide for this crop might be.

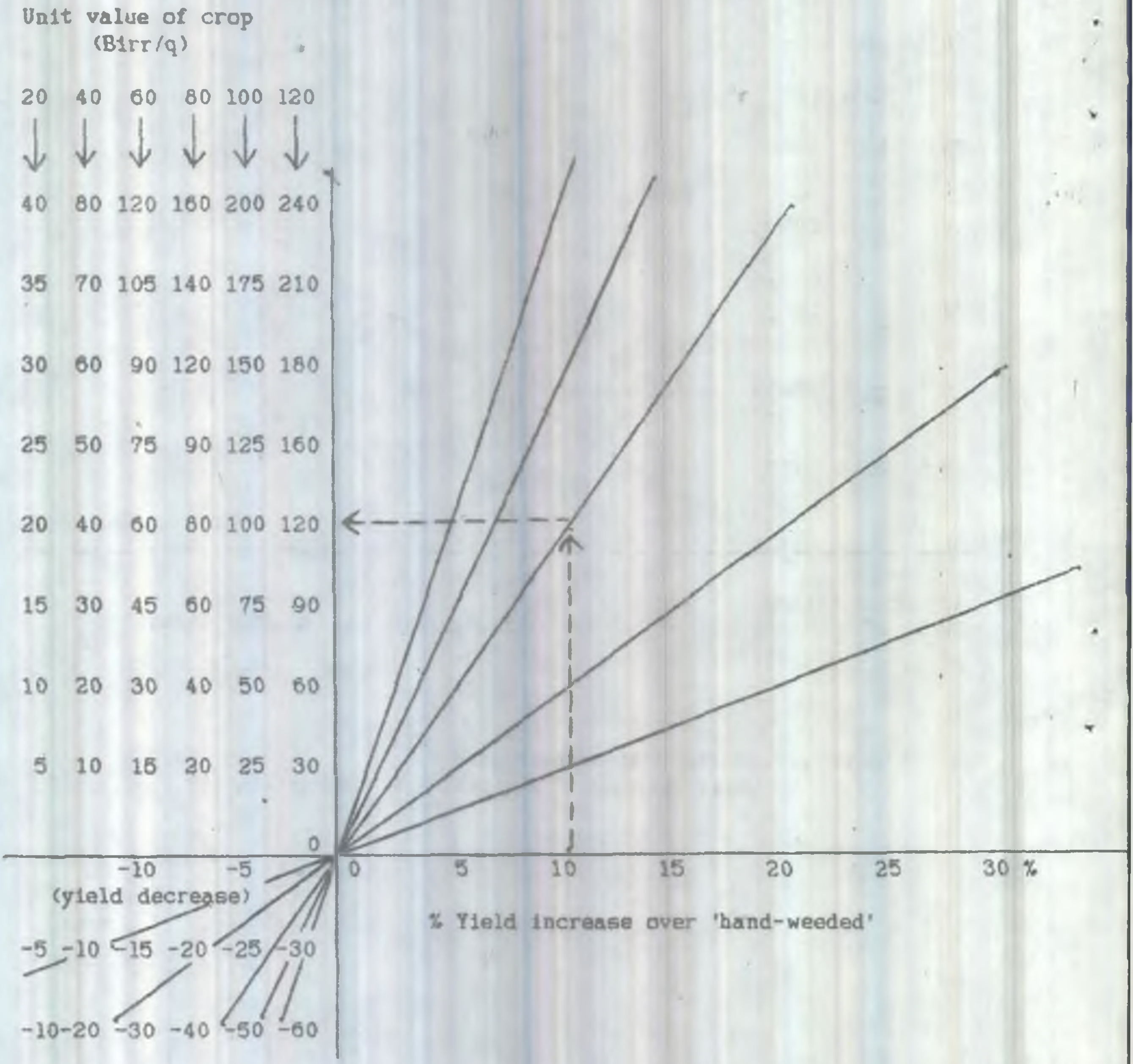
Figure 3: Acceptable cost of herbicide treatment resulting in increased in yield (ignoring savings in labor for weeding) at 3 levels of crop value*



* Formula: Acceptable cost of herbicide = yield increase X unit value X discount factor

e.g. 50 = 2 X 50 X 0.5

Figure 4: Calculation of acceptable cost of herbicide treatment (Birr/ha) assuming 100% return on investment, and ignoring savings in labor for weeding*



* Formula: Acceptable cost of herbicide = % yield increase X base yield X unit value X discount factor

e.g. 60 = 10% X 20 X 60 X 0.5

Table 4. Results from herbicide use in small-grain cereals

WHEAT at Ambo, 1982-84. (from SPL, 1986)						
	Grain yield (q/ha)					
Treatment	1982	1983	1984	Mean		
Unweeded	21.8					
Weeded x 2	29.5	11.7	14.7	18.6		
Terbutryne 1 kg a.i./ha	28.0	12.9	30.4	23.8	+28%	
2,4-D 1 kg a.i./ha		10.2	11.5			
WHEAT at Debre Zeit, 1978 (from AAU, undated)						
Unweeded	2.79					
Weeded x 1	3.89					
2,4-D 1.5 l/ha	3.37	-13%				
BARLEY at Ambo, 1981-84 (from SPL, 1985)						
	1981	1982	1983	1984	Mean	
Unweeded	18.7	21.4	4.5	3.7	12.1	
Weeded x 2	28.2	25.9	7.5	5.1	16.7	
Terbutryne 0.75-1 kg a.i./ha	27.8	28.5	8.5	7.2	18.0	+2%
L.S.D. (5%)	3.6	4.4	0.7	1.3		
TEF at Kulumsa, 1969 (from CADU, 1969, p.87)						
Unweeded	1.40					
Hand-weeded	2.02		LSD (5%) = 0.30			
MCPA	2.18	+8%				
TEF at Kulumsa, 1970 (from CADU, 1971, p.75)						
Unweeded	1.23					
Hand-weeded	2.17		LSD (5%) = 0.26			
MCPA 0.6 kg/ha	1.80	-17%				
TEF at Kulumsa, 1970 (from CADU, 1971, p.77)						
Unweeded	0.59					
Hand-weeded	1.93		LSD (5%) = 0.16			
Dichlorprop 2 kg/ha	2.03	+5%				
L.S.D. (5%)	0.16					
TEF at Debre Zeit, 1978 (from AAU, undated, p.46)						
Unweeded	0.68					
Weeded x 1	1.24					
Weeded x 2	1.53		LSD (5%) = 0.51			
Gesaten 3 kg/ha	1.93	+26%				

CONCLUSIONS

From the data and calculations presented above, it may be calculated that herbicides costing up to Birr 60 per ha are likely to be widely suitable economically, simply for replacing hired labor on the larger farms, and more expensive compounds may be acceptable where higher than average labor input is needed.

On small farms where labor is not normally hired, but is sufficiently available within the family to prevent weed competition, only the cheaper herbicides costing up to about Birr 30 per ha are likely to be justified.

Where the family labor is inadequate, or is over-stretched at the time that weeding is needed, or when wet conditions prevent efficient weeding, there is very likely to be a yield increase by herbicide use, over that achieved under 'farmer practice'. In these cases, a considerably higher cost of herbicide may be justified. To say just how common these situations are likely to be, and in which crops, is very difficult to predict. The data quoted above show how variable the benefits can be, and much of that available does not tell us what the benefits are likely to be in farmer practice. The sort of further information that we need is a) more survey data on actual farmer practices, in terms of timing and total man-days of labor devoted to weeding, and b) yield data from trials in which highly effective herbicides, with supplementary hand-weeding, are compared with realistic 'farmer practice', which is so often less than ideal for preventing at least moderate weed competition. If the farmer normally does no weeding, then it is valid and useful to determine by suitable weeding and/or herbicide treatment how much loss is occurring as compared with no weeding. Where the farmer is normally doing only one rather late weeding, then this is the 'control' against which herbicide or other improved practice should be compared. Evidence for increased yield due to herbicide use will be of particular value in presenting a case for the import-substitution value of herbicides, and hence the economic benefit of herbicides at the national level as well as at the farmer level.

This paper does not set out to propose that herbicides should necessarily be widely used in Ethiopia, and we believe that much can be done to improve the effectiveness of the farmer's limited labor, without chemical use. We hope, however, that the approaches suggested for calculating the economics of herbicide use, and the suggestions for further trial, will contribute to some logical development of herbicide use in the crops and situations where they will have the greatest impact on farmers' productivity and hence contribute to the country's drive for food self-sufficiency.

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THE STATUS OF HERBICIDES ON STATE FARMS

Shewarega Berhanu[1/]

ABSTRACT

Herbicides are used on over 85% of the wheat and barley area of the State Farms and on a large proportion of the maize. Smaller area of cotton, haricot bean and rapeseed are also treated. About 90% is applied by aircraft. The range of herbicides used in 1986 is listed. Selection of herbicides is based on research results from IAR and other research institutions and adaptive trials of the staff of MSFD over a 3 to 4 year period. The finally recommended herbicides are obtained from suppliers by direct tender.

