PB-219 747

MORE WHEAT FROM FALLOW FARMING

Homer M. Hepworth

National Fertilizer Development Center

Prepared for:

Agency for International Development

January 1973

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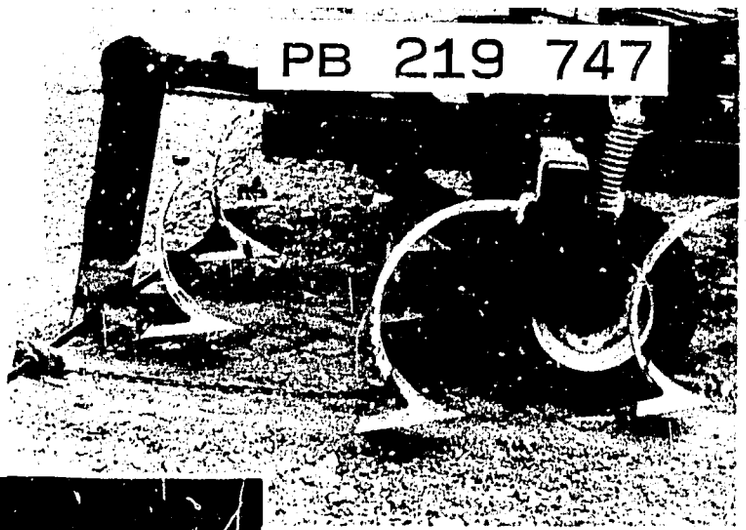

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MORE WHEAT FROM FALLOW FARMING

USAID/Oregon State University Team

January 1973

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BIBLIOGRAPHIC DATA SHEET	1. Report No. TU-633.11-H529	2.	3. Recipient's Accession No. PB-219 747
4. Title and Subtitle: More Wheat from Fallow Farming.			5. Report Date: Jan 73
			6. 105
7. Author(s): Homer M. Hepworth.			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: Oregon State Univ~~ersity~~.			10. Project/Task/Work Unit No.
			11. Contract/Grant No.
12. Sponsoring Organization Name and Address: Department of State, Agency for International Development, Washington, D. C. 20523			13. Type of Report & Period Covered: Research Report
			14.
15. Supplementary Notes			

16. Abstracts

Statistics show that wheat production varies widely even in areas of the same climatic conditions. Research conducted by National Wheat Improvement Center provides necessary information and production sources for optimum wheat production in the shortest possible time. It is observed that moisture conservation in soil (fallow system) with other improved agronomic practices can produce the optimum yield capacity. An effective fallow system involves storing water when it comes as rain or snow and minimizing losses prior to planting the crop. In order to achieve maximum efficiency in the accumulation of moisture, attention is focused on (1) control of weeds, (2) infiltration of soil, (3) slowing the surface movement of water permiting infiltration and reduction of water erosion, (4) avoiding tillage that loosens moist soil and exposes it to drying, and (5) creating a moisture barrier at proper depths. Additional factors complimenting this system are: fertilizer rates, row spacing, weed control, and better varieties of wheat. Research and training programs are designed to adapt improved technology to local conditions. Also presented is an analysis of the approach taken to facilitate the transfer of technology to local conditions in Turkey.

17a. ~~Key Words and Document Analysis. 17a. Descriptors~~

17b. Identifiers/Open-Ended Terms

*Wheat, *Crops and climate, *Fallowing

17c. COSATI Field/Group 633

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages ~~51~~ 55
	20. Security Class (This Page) UNCLASSIFIED	22. Price $4.75

FORM NTIS-35 (REV. 3-72) USCOMM-DC 14952-P72

IMPROVED TECHNIQUES FOR DRYLAND MEAN

MORE WHEAT FROM FALLOW FARMING

The story of the research and training involved in developing improved summer fallow technology for adoption by Turkey's Anatolian farmers

Details of illustrations in this document may be better studied on microfiche

USAID/Oregon State University Team

January 1973

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FOREWORD

Statistics show that there are rather wide differences in wheat production per land unit in areas having very similar climatic conditions. These differences are the basis for attempting to transfer technology from one region to another in an effort to increase production in the areas where yields are low.