INTRODUCTION

In the 1987 crop season MSFD has planned to cultivate a total of 222,819 ha. Of the total planned production wheat and barley make-up 35.7%, maize and sorghum 34.0%, cotton 19.6%, pulses and oil crops 4.2%, vegetables and fruits 2.6% and others 3.9%. These crops are produced both under irrigated and rainfed conditions. Although some progress is being made in the irrigated cotton farms, it has not been possible to attain targeted yields for the majority of rainfed field crops. Out of the many main causes for low productivity, the weed competition is identified to be one.

Weeds by their nature are very prolific in multiplication and excessively competitive for soil moisture, nutrient and light. As a result of weed survey, collection and identification the major weed species responsible for yield reduction in state farms include both broad leaved and grass weeds. Eventhough it is hard to present figures which indicate the extent of yield loss due to weed competition in state farms, crop stunting, yellowing, thin population of crops etc. have been observed.

There is a tendency for weed infestation to increase every season especially in farms where the seedbed preparation is poorly done, where uncleaned seed materials are used and

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where proper weed control activities are neglected. Most of the field crops are produced as mono-crops, which is an additional factor responsible for the fast increases of certain specific weeds. Mono-cropping system makes weed control measures very difficult and expensive. Out of the many different universally accepted weed control methods both cultural and chemical methods are adopted in state farms.

CHEMICAL WEED CONTROL

Traditionally, weed control in Ethiopia has been mainly done manually and to some extent mechanically. Recent observation points to a rapidly changing emphasis towards chemical weed control methods. This is noticeable in mechanized farming situations where the trend of labor shortage is becoming apparent and herbicides are replacing manual labor. A relative seasonal and regional labor shortage in the different state farms has stimulated the use of herbicides.

Eventhough, the most obvious method of dealing with weed problem is chemical control, it is always regarded as a last resort. This is because chemicals are often indispensible as immediate remedies but, they will not replace good husbandry. It is worth mentioning our experience in which repeated application of broad-leaved-controlling-herbicides in cereal growing state farms has been responsible for creating grass weed problem.

In the state farms, different kinds of herbicides are recommended for wheat and barley, maize, pulse, oil crops, cotton, citrus and vegetables.

Wheat and barley

In the wheat growing regions the complexity and population density of weeds varies from farm to farm. Over 85% of the total wheat and barley cultivated area is receiving application of broad-leaved weed herbicides while about 35% is treated for grass weed control as well. At present we have four different groups of herbicides recommended for the control of broad-leaves and for grass weeds (see Table 1). These herbicides range from the simplest phenoxy derivatives to the most sophisticated herbicide combination of hydro-benzonitriles (HBN).

These products are utilized according to their merit, that is the weed infestation level and complexity dictates the selection to be sprayed on each farm. In addition cost/benefit analysis is excercised in the selection of the products and their implementation.

Table 1. List of herbicides recommended in MSFD

Crop	HERBICIDE		Product rate l or kg/ha	Application time
	Common name	Trade name		
Wheat & barley	Ioxynil + bromoxynil + CMPP	Brittox 52.5%	2.5	Post - emergence
(Annual broad-leaved weeds)	Ioxynil + bromoxynil + CMPP	Swipe 560 F.L.	3.-	" "
	Fluroxypr + chlopyralid + Ioxynil + bromoxynil	Sterane 728	2.-	" "
	Bromoxynil	Brominal 24% EC	2.-	" "
	Mecoprop + 2.4 D	U46 D.K.V. fluid 600 + U46 D fluid 720 g/l	2.5 + 1.-	" "
	Mecoprop	Compitox plus	3.5	" "
	Mecoprop	Iso - Cornox 570	3.5	" "
	Mecoprop + 2.4 D	Polymon 60	3.4	" "
Wheat & barley (Annual grasses)	Diclofop - methyl	Illoxan 28% EC	2.5	Post - emergence
	Tralkoxydim	Grasp 10%	3.5	" "
	Barban	Carbyne 2E	1.75	" "
	Difenzoquat methyl	Avenge 250	3.-	" "
Haricot bean (Complex weeds)	Metolachlor	Dual 960	1.75	Pre - emergence
Maize (Annual broad leaved and grasses)	Metolachlor + atrazine	Primagram 250/250	5.-	Pre - emergence
	Metolachlor + atrazine	Primextra 330/170	5.-	" "
	Alachlor + atrazine	Lasso/Atrazine 336/144		" "
	Alachlor + atrazine	Alanex + Atranex 48/50	4 + 1.7	" "
	Atrazine	Atrazine 500 g/e	5.-	Post - emergence

Table 1. continued

Crop	HERBICIDE		Product rate l or kg/ha	Application time
	Common name	Trade name		
Cereals (Minimum tillage)	Glyphosate	Round-up 48% EC	4.-	Post - emergence
	Paraquat	Gramoxone 20% EC	3.-	" "
Cotton (Complex weeds)	Prometryne + metolachlor	Codal 400 EC	6.5	Pre - emergence
	Oxadizon + diuron	Ronstar/Diuron	3.-	" "
Rapeseed (Grass weeds)	Fluaziofop - butyl	Fusilade Super 12.5%	2.-	Post - emergence
	Haloxyfop	Gallant 25%	2.-	" "
	Metolachlor	Dual 960	1.75	Pre - emergence
	Alachlor	Lasso 48% E.C.	5.-	" "

Maize

The maize growing regions under the state farms are found within different climatic conditions ranging from high altitude having abundant rainfall and the lowland with moderate rainfall. The weed flora composition also varies, grass weeds being the major problem in high altitude farms. At present different range of products are recommended which have an outstanding performance on broad-leaved weeds (Table 1), but the problem of grass weeds remains unsolved.

Cotton

In general, all cotton producing state farms more or less follow similar cultural practice with the exception that either the system of pre-irrigation or of dry-planting is adopted. In pre-irrigated farms the weeds are stimulated to germinate and are cultivated soon before planting. This system helps in a substantial reduction of the weed problem. The major weed problem then remains to be the late-emerging ones which interfere with the efficiency of harvesting.

In the dry-planted cotton farms the weed problem starts early in the season and then extends till harvesting. Because of this reason the dry-planted cotton farms are practicing chemical control.

Herbicide application methods

For the application of herbicides, ground sprayers either tractor pulled or mounted and air-craft are used in the state farms. About 85-90% of the total herbicide application is by air-craft. There are a number of advantages to the use of air-craft over ground equipment. The most important factor in the preference of aerial application is that herbicide spraying can be done at the right time with a maximum possible coverage of the required quantity of the product to the target. Spraying can be done irrespective of soil condition, steep grades and difficult terrain. Crops are not damaged and soil compaction will not be a problem when treated aerially. The use of air-craft is, however, dependant on the prevailing meteorological conditions, and high temperature and low relative humidity restrict use. Wind velocity should not exceed 3.5 m/sec because of drift.

During the application of herbicides certain precautions for the safety of operators are made. All ground support crew, mixers, loaders and flagmen are required to wear protective devices in order to reduce the risk of contamination with herbicides. The crew who have been engaged in this operation are subjected to medical check-up in order to investigate if they are poisoned by the chemicals used during the spraying operation.

Procedures adopted in selection and tendering of herbicides

As far as pesticide registration and control is concerned no policy yet exists at a national level. This has led pesticide-using organizations like MSFD to develop their own internal policy with regard to pesticide importation and registration. As far as plant protection research is concerned Research and Advisory Division (RAD) of the MSFD have the responsibility to conduct adaptive trials based on findings obtained from the national research institutes. Whenever it fails to obtain information from such institutes, RAD has no other alternative except to indulge in the screening trial phase by gathering research result information from other countries. To this effect, chemical agents registered in this country will be notified officially to participate in the programme by supplying herbicide samples. Those interested chemical agents are required to submit technical literature which describe the main features of the product, reliable information on registration outside Ethiopia, documents on FAO-WHO or joint specification and recommendation etc. Those products accepted for trial will be tested under state farm conditions and only products with outstanding performance will be eligible for registration. In the process of evaluating the trial results all data recorded before or at the time of application of the herbicide and in the period between application and completion of the trial are considered. In addition to the treatment effects, both on the weeds and the crop, safety to human beings and animals and ease of application are given particular attention.

At the end of each season RAD holds meetings of crop protection personnel of MSFD in order for researchers to present trial results of completed projects. Those products with a positive result are then considered to be observed on 500 ha. pilot areas at different farms. Then in the coming season it will be registered for use in MSFD depending on the result of the pilot observation being acceptable. All registered products are monitored each season in order to evaluate and to determine if their effectiveness continues and is satisfactory.

In the purchase of herbicides for state farms only products registered in the recommendation list are considered. In order to guarantee the reliability of the products, active material and the solvents, we depend on the chemical manufactureres who participated in the trial programme.

All bid winners are required to supply one litre product sample and 5 gr. of the active material. The purpose of these materials is for counter checking, to confirm that the product is up to the specification tendered.

SESSION V A

STRUCTURED DISCUSSION

On priorities for herbicide research and procedures for the development of safe and reliable herbicide recommendations

Chairman : Mr. D.G. Tanner

Rapporteurs : Ato Ermias Kebede

: Ato Sebsibe Abebie

STRUCTURED DISCUSSION

1. METHODS OF WEED CONTROL

Demisse G. Michael: From Chris Parker's paper, it seems that herbicides are very beneficial, but needs more data on how much yield we can get, on what crops we must use herbicides and how to manage the cost.

Douglas Tanner: I think there should be a standard procedure, weed population should be representative before giving recommendations and there should be centralization of work.

Seifu Ketema: Herbicides were compared in most trials, but other cultural practices should also be included, such as agronomic studies.

Shewarega Birhanu: The state farms also give attention to cultural practices and IPM.

Tibebe Tessema: In coffee they use mulches to reduce weed infestation.

Dereje Ashagari: The state farms are not for chemical weed control, but it is our last resort. We mostly depend on cultural practices such as pre-irrigation in cotton in the Middle Awash farms, in other places we employ good seed-bed preparation and clean seed. As for the question of sufficient evidence for herbicide use, we still need more information from research organizations.

Douglas Tanner: Information are useful to present evidence to policy-makers.

Ann Stroud: For presentation to policy-makers, it is necessary that there should be complete data.

Berhanu Kinfe: In large farms using herbicides is alright. But in peasant farmers sector we have to consider the hard currency and adequate data should be available to justify the use of herbicides. We need to know, for instance, overlap of work, shortage of labor as well as critical time of weed/crop competition.

Messeret Wendimu: We need more information on the frequency of weeding. We do not have to embark on herbicides alone. Practices such as spacing, and hygienic systems should be considered.

Chris Parker: Analysis of the economic impact of the products under use at this moment is necessary.

Tibebu Tessema: There are regulations limiting farmers not to use herbicides. Earlier the prices of crops was very low and EPID was not recommending herbicide use by farmers. But now, since the price of farm products is high, it is payable to use herbicides.

2. PESTICIDE SAFETY

Douglas Tanner: The state farms seem to give attention to safety, but it is possible that in the peasant sector this is not given due attention like someone throws a Gramoxone container and somebody else uses it for watering.

Seifu Ketema: I think Awash river should be analysed like what is done in other countries.

Chris Parker: There are guidelines from FAO and other organizations. As for Ethiopia, there should be a regulation for importation and usage of pesticides.

Demisse G.Michael: In cooperative farms we are in a better position because there are people to be consulted/adviced, trained in Agarfa. But the problem is with the settlers.

Ann Stroud: Fact sheets are being prepared for caliberation of sprayers and usage of herbicides. However, labeling in Amharic and English is very necessary.

Dereje Ashagari: Until national regulations come out, we have to inform the chemical companies need for labeling. Professional committees should prepare guidelines in Amharic.

Mesfin Tadesse: Selectivity and efficiency of herbicides should be considered thoroughly.

3. PRIORITIZATION IN RESEARCH

Mesfin Tadesse: Weed species must be thoroughly studied.

Ermias Kebede: There is a need for more taxonomists for weed identification.

Douglas Tanner: This should be looked together with the collaboration with breeders and agronomists.

4. PROCEDURES

Douglas Tanner: Informations should be available from trial sites.

Hailu G.Mariam: Information from outside is necessary. The participation of chemical companies in trials outside research stations is very low or not at all. Thus, in the further this should be given due attention.

Sebsibe Abebie: We have very good communication with the state farms. We assist them in bringing application experts and other specialists.

Dereje Ashagari: We need to organize ourselves in order to get support from chemical companies, like that in other countries.

Tibebu Tessema: It seems that weeds are developing resistance to herbicides in coffee through repeated use of the same compounds.

Douglas Tanner: Monocropping should be given due attention.

Shewarega Birhanu: Weeds that were not controlled at the time will develop resistance gradually.

SESSION VB

BIOLOGICAL CONTROL OF WEEDS

Chairman : Mr. D. G. Tanner

Rapporteur : Ato Ababu Demissie

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

THE POTENTIAL FOR BIOLOGICAL CONTROL OF WEEDS IN ETHIOPIA

Tadesse Gebremedhin and Chris Parker[1/]

ABSTRACT

The history of biological control work in weeds and outstanding examples of successes elsewhere, but of relevance to Ethiopia, are reviewed. The risks which could be involved in biocontrol work, particularly with regard to the classical approach; and procedures for safety precautions are indicated. The possibilities and the potential of biological control of parasitic and non-parasitic weeds that exist in Ethiopia and how to use either the inundative or classical approach are suggested.

INTRODUCTION

Biocontrol is the use of living organisms for the management of other harmful or noxious organisms such as weeds. The objective of biocontrol of weeds is the reduction of densities to non-economic levels. Great stress has been placed on the action of insects which attack seeds or flowers or which bore in the roots and stems. Any organism which curtails the growth or reproduction may be used as a biological weed control agent; such could potentially include animals either higher or lower than insects and, as well, parasitic higher plants, fungi, bacteria and viruses (DeBach, 1970).

The first published report on the deliberate use of insects to control unwanted plant species or the use of insects in the biological control of weeds was made by Perkins and Swezey (1924) of the work undertaken in 1902 in Hawaii, where Lantana camara, an introduced ornamental plant, had escaped cultivation and had taken over large areas of rangeland that was causing great concern. Up to 1979, biocontrol had been used in some 44 countries against some 86 species of weeds and satisfactory control was achieved on at least 49 occasions (Julien, 1982). One of the most outstanding recent successes has been with Salvinia molesta, one of the world's worst aquatic weeds on which biological

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control using a beetle has become a reality (Thomas and Room, 1986). Most of these results were obtained using insects but plant pathogens are now being more widely considered (Hasan, 1983).

Whereas most of the earlier examples involved the introduction of exotic organisms (the classical approach) usually to control exotic weeds that had come in without their damaging insect companions, there is now increased interest and exploitation of biological control employing native organisms, (inundative approach) for short-term weed suppression, especially using "mycoherbicides" which are developed from pathogens that incite disease at endemic levels in specific weed populations (Templeton, 1985). Biocontrol is most appropriate for the suppression of perennial weeds in non-arable situations such as rangeland, where herbicidal control would be uneconomic, but it can also be effective in other situations where there is a single dominant weed species (Greathead, 1985).

RISKS INVOLVED IN THE BIOCONTROL OF WEEDS

Biological weed control involves significant risks. There are no absolute guarantees of safety. The risks are relative to the degree of host specificity and specialization of the agents to be introduced and the botanical position or special features of the weed; weeds related to cultivated crops pose the greatest risks (DeBach, 1970). Therefore, in the biocontrol of weeds, safety is the prime consideration.

The risks of the classical approach involving importation of exotic organisms is naturally considerable and great care has to be taken to ensure that the organisms do not transfer to other more desirable species. Therefore, most countries which desire to try this method of weed control require that potential biocontrol agents are screened to determine, beyond all reasonable doubt, that they will not damage any desirable plant after release in a given area where control of the target weed is required (CIBC, 1978 a).

An advantage of the recent mycoherbicide developments is that they can and generally do involve indigenous fungal organisms which are not new to a given locality. There is not, therefore, the same risk, as with introduced organisms, that they will unexpectedly spread and/or attack crop plants. Their release may still involve some increased risk to crops, but this can be readily checked in short-term trials.

A classical biological control programme in weeds can have four major activities:

1. Study of available literature and identification of potential exotic organisms for importation to Ethiopia,

2. Importation under quarantine and any host specificity tests and separation of parasites as may be needed,

3. Field release and monitoring (CIBC, 1978 a),

4. If organisms are not yet identified for specific and important local weed problem, it may, with the necessary funding, be possible to arrange for exploration surveys and collection of potential agents in appropriate areas abroad.

For the inundative approach, based on indigenous organisms, the activities would be:

1. Survey and identification of suitable organisms,

2. Testing effectiveness and host specificity,

3. Developing methods for the propagation of biocontrol agents suitable for release, and

4. Release and monitoring.

EXAMPLES OF SUCCESSFUL BIOLOGICAL CONTROL IN WEEDS OF RELEVANCE TO ETHIOPIA

(1) Water hyacinth (Eichhornia crassipes)

The water hyacinth is a free-floating aquatic plant native to the northern part of South America. The introduction and rapid spread of this plant in the White Nile system has produced serious problems for the use of that river as a resource. Therefore, a biological control programme was started in 1979 by the introduction of natural enemies of the weed, such as Neochetina weevils which were successfully established spreading in the river system (Irving and Beshir, 1982). The establishment of the weevil, Neochetina eichhorniae at all sites surveyed along the Nile Valley in the Sudan with 100% damage of plants was confirmed by Beshir (CIBC, 1985). The effectiveness of the insects may be enhanced naturally as well as artificially by the additional effect of fungal infection (Galbraith, 1984). This could be one of the means of water hyacinth control to be considered in some parts of the Awash River and Fincha Dam.

(2) Dodders (Cuscuta spp.)

These are parasitic weeds which grow in such intimate relationship with the host plant that control of these weeds becomes a hopeless task.

Biological control efforts elsewhere show that insects such as Melanagromyza cuscutae and fungal pathogens such as Alternaria cuscutacidae have been identified to be promising and specific to Cuscuta spp. (Greathead, 1985); though they have not yet been applied successfully in practice, they should be considered for future introductions.

(3) Broomrapes (Orobanche spp.)