This report discusses briefly the production of wheat under a summer fallow system. It explains why a fallow system is practiced and compares traditional and improved fallow methods.

This report also describes very generally the approach taken by the USAID/Oregon State University team, in cooperation with several Turkish agencies and other supporting institutions, to facilitate a transfer of technology.. Research and Training programs designed to adapt improved technology to local conditions while training technicians for both adaptive research and farmer education programs are briefly described.

Many people and organizations are cooperating in this work. We wish to acknowledge this effort. The General Directorate of Agriculture especially The National Wheat Research and Training Center supported by the Rockefeller Foundation group, The Directorate of State Farms, The General Directorate of TOP RAKSU especially the Soil and Fertilizer Institute and The General Directorate of Plant Protection are all making major contributions. Not the least benefit from such endeavors are the friendships which develop. It is a privilege to participate in this important work.

The OSU Team
Homer M. Hepworth
Thomas G. Zinn
Wilbert L. Andersen

MORE WHEAT FROM FALLOW FARMING

Introduction

The Government of Turkey beginning in 1969 engaged in a joint effort with the Agency for International Development, through a contract with Oregon State University to increase cereal production in the Dryland regions of the Anatolian Plateau. These project activities are coordinated through the Ministry of Agriculture and the Ministry of Rural Affairs. The primary emphasis for increased cereals production has been directed toward the continuation of the research and adaptive research projects now underway to develop a mulch/fallow system, utilizing new and special techniques and to developing an effective extension and farmer education program covering:

1. Soil moisture conservation (improved summer fallow tillage).
2. Use of new or improved tillage and seeding equipment.
3. Use of fertilizers.
4. Use of pesticides and herbicides.
5. Use of improved varieties of seed.

Research has been and is continuing to be conducted cooperatively to determine the systems of soil management which will conserve the maximum amount of soil moisture. Based on observations of current tillage methods and research conducted in Turkey, it is apparent that higher yields are possible. Through the use of more advanced equipment, improved and refined soil moisture management practices it should be possible to stabilize higher yields, increase profits for the wheat farmer and help Turkey produce her cereal needs. The soil tillage research now being conducted is of primary importance in order to formulate a combination of tillage operations needed to conserve the maximum amount of moisture.

With the establishment of the National Wheat Improvement Center, research is being carried out to determine optimum fertilizer rates, seeding rates, row spacing, weed control practices and varieties of wheat that are capable of maximizing the benefits of increased moisture. It is extremely important to understand that it will require the application of a combination or package of these practices, rather than any one individual practice, to achieve the most significant influence on dryland cereal production on the Anatolian Plateau. Although the combination of these practices is necessary, we feel that moisture conservation under a fallow system is the most important single factor. Without the added moisture the other practices are limited in their capacity to produce maximum yields. With the accumulation

of additional moisture from an improved fallow system and the application improved agronomic practices the newer High Yielding Varieties being developed will be able to produce at their optimum capacity.

Why the Fallow System

Where rainfall is too limited to permit annual cropping, as in many areas of the Middle East and the semi-arid lands of the United States, a system has been developed to keep the land free of a crop for one year. The purpose of this to accumulate moisture in the root zone for the subsequent crop on alternate years.

This system has been more commonly used in producing winter types of small grain rather than spring types or summer crops such as sorghum and millet and in areas of pre dominantly winter rainfall. The soil is usually dry at the time the winter wheat is harvested in July and August. Little accumulation of moisture will normally occur by planting time in September. Annual planting of winter wheat in low rainfall areas usually produces low yields and many crop failures.

Fallowing for winter wheat as compared with annual cropping has shown higher total production and greater stability of production. It tends to even out the production function curve particularly during the years of short moisture. It also produces a lower unit cost of production, and a greater efficiency in moisture use.