Orobanche is an important parasitic weed on many types of cultivated plants. Effective biological control work was carried out in the USSR with Phytomyza orobanchia (Agromyzidae) and the fungus Fusarium oxysporum var. orthoceras in tobacco and tomato (Greathead, 1985). Promising results were also obtained with Phytomyza orobanchia in Yugoslavia in the reduction of broomrapes (Mihajlovic, 1986). This species of fly occurs widely in Ethiopia and could perhaps be exploited by the inundative approach. Another insect (Psila sp.) has been identified causing similar damage but requires further study; the possibility of using Fusarium sp. is already being explored by IAR.

(4) Witchweeds (Striga spp.)

These are parasitic weeds on crop plants, particularly cereals in the tropics and sub-tropics. It appears that there has not yet been any practical application of biological control attempts to suppress Striga spp. However, observations on Striga spp. infestations by C. Parker in 1977 in the Sahel region of Western Africa suggest that insect damage may be of greater significance in which up to 80% destruction of fruits of Striga hermonthica by weevil larvae (Smicronyx spp.) has been recorded (CIBC, 1978 b).

Some limited survey conducted in Ethiopia on Striga spp. did not detect significant insect damage. Thus, two insect species, Eulocastra argentisparsa (Lepidoptera: (pyralidae) and Smicronyx albovariegatus (Coleoptera:) curculionidae) were introduced from India and liberated in Striga infested sorghum fields in Humera during the 1974 crop season. However, prevailing situations in that area did not allow the follow up of the establishment of these biocontrol agents. On the other hand, related species of the weevil, S. umbrinus and Baris sp. were recorded on Striga near Asteromariam, Gojam; S. albovariegatus was also collected from other parts of the country from this weed, which suggests that Smicronyx may not be exotic to Ethiopia, probably it occurs naturally in the country but does not give adequate control (Tsedeke, 1985).

Again in 1978 Eulocastra and Smicronyx were introduced to Kobo from India. One year later a survey was conducted and it was confirmed, through specimens sent to CIE, that Smicronyx albovariegatus was established but Eulocastra was not. The effect of the weevil was not assessed in the subsequent years because of the drought periods that prevailed. Attempts should be made to reinitiate the work through exploration, collection or even introduction of successful biocontrol agents in order to suppress Striga in the overall management of this weed.

(5) Rottboellia cochinchinensis (= R. exaltata)

This is a very serious grass weed with hairy stems rendering it difficult for hand-pulling. It is under study in the U.K. for possible control by fungal mycoherbicide and it is hoped to arrange survey work to identify any indigenous fungi which might be considered in future biocontrol programmes.

BIOLOGICAL CONTROL POSSIBILITIES

There are some parasitic and non-parasitic, very noxious weeds in Ethiopia for which biological control attempts can be made. Examples of such weeds are Striga spp., Orobanche spp., Cuscuta spp., Eichhornia crassipes, Opuntia spp., Lantana camara and Rottboellia cochinchinensis.

Inundative techniques can be pursued without specialized facilities or procedures, and it is envisaged to pursue possibilities on Orobanche, Striga and Rottboellia. Therefore, focus should be made on the survey for indigenous, potential biocontrol agents which may be available in the country associated with the above mentioned serious weeds. If efficient agents are identified on any of these weeds, specificity tests can be carried out to ensure safety before one can embark on mass release of multiplied promising biocontrol agents.

For classical approach, for example on Eichhornia and Striga both specialized facilities and procedures are needed. In this context it is time that the country had a clear policy and regulations related to quarantine and importation of exotic organisms. Regarding facilities, these might only be justified on the basis of clear need and potential.

At any rate, in order to conduct an efficient biological control work on weeds, the necessary manpower and facilities must be available. In the mean time, it is suggested that a biocontrol expert should, perhaps, be engaged for a short period as a consultant to give the necessary guidance.

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SESSION VI

Extension

Training

Chairman : Ato Takele Gebre

Rapporteur : Ato Adugna Haile

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

RESEARCH ACTIVITIES NEEDED BY EXTENSION TO PROMOTE APPROPRIATE WEED MANAGEMENT TECHNOLOGY FOR SMALL FARMERS AND COOPERATIVES

Ann Stroud[1/]

ABSTRACT

In order to have successful technology transfer, a reliable extension service as well as appropriate technology from research must be present. To support the new "Food Crop Self Sufficiency Program", a modified Training and Visit extension service is being implemented. Suggested inputs concerning weed management from research are: yearly updated recommendation with economic data based on research using a farming systems perspective and multilocational testing; a protocol for testing herbicides; an increased priority to personnel and resource allocation for weed research; an integrated approach including agronomy, chemical and mechanical controls; and greater emphasis on weed biology. Areas and methods of coordinating with the Ministry of Agriculture, Crop Protection Department weed unit specifically include: a yearly joint planning meeting concerning research and extension activities on weeds; joint participation in weed surveys; continued exchange of reports and literature; training inputs by research into the extension system.

INTRODUCTION

This year the Ministry of Agriculture (MOA) has embarked on a "Self Sufficiency in Food Crops Program". Initially 148 woredas have been chosen as potentially surplus producing areas. This will increase to 182 woredas by 1989. These areas are targeted to have concentrated services such as increased extension efforts and input supplies to help reach the goal of self-sufficiency. A modified training and visit (T & V) extension management system is being imposed. Crop protection and production subject matter specialists (SMS) based at the awraja level will receive intensive training on recommended agronomic and crop

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protection practices including weed management, and will organize subsequent trainings for woreda staff. An organized system will ensure timely and frequent visits to farmers in order to pass messages concerning recommendations. This new program has given impetus to the various MOA departments, such as Crop Protection, Agricultural Development (ADD) and Extension to organize themselves to ensure coordination and cooperation. This will certainly be strengthened further as the new emphasis goes forward.

One of the major roles of the Crop Protection Department is to take information from research and pass it to extension where it will be translated into a form farmers can use. Theoretically, the department is also in the position to collect extension's feedback from farmers concerning technology needs and recommendation successes and failures. In order for technology transfer to be successful, we need qualified extension staff, an effective technology transfer system with good research extension linkages. Relevant innovations, support from the policy sector credit, input supply, marketing mechanisms among others. The new modified T & V extension system should help to give the extensionist direction with primary emphasis on transfering technology. A successful T & V system, however, assumes that relevant research information is forthcoming (Agricultural Administration Network, 1986). "A continuing interaction between research and extension strengthens the possibility of conducting relevant research and the dissemination of research-based findings. An effective linkage between research and extension, therefore, is considered critical to an effective technology development and transfer system" (Sigman and Swanson, 1984).

Weed science, as a discipline, has suffered throughout Africa in particular, from the lack of well-trained research and extension personnel. In Ethiopia, as in other countries, there have been relatively few resources, in research and extension, designated towards solving weed problems. It has been assumed that weed control problems can be easily solved using abundant labor. However, regardless of this resource, crop losses ranging from 10 - 50% due to weed competition continue. This is primarily due to 'labor bottlenecks', many activities competing for labor simultaneously, which result in untimely or no weeding. Greater emphasis on economic solutions to weed problems can increase yields, transfer labor to other beneficial activities and improve the quality of life.

The farmer is our target and our consumer. "If the extension agent cannot provide the necessary and appropriate answers to a farmer's questions, or if he gives wrong advice, the farmer is going to suffer and the extension agent is going to lose his confidence." For research and extension to be relevant to the problems of farmers, requires mechanisms that increase the likelihood that the resulting innovations are capable of solving farmer's problems, whatever the environment. Generally, the failure of adoption of any method can be due to: no technology given; technology given is not valid because there is no economic advantage, it is not important to the farmer or it may have been developed in an environment different from the farmers and is not transferable; or to the inability to teach farmers to use it (Chaudry and Al-Haj, 1985). Obviously, in successful technology transfer, there must be a good system to transfer it (extension) as well as good technology (research). It is the purpose of this paper to address the question of what the extension worker needs from the IAR in terms of weed research, in order to move towards the goal of self-sufficiency.

SPECIFIC RESEARCH NEEDS AND APPROACHES

Yearly Updated Recommendations

Extension's greatest need is for IAR to publish weed management recommendations based on a review of past research by crop and by problem weed. This can then be updated on a yearly basis. These should provide various economic options including herbicides and cultural control measures as well as be able to suggest under which conditions any given recommendation should be used. There is a need to avoid 'blanket' recommendations, which make no concessions to varied economic circumstances and widely different farming systems. Research input using a farming systems perspective is very important particularly in situations where extensionists do not have sufficient background and where centralized systems make it easier to give 'blanket' recommendations to farmers. This will also happen when the research information is not there. A reasonable research approach can make up for extension deficiency until the staff become better trained and experienced (Agricultural Administration Network, 1986). The recommendations should be accompanied by economic data including the assumed costs used in the calculations. This information concerning all types of weed control and integration of methods, can be translated into extension messages by the Crop Protection Department, Weed Unit and used in the new T & V system.

Use of the Farming Systems Approach

"Farming in most developing countries is more than simply a business. For small scale subsistence farmers and their families it is a way of life that has evolved over time, often centuries. Such rural populations have experimented with nature, manipulating resources, and adjusting human culture and technology to the demands of their physical environment. They have through trial and error, learned to arrange themselves socially and psychologically in order to successfully execute the mundane tasks of day-to-day farming. The agricultural systems encountered around the world today are logical out comes of such time-tested adaptations. They are in a sense rational " (Rhodes, 1982). Many present day researchers feel that research should take existing indigenous practices as its starting point, seeking to refine these in various ways and then to feed the results back into the system (Howes and Chambers, 1979). Innovations developed by research, therefore, must come from understanding the farming system and ultimately be tested within this system for their relevance to the farmer's environment.

This realistic and sensible philosophy, usually termed Farming Systems Research (FSR), is quickly being adopted by researchers throughout the region, including Ethiopia. Adoption of this methodology, however, has primarily been by farming systems teams, consisting of agronomists and economists, which have no commodity or disciplinary bias. The methodology briefly includes using an informal, often followed by a formal, survey to identify farmer problems and constraints, both of a technical and non-technical or policy nature. The survey information is used to help suggest and prioritize research thrusts which can effectively solve the more severe problems identified, using the research organization's resources in the best way. Experimentation is implemented with the sole purpose of designing acceptable technology for use by small farmers that will improve yield, alleviate labor bottlenecks, decrease production risks and perhaps make work physically more acceptable. Technology testing is in part done in the farmer's environment with his participation. Improved treatments should always be compared to the farmer's practice. Loss assessment trials should also include the farmer's practice. In this way, we will understand what disadvantage, if any, the farmer's practice represents. Evaluation includes agronomic or statistical methods, economic scrutiny and farmer evaluation. The FSR methodology helps the researcher find out why the farmer is doing what he is doing; encourages faster and more accurate feedback of the technology's relevance; accomplishes a more realistic test of proposed technologies and encourages extension involvement in the research process (Stroud, 1985).

In the specific case of weed research and for that matter, extension of the information, it is suggested that the farming systems approach be used. Under the socio-economic program of IAR, this approach has been used. IAR surveys of areas adjacent to several research stations (Bako, Nazret, Sinana, Holetta) have identified weeds as being the first or second most severe problem faced by the farmers. This season the survey results are being used by the Agronomy Department and some of the weed researchers in the design of their research. The adoption of this approach is greatly encouraged as it will focus research so that useful, applied recommendations should evolve, an output which extension needs. Expansion of farming systems surveys to new areas followed by weed management experimental work based on the needs of the various identified target groups, is encouraged.

Multilocational Testing - Options for Different Conditions

In the past, most weed-research has been conducted on research stations under controlled conditions. This type of research should not be abandoned; however, the most promising technologies should be tested further in a wider range of climatic, soil and management environments. This would help to verify the technology and identify any potential adoption problems. Multilocational testing, using a farming systems perspective to help locate the trials and choose the treatments, will lead to the formation of specific recommendations.

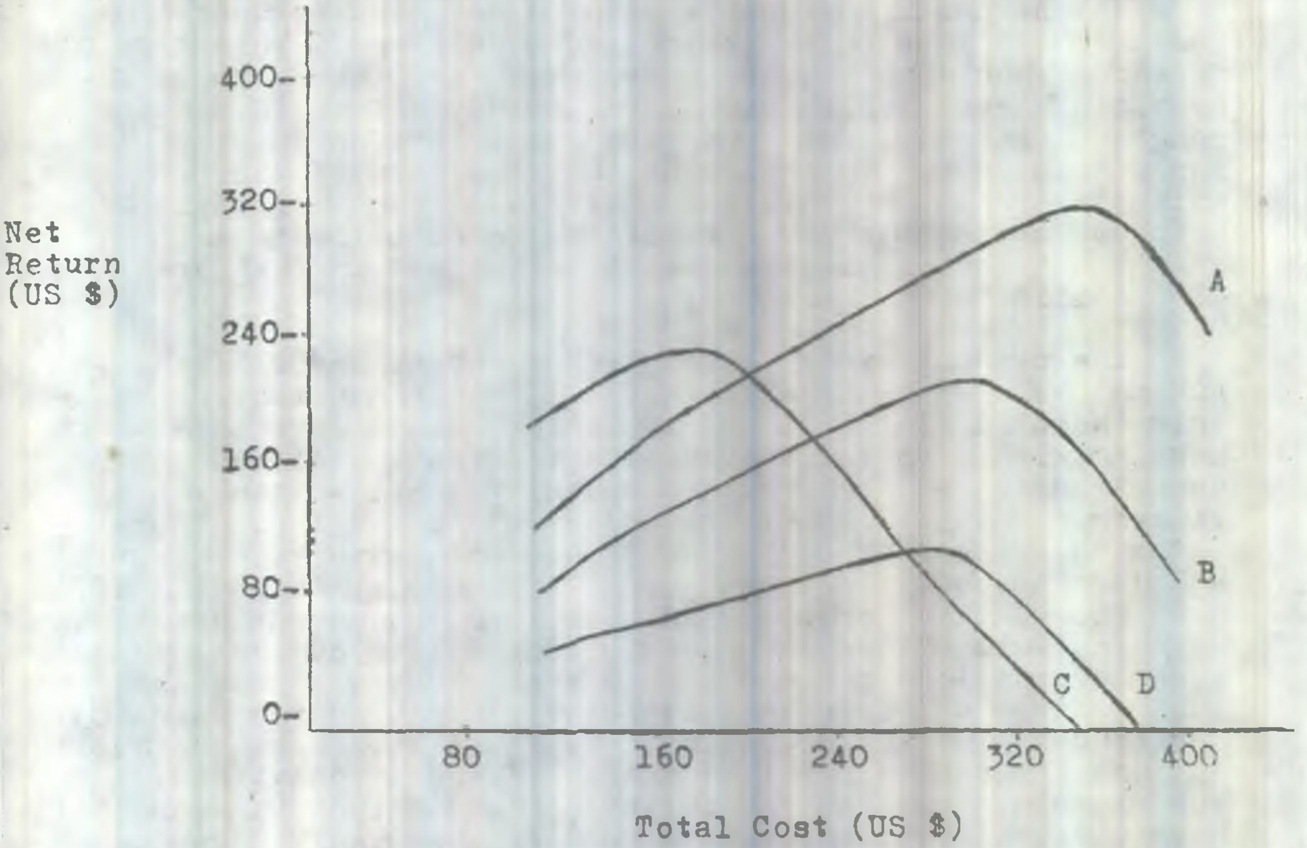
The present system tests technology at several IAR/ ADD and ADD 2.5 ha trial sites. It is planned that once this phase is finished, the technology would move to on-farm testing with farmer involvement. The last phase would be demonstration to farmers through the research-extension liaison committee (RELC) or the extension service. These existing systems should be used more extensively for testing and demonstrating weed management technology, including herbicides. Weed problems and the farm management practices which encourage them, are more site specific compared to other production problems. This means that weed research must be done on representative areas involving representative management practices. Ultimately, there should be various options for weed control to match different conditions. For example, weed control in tef can be solved by using a herbicide, a herbicide plus a handweeding, one handweeding or two handweedings. Any one method may be the best under a certain condition, but under which conditions (management, weed problems, economical) should each of these methods be employed? Research needs to identify this sort of relationship and pass the information onto extension through the Crop Protection Department weed unit.

Integration of Agronomy, Weed Research and Economics

The following example illustrates the benefits of combining agronomic, weed management and economic data when deriving recommendations. The data presented in Figure 1 illustrates that the beneficial effect of extra weeding occurred when improved varieties were used... because traditional maize is very tall and after the first two weedings, develops a canopy well above the level of the weeds. Improved varieties tend to be much shorter with a canopy that is invaded by taller weeds. In order for farmers to benefit from adopting the improved variety, they must plant at a higher density and intensify weed control (A vs D). The traditional variety performed better than the improved variety under low management (C vs D). The traditional variety performed slightly better when given improved management (B vs C).

The results have economic implications for partial or complete adoption of the recommendation of using improved practices and an improved variety. In this situation, there

Figure 1: Integration of agronomic, economic and weed control data on maize.



A = improved variety, high population level, intensified weed control
B = traditional variety, high population level, intensified weed control
C = traditional variety, low population level, less weed control
D = improved variety, low population level, less weed control

(Zandstra, et al., 1975)

was no production alternative that increased yield and income that did not also increase costs of production. However, there were two strategies that emerged that would increase yield and income (Zandstra, et al., 1975).

Although agronomy and weed management disciplines are separated both in the present research and extension systems, a mechanism for cooperative effort in designing, testing and demonstrating weed management solutions must be sought. The positive implications for recommendation packages or control options is obvious.

Herbicide Testing Protocol

The development of a herbicide testing protocol is recommended. It should have a screening and experimentation process including multilocational testing with each phase occurring over a decided period of time. This would help ensure that herbicides have passed through a uniform testing program. Experiment methodology for the various stages should also be outlined to that confidence in the results is generated. This would discourage experiment duplication and would encourage a systematic use of resources to arrive at reliable recommendations. It is suggested that past herbicide research be reviewed after the protocol is developed to identify research gaps. The proposed protocol should be reviewed by the weed units of the Ministries of Agriculture, State Farms and Coffee and Tea as well as having input from industry before final adoption. Protocol review should take place so that changes or additions can be made after gaining future experience.