By following a cereal/fallow rotation, yields far greater than can be expected from the rain falling during the crop season have been obtained; there is no doubt that under certain conditions the practice of fallowing does result in the storage of moisture in the soil. Therefore part of the rainfall of one season can be made available to crops grown in the next season. In many areas where this system is practiced the rainfall during the growing season does not generally exceed 150 mm. Using a successful fallow system, it is possible to grow crops of wheat yielding up to 1,000 kg./ha. The requirement for such a crop is estimated to be equivalent to 260 mm of rainfall so it becomes obvious that a considerable part of the rainfall is being conserved. In the dryland areas where rainfall varies between 300 and 500 mm per year experience proves that 100 to 150 mm of water may be stored in the soil during the fallow year under this system. The fallow system

is regarded as particularly necessary because rainfall is highly variable and because in a dry year a crop can be saved with very little additional moisture stored in the soil.

In the semi-arid areas of the world where the fallow system has been employed successfully it is clear that early planting in Autumn is giving higher yields. The early seeded wheat planted in mid-September and early October develops a larger root system and is able to take advantage of spring and summer rainfall when the long days permit rapid growth.

The earlier germination and seedling development in the fall often advances the date of maturity from 1 to 2 weeks the following year. This means that these wheat plants might escape some hot, dry weather that could have serious effects on later maturing wheat.

Rainfall is highly variable in frequency and amount in regions where the summer fallow system is practiced. Several days of hot dry weather between light showers will evaporate most of the water from the soil surface. Many years of measurements show that only 20 to 30 percent of the precipitation is saved during the fallow period. An effective fallow system must store water when it comes, whether as rain or snow, and minimize losses prior to planting the crop. Maximum efficiency in accumulation of moisture requires the following:

1. Control of weeds since weeds act as a water pump and will use much of the water stored during the fallow cycle.

2. Maintain high infiltration rates so that the rain that falls enters the soil.

3. Slow the surface movement of water to permit infiltration and reduce water erosion.

4. Avoid tillage that loosens or turns up moist soil and exposes it to rapid drying.

5. Create a moisture barrier, or mulch at the proper depth so that it will hold the stored soil moisture during the fallow season until seeding time.

It is very important that the mulch hold the soil water at a level in the soil so that the seed can be planted into a moist soil layer.

When a good mulch has been established, less moisture is lost from soils, if it has penetrated below a depth of 7.5-10 cm. Tillage which loosens and exposes the moist soil and weed growth will cause water loss.

Timeliness is important in cultural practices. Mechanization has improved timeliness by speeding up field operations. Efforts in developing a summer fallow system and perfecting a stubble or dust mulch were more significant in the semi-arid lands of the Pacific Northwest of the United States after the use of tractors became widespread. This work began about 25-30 years ago and has been very successful.

Whenever a farmer takes implements to the field, he should have important tillage objectives to accomplish. His implements should be the proper ones to do the work.

Purpose of the Fallow System

The primary purpose of the fallow system is to accumulate moisture in the root zone. Available nitrogen and other nutrients also result from microbiological breakdown of soil humus during the fallow period.

The summer fallow operation has two distinct objectives in moisture conservation; to increase (1) the total amount of moisture stored in the root zone that can be used by the next crop and (2) the amount of moisture that can be maintained at a depth of 12 to 14 cm. so that seed can be planted into moist soil before the fall rains start. Accomplishing this second objective is extremely important and requires a series of timely tillage operations. Planting winter wheat into moist soil between September 10 and October 1 in the dryland regions of the Anatolian Plateau of Turkey allows the wheat plant to become established early enough to develop a secondary root system before winter dormancy occurs. Many winter wheat plantings that wait for mid-November rains for germination, which is typical under the present system on the Anatolian Plateau, do not develop the secondary root system before winter dormancy occurs and sometimes never develop a secondary root system.

When the wheat plant is able to develop a strong root system, which includes the secondary and primary roots, prior to going into winter dormancy it then has the chance to take advantage of the soil nutrients and early spring moisture. It is less dependent upon the late spring rains in order to yield well. With early germination in the fall the root system has developed to the point where it can utilize more efficiently soil nutrients and moisture. Therefore if there are late spring rains the plant can take advantage of the additional moisture but is not dependent upon it to produce a crop.

The Fallow System on the Anatolian Plateau

Summer fallow