Weed Biology

Weed biology studies, which are concentrated on species indigenous to Eastern Africa or on those which lack relevant research for the farming systems present in Ethiopia, are needed. IAR is proceeding on this type of research for parasitic weeds which will be complementary to more applied research. This approach should be extended to other weeds such as Digitaria abyssinica or Argemone mexicana, as problems are identified.

Mechanical Weed Control

One of Ethiopia's major resources is animal power; however, very little research and development work has been done on using animal drawn cultivators, harrows, etc. for weed control on various soil types in row seeded crops. This type of research work is encouraged. It is recommended that contributions from engineers, animal scientists, agronomists including weed specialists and economists, be integrated. Many projects concerning animal traction have failed because of the isolation of disciplines related to this subject. Hand hoes and planters should also be investigated using this approach.

Increased Priority to Personnel and Resources for Research on Weeds

As mentioned in the introduction, weed science as a discipline is under-represented. The number of well-trained personnel is low. Given the latest farming system survey results from IAR illustrating the problem of weeds, a greater priority should be given in terms of manpower, training and resource allocation, to help solve the problem. Also, due to the site specificity of weed problems and the complexity of offering recommendations which are suitable across many different environments, research will have to be more extensive to solve the problems. Integration with agronomy and farming systems may help. Involvement of extension in the later stages of research (multilocational testing and on-farm trials) can also help to alleviate the burden to IAR and to help to expand activities.

PROPOSED AREAS AND METHODS OF COORDINATING RESEARCH AND EXTENSION ACTIVITIES ON WEED MANAGEMENT

The MOA and IAR presently have mechanisms for cooperation: RELC, IAR/ADD sites. It is felt that the following suggestions, which are in addition to these, would be beneficial for coordinating activities specifically on weeds.

Joint Planning Meeting on Weed Management Activities

A small group consisting of representatives from IAR, the Extension Department, Crop Protection Department, ADD and RELC could meet once per year to discuss new developments in research, to feedback extension results to research, and to plan survey, trial and demonstration activities.

Joint Surveys

In 1986 a survey was organized by the Crop Protection Department Weed Unit in Habro Awraja, Harerge Region on Striga with participation from IAR. Both organizations benefited from the activity. A proposal for a training, research and extension program was jointly formulated. This sort of activity fosters communication between the two organizations as well as helping to coordinate both extension and research action on severe problems and can be organized on an as-needed basis.

Involvement of extension in the IAR farming systems surveys is encouraged as long as it is fitted into the extensionists work program. This methodology is useful to extension as it can help them to improve their understanding of farmer aims, problems etc. Extensionists can be used to help liaise with local leaders, select farmers and to act as informers themselves about the area (CIMMYT, 1984).

Shared Trial and Demonstration Program

Extensionists can be valuable resources in an on-farm research program which has been advocated previously. They can assist in selecting sites and farmers, evaluating solutions with farmers input, managing trials, collecting data and giving feedback. This sort of activity could help expand multilocational testing and at the same time expose extension to potential technologies. In order to solicit good results, however, training in these areas will be needed (CIMMYT, 1984; Vaughan-Evans, 1987; Stroud, 1985). Direct communication between the weed unit of the Crop Protection Department and IAR is recommended to solve these problems.

Coordination of inputs into the IAR/ADD sites, ADD 2.5 ha sites and RELC activities could be improved. It is suggested to use the planning meeting as a forum to discuss this and perhaps appoint sub-committees.

Exchange of Reports

It is suggested that IAR send copies of all reports dealing with weeds to the Weed Unit as well as to the Crop Protection library. This will enable the Weed Unit to have their own resource materials. The Crop Protection Department will reciprocate.

Training Inputs into the Extension Modified T & V System

Researchers will be called upon to give the SMSs and upper level extensionists training in various areas of crop and animal husbandry. It is recommended that an organized effort be made to give training on weed management. This effort should be coordinated with the Weed Unit of the Crop Protection Department because they too will be involved in extension training. The present FAO project on weed management will support training during the next year, however, training will obviously have to be an input over the long term. Areas which need particular attention include: weed identification; control of problematic weeds such as Striga, Orobanche, Cuscuta, Rottboellia, Cyperus spp., perennial grasses; herbicide use; survey techniques; trial and demonstration management.

SUMMARY

It is recommended that the above proposals concerning research activities and approaches, which can be useful to extension, be considered by both the IAR and MOA. It is recommended that discussions concerning adoption of multilocational testing, involvement of extension in farming systems surveys, trials, etc. be held jointly between involved departments of the MOA and IAR at headquarters level to develop a mutually suitable system with shared input. This could be useful for other disciplines as well. It is most important to maintain and expand the open communication which is present now, in order to foster cooperation concerning the self-sufficiency for food crop effort.

The Crop Protection Department, using assistance from FAO, is presently training two people at the MSc level, specifically on weed mangement. There are plans in Phase II of the project to train an additional five people in this area. This projected higher level of training should encourage greater interaction between research and extension as well as encourage a more professional quality of activity from the extension side.

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DISCUSSION

Seifu Ketema: In crops, the improved seeds or varieties are released by Seed Release Committee how are herbicides and other pesticides and crop protection results are released and who releases them?

Hailu Kassa: Until now crop protection results are available only from IAR progress reports. As regards the future, a legislation is approved, a national committee will be formed which will have the mandate to approve the entrance of pesticides into the country as well as the verification and release after confirmation.

Takele Gebre: According to Ann's paper there are no technologies available in weed science from the IAR at present, how true is this?

Birhanu Kinfe: There are many research results available on herbicides as well as on critical period of competition. However, they are not widely used due to some constraints.

Ann Stroud: My paper indicates, in general, that the technologies available on weeds should be compiled and distributed to user organizations.

Messeret Wondimu: Farmers spend 80% of their time in weeding of tef, then why are they not allowed to use herbicide?

Mulugetta Mekuria: Herbicides are not totally to replace labor. Even if herbicides are available to farmers, it does not mean that the farmers should not use labor, it will be used only to reduce the burden of labor required for weeding.

Proceedings First EWSC Workshop Problems and Priorities for Weed Science in Ethiopia, Addis Abeba, May 1987

THE IMPORTANCE OF TRAINING FOR WEED RESEARCH AND EXTENSION IN ETHIOPIA

Berhanu Kinfe[1/] and Ahmed M.Sherif[2/]

ABSTRACT

The importance of weeds in Ethiopian agriculture is discussed. The present status of weed scientists and training in weed science indicates an inadequate number involved in the discipline. These staff shortages lead to a lack of trained manpower at all levels (research, extension, other training institutions). Specific areas of emphasis in training are discussed and recommendations from FAO/IWSS Expert Consultation on Improving Weed Management are presented.

IMPORTANCE OF WEEDS AND WEED SCIENCE

Weeds have always been with us from the beginning of agriculture. The primitive farmer who first hand-pulled the plants that competed with his cereal crops initiated the process which has through the years been one of the most tedious of all agricultural operations. The universal occurrence of weeds as a constant component of agricultural environment, as opposed to the epidemic nature of other pests, has partly contributed to the delayed recognition of weed control as part of crop production. Otherwise, many research results show that crop losses caused by weeds exceed the losses from other categories of agricultural pests and that is why herbicide sales are higher than other pesticides as shown below (Lerch, 1982):

Agrochemical :	Herbicides	42%
	Insecticides	34%
	Fungicides	19%
	Others	5%
Regions :	USA & Canada	30%
	Europe	23%

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Japan & Far East 19%

Rest of the world 28%

Fryer (1982) presented the cost of pesticides used in Great Britain in 1981 as follows:

Herbicides £134m

Insecticides £18m

Fungicides £51m

In Ethiopia, studies show that about 50% of the total crop production time is devoted to weeding (Birhanu, 1981). Significant yield losses in cereals due to weeds have been reported (Table 1).

Table 1. Crop loss assessment in cereals in Ethiopia

Crops	% Loss
Wheat	36 - 38
Barley	10 - 20
Tef	48
Sorghum	40
Maize	20 - 53

1. Status in developing countries other than Ethiopia

Eventhough weed science plays an important role in crop production, the necessary attention is not given towards the development of this discipline in many countries. Many weed science research teaching and extension activities are on-going in Central and South America, the Middle East, and Asia but strengthening and integration of efforts is still needed in all countries. Research is often conducted by people who have general agronomy responsibilities for a crop or crops rather by a person devoted exclusively to weed science (Doll, 1982; Fryer, 1982; Saghir, 1982). Teaching and extension are usually less adequately addressed than research in Latin America.

While some countries offer formal weed science courses, many only cover the topic as part of a general production course. Rarely is weed science a required course for undergraduates in agronomy, but entomology and plant pathology are nearly always required. This short-coming seems to be more pronounced in Africa where, Deat (1982) notes, although research in weed science is presently undertaken in nearly all African countries, the fundamental studies on ecology and weed biology are often neglected or are just beginning. He adds that, all human and financial resources are being used to solve the immediate weed management problems instead of being devoted to long-term studies. This is most likely a result of the limited number of people assigned to work on weed problems, thus, practical considerations are answered first at the expense of stress.

Saghir (1982) cites examples of Mexico and Lebanon, where trained personnel are highly needed, have the least number of weed specialists. His survey results give an indication of the situation in 18 countries (Table 2).

2. Status in Ethiopia

Weed control research was started in Ethiopia in Chilalo Agricultural Development Unit (CADU, now known as Arsi Rural Development Unit - ARDU) in 1967. In the Institute of Agricultural Research, weed research activities have been carried out since 1969. In Alemaya College of Agriculture (now known as Alemaya University of Agriculture), a general weed science course is presently offered to undergraduate students in the Department of Plant Sciences. For diploma students, in the same department, weed control is given as a minor part of crop protection courses.

Table 2. The availability of weed science education in advancing countries (based on the responses to a postal questionnaire from weed scientists in 18 countries) (Saghir, 1982)

	% response
Post-gradute Training	
Yes	31.1
No	44.8
Unreported	24.1
Weed Science Teaching Situation in	
Basic Sc. Dept. only	0.0
Crop Production Dept. only	46.7
Crop Protection Dept. only	20.6
Crop Production & Protection	13.3
Combination Depts.	6.7
Agronomy only	6.7
Unreported	6.6
Prerequisite Courses	
Yes	63.6
No	20.0
Unreported	16.7
Qualifications of Teachers	
B.Sc. only	6.7
M.Sc. only	20.0
Ph.D only	20.0
Combinations	53.3

Weed science has been one of the most neglected fields of agricultural study in developing countries such as Ethiopia. Table 3 illustrates the small number of individuals who have received advanced training in weed science and who are presently working for governmental organizations in Ethiopia.

Table 3. Number of Ethiopian post-graduate trained manpower (M.Sc, Ph.D)

	Agricultural Organizations				
	IAR/SPL	AUA	MSFD	MOA	MCTD
Trained manpower	3	2	2	-	-
On study leave	2	1	-	2	1

* Key to the agricultural organizations

IAR = Institute of Agricultural Research
SPL = Scientific Phytopathological Laboratory
AUA = Alemaya University of Agriculture
MSFD = Ministry of State Farms Development
MOA = Ministry of Agriculture
MCTD = Ministry of Coffee and Tea Development

The table above indicates that there are few personnel with advanced training and one can conclude that more trained personnel are needed. In order to improve weed management practices, efforts must be made to include weed science education as a top priority. It must be emphasized that there is a serious shortage of senior weed scientists qualified to teach graduates and as thesis advisors in weed science in Alemaya University of Agriculture. This problem is very far from being resolved.

Professors in weed science are essential as well as improved field, laboratory and controlled-environment facilities to conduct necessary research. Hence, Alemaya University of Agriculture needs to make weed science a required course for agronomy as well as crop protection students.

As regards the close relationship between research and extension, there are no extension agents who have advanced and a few with a general knowledge of weed science in Ethiopia. Fryer (1982) states that government sponsored weed research should not be an isolated activity, but should be integrated with extension.

In recent years, the importance of extension in improving weed management systems has been recognized in Ethiopia. Short-term trainings in weed science have been given to extension agents of the Ministry of Agriculture (MOA) and Relief and Rehabilitation Commission (RRC). The First Ethiopian Weed Management Training Course was given in 1985 followed by several training courses, which concentrated or included weed science, organized by Research and Extension

Linkage Committee (RELC), Ministry of Agriculture, IAR and other donor organizations (CIMMYT, ICARDA, CIAT).

EMPHASIS FOR TRAINING

Areas that should receive emphasis in weed science training for Ethiopian are:

a. Identification of weeds-basic to the study of weeds and their control.

b. Weed biology and ecology-survival mechanisms of weeds.

c. Integrated control measures including physical, cultural, biological and chemical control methods keeping programmes balanced so as not to over-emphasize the use of herbicides.

d. On-farm research methodologies to help avoid 'top-down' research approaches to farmers' weed management and other problems.

Weed science societies such as the Ethiopian Weed Science Committee (EWSC) are created to give service or to support services of the farming community and to increase communication among weed scientists and need strong financial, material and moral support in order to function properly. The EWSC gives particular emphasis to:

a. Publishing research results in proceedings of professional weed science meetings.

b. Encourage weed science to be a required course at universities.

c. Have greater contact with regional or international weed science societies.

d. Obtain and distribute weed science publication to relevent consignees.

e. Arouse awareness at higher level about the needs of weed science with the aim of increasing governmental support. and

f. Strengthen training in weed science.

CONCLUSION

The information presented in this paper was intended to show the importance of weeds in crop production and that greater efforts need to be made to strengthen manpower development for both research and extension in weed science. Emphasis should be made towards using an integrated approach to weed management where farmers are fully involved in designing weed management systems in On-farm Research undertakings and extension activities. In view of the grave economic situation Ethiopia is in at the present time, it becomes imperative to convey the message forwarded by the

FAO/IWWS Expert Consultation to concerned government institutions, likely donor organizations and/or agrochemical companies. The following were the recommendations put forward by the 36 international experts and weed scientists from developing countries between 6-10 September, 1982 in Rome:

I. RECOMMENDATIONS ON THE ROLE OF EDUCATION IN WEED MANAGEMENT IN THE ADVANCING COUNTRIES.

The development of effective and economical systems for weed management depend on the availability of well-trained and educated weed scientists who are familiar with the complex cropping systems and socio-economic conditions of farmers in the country. Despite the urgency of the weed problems, such well-trained people are in very short supply throughout the world. Many advancing countries have no weed scientists at all, eventhough most have entomologists and plant pathologists to deal with these usually less important restraints on crop production. Similarly, few if any students complete first degrees in general agriculture or agronomy without some training in entomology and plant pathology, yet the majority receive no tuition in weed science. Most agronomists, extension workers, and farmers are aware of the severe problems that weeds cause in almost every crop production system, yet few have access to short courses and other methods of broadening and updating their professional competence in this subject.

1. We Recommend that deans of colleges and universities and government administrators and policy makers be made aware of the importance of weed management in agricultural development. Top priority in planning weed management strategies for the eighties should include the elevation of weed science to that of the other plant protection disciplines.

2. We Recommend that the teaching of weed science principles be included as a compulsory component in all appropriate first degree agriculture programmes in advancing countries with adequate facilities and support. We recommend that those courses be taught by trained weed scientists where possible. Where crop protection options are available or planned, it is essential that a weed science component be included as an integral part of such programmes.

3. We Recommend the encouragement of weed research in regionally selected universities within the advancing countries which will lead to the availability of advanced degrees in weed science.

4. We Recommend the widespread availability of short courses within the advancing countries which tackle specific themes relevant to weed science and weed management, and that wherever possible these courses address problems of immediate practical importance.

5. We Recommend that more scholarships be made available to students from the advancing countries for study and training in weed science at appropriate internationally recognized institutions.

II. RECOMMENDATIONS ON THE ROLE OF EXTENSION SERVICES IN WEED MANAGEMENT IN THE ADVANCING COUNTRIES:

Extension services are the informal educational system through which farmers and their families learn to recognize, understand and solve their crop production problems. Extension services are therefore the vital links between the research stations and government policy makers and the farmers. Extension services in most advancing countries are devoid of training programmes or personnel experienced in weed management, and this is a serious limitation of the national agricultural development programmes of many advancing countries.

1. We Recommend that concerted efforts be made by extension services to demonstrate to decision makers in the advancing countries the importance of weeds and the economic losses caused by them.

2. We Recommend that extension services be strengthened in the advancing countries to ensure that all available information on weed management is gathered and utilized.

3. We Recommend that training programmes for agricultural extension service staff include components of weed management as an integral part of crop production systems.

4. We Recommend that there be much closer cooperation between researchers, extension workers and farmers to ensure three-way communication of information in the development of improved weed management systems. We further recommend the creation of extension weed scientist positions in the advancing countries to facilitate this communication and to promote improved weed management at the farmers' level.

5. We Recommend that extension services integrate the information available to them into well-balanced weed management systems appropriate to local conditions and use adequate on-farm demonstration plots and the mass media to promote these systems.

6. We Recommend that where herbicides are used, extension workers play an active role to ensure they are applied correctly and safely.

7. We Recommend that extension officers consider the eventual use of the benefits derived from improved weed control practices.

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DISCUSSION

Ann Stroud: How many weed science teachers are there in the country?

Birhanu Kinfe: Except in Alemaya, there are no weed scientists in the junior agricultural colleges.

Ann Stroud and Mulugetta Mekuria: How do you define training , is it defined as going to school or experience? What are the plans and proposals for weed scientists development in the country?

Birhanu Kinfe: I define training to mean, teaching for higher degrees like M.Sc. and Ph.D. So far there is no clear plan in the university regarding the development of weed scientists.

SESSION VII

GENERAL DISCUSSION

On major points arising, and the needs and mechanisms for collaboration between institutions involved in weed science

Chairman : Dr. Demisse Gebre Michael

Rapporteur : Ato Ahmed M. Sherif

GENERAL DISCUSSION

The discussion was on major points which were raised and the needs and mechanisms for collaboration between institutions involved in weed science.

1. COLLABORATION OF RESEARCH SECTIONS

Doug Tanner: There is interaction between zero tillage and other agronomic aspects. There is also limited manpower in weed science. Therefore, combination of agronomy and weed science may make the problem less felt.

Hailu Gebre: Economics of herbicide use may force us to seek for other methods of weed control, especially on some non-imported crops. The alternative methods need close collaboration of the two units (agronomy & weed science), herbicides may be used for selected crops.

Birhanu Kinfe: Weed control is not only with herbicides, there are many others which look like agronomy but closely related to weed control, (seed rate, sowing date, etc.). Hence, close collaboration of the two units is needed.

Seifu Ketema: Weed Science should also collaborate with Farming Systems Research (FSR). Economics of farm implements should be considered in the designing and economists should be consulted beforehand.

Felix Pinto: In small-grain crops row planting should be encouraged. It is very difficult to use herbicides on broadcast crops.

Doug Tanner: Why don't you integrate the two research sections, agronomy and weed science?

Seme Debela: This matter should be examined thoroughly. However, the issue is the need for closer collaboration between them. The other units also have to work closely. The better alternative between merging sections and working more closely should be examined. In each crop team, all disciplines are incorporated. That should, perhaps, solve the problem.

2. COLLABORATION OF IAR WITH OTHER INSTITUTIONS (MOA, MSFD, MCTD, AUA, etc)

Birhanu Kinfe: Who is the user of research results? MSFD should acknowledge that it is one of the users. Eventhough it is undertaking developmental research, researchers should be aware of what is being carried out in MSFD. The State Farms definitely need consultation from research organizations.

Ermias Kebede: Recommendations from research should serve both big and small farms. But there are no results available for implementation at the moment and we cannot wait until they are available. So, we carry out our own research.

Demissie G.Michael: Availability and difussion of technology is to the peasant farmers rather than to the MSFD. Technology acceptable by farmers should be acceptable by the MSFD.

Hailu Kassa: There is need for cooperation between research and MOA as well as MSFD. We have not expressed our need for research results earlier. Now there is a project in crop protection for more collaboration between MOA & IAR.

Hailu Kassa: Are herbicides an answer to all weed problems? We depend on IAR for herbicide recommendation and importation as well as usage because there are about 80 market centers who sell chemicals and farmers could not be controlled as to which herbicide to use for selected crops.

Wondimu W.Hanna: I think there is strong collaboration between IAR and MSFD at present, particularly in Striga and Orobanche control research.

Seme Debela: Actually there isn't strong collaboration between IAR and other organizations. They are ad-hoc meetings rather than formally institutionalized collaborations. There are duplication of efforts. We have tried to create formal linkage and, thereby, formed Research and Extension Liaison Committee (RELC) between the IAR and MOA. Its effectiveness is to be seen in the future. As regards IAR/MSFD, there is no real collaboration to date. Some years ago there was a committee formed by the two organizations. But now it is not operating. It has to be reorganized and the collaborative confidence has to be emphasized. We are doing our best regarding the availability of research results to users and nowadays some are being published to help transfer the technology. The collaboration between IAR and AUA also is based on personal contact. The only vivid relationship in existence is between IAR and MCTD.

Hailu Kassa: Mandates of organizations differ, even among different departments in MOA, where they carry out research by themselves. Therefore, encouraging and strengthening societies like this one (EWSC) is necessary because they bring together various people from different organizations to discuss problems common to all and share experience.

Takele Gebre: Management systems which impose collaboration among organizations are needed. The IAR should be left free to carry out all basic research. Hence, directives from higher body is needed.

Seifu Ketema: This problem has been emphasized earlier, for instance in the NCIC, where a united focus was raised. Therefore, joint committees similar to RELC are needed. MOA and MSFD lack contact with IAR and I think they should give feed back to IAR. In addition, at higher level, defining research limits in each organization should be sought.

3. BALANCE BETWEEN HERBICIDES AND AGRONOMIC APPROACH FOR THE CONTROL OF WEEDS.

<u>Peasant sector</u>

Felix Pinto: I think there is a committee which decides the importation of herbicides in MOA.

Seme Debela: There is no formal committee. If chemical registration proclamation comes out by the government, a committee may be formed.

Doug Tanner: It is a serious limitation because chemicals not known by IAR are used by MSFD.

Hailu Kassa: I recommend that there be a committee as soon as possible. There is a code of practive sent to all organizations from FAO. All pesticides should have manual and/or label in Amharic. We are trying to enforce this.

Doug Tanner: Priority crops are set by IAR, how are we to balance when we have breeders and agronomists but no weed scientists?
The result will be biased. Focusing on limited problems without weed science, how is it going to be carried out?

Seme Debela: Each zone is going to have its own weed scientists as well, that is development of research in all aspects. For agronomists, organizing weed science crash programs may be possible. It may also be possible to integrate the two units after discussion with crop protection and agronomy people.

Seifu Ketema: At present there is great inbalance. We are trying only herbicides. In the future, integrated weed control apporach should be considered.

State farms sector

Ermias Kebede: Good seed-bed preparation plus herbicides is important. Herbicide rotation with crop rotation will contribute a great deal.

Ann Stroud: We have agreed that integrated approach is important, but shall we suggest where herbicides should be used.

Felix Pinto: Central zone has experience in herbicide usage, for other zones to benefit from it, we need the Committee's (EWSC) assistance.

4. PESTICIDE REGISTRATION COMMITTEE

Hailu Kassa: Formation of a committee is not hindered by the already present committee in MOA.

Chris Parker: Agriculturally technical recommendation approval is what we need. Who should take the initiative, IAR or EWSC?

Seme Debela: IAR and EWSC have close collaboration. Release VS recommendation should be defined. Breeders are different from other disciplines. For all pesticides, mechanical implements, etc, National Technology Release Committee (NTRC), which may have other smaller units under it, may be formed. EWSC should address itself to NTRC through the IAR.

FIRST ETHIOPIAN WEED SCIENCE WORKSHOP

POSTSCRIPT

After introductory presentations by the President and Secretary of EWSC and the General Manager of IAR, the first day began with a general appraisal of the different types of weed problem on both state and individual farms, including both technical and socio-economic aspects. There were then presentations on tillage and implements, followed by an in-depth 'structured discussion' devoted to the question of why farmers are not able to cope with weeds by traditional methods and what new non-chemical agronomic approaches could contribute to improved weed management, particularly on the small-scale farm. It was first generally agreed that farmers had genuine problems of inadequate labor at critical times of weeding and could not simply be ordered to try harder. Among ideas for helping them to manage with their available labor, row-planting was probably the most important. Unfortunately farmers are most conscious of the extra labor involved at the time of planting and need help firstly with suitably simple row-planting techniques, and secondly being convinced that extra work at that stage can lead to significant savings later. Other suggestions related to the importance of sowing clean seed, the use of varieties best adapted to compete with weeds (especially in the least-weeded, broadcast-seeded crops such as field peas, faba bean, cowpea and haricot bean), pre-irrigation in cotton, and cover crops in coffee. There was also thought to be scope for reducing the amount of time spent in land preparation, most simply by reducing the number of tillage operations, but also in some situations, by going to zero tillage. The latter would almost certainly depend on the use of some herbicide, but the non-selective pre-planting herbicides used for this technique require much less education and involve much less risk of crop damage than the selective herbicides used after planting. More general points arising from this discussion were the need for closer linkage between the weed research and agronomy programmes within IAR, and the need for more socio-economic analysis of the exact problems posed by weeds and the constraints faced by farmers at critical times of the cropping season.

The second day began with papers on the economics of herbicide use and the status of herbicide use in the State Farm and peasant farming sectors. There was then a second structured discussion concerning the place of herbicides in Ethiopian agriculture and the priorities for herbicide research and development. Many doubts were expressed concerning the use of herbicides in peasant farming, and the problems and risks involved. It was pointed out, however, that farmers have been making apparently safe and effective use of 2,4-D for many years, and provided new chemical treatments were selected and researched with sufficient care and attention to safety and economics, they could make very important contributions to improved food-crop production. The economic benefit should be measured menly in increased crop production rather than in reduced labor costs and the economic analysis should also ensure that the economics were sound on a national basis (in terms of import substitution) rather than merely at the farm level. It is clear that the need and scope for new herbicide research needs to be more consciously focused on their needs, while any work specifically for individual farms should be based on very careful analysis of the prospects for technical and economic acceptibility. Of great concern was the need for much sounder procedures for the testing and eventual approval and recommendation of herbicide treatments, including the possible creation of a committee corresponding to that which approves release of new crop varieties. The continuing lack of official regulations on the registration and use of pesticides, in spite of their being drafted and passed to the Govt. some years ago, is a serious hindrance.

A paper on biological control of weeds pointed to the technical potential on a number of major Ethiopian weeds, using either the 'classical' approach involving importation of exotic organisms, or the less controversial 'inundative' approach using indigenous organisms, especially fungal pathogens as 'mycoherbicides'. It was suggested that expert consultant advice might be sought to define the potential more clearly, and how a suitable research and development program could be implemented. In the meantime, the continuing lack of national quarantine regulations and procedures make it difficult to proceed even with simple bio-control projects.

Papers on extension and training needs were followed by a final general discussion in which the main points were:

i) the need for strengthening weed research capacity in Ethiopia,

ii) the need for closer integration of weed research with the agronomy program in IAR,

iii) the need for guidelines to be developed for the testing of herbicides, in which connection it was agreed EWSC should take a lead,

iv) the need for legislation to be enacted on pesticide registration and on plant and animal quarantine.

Chris Parker

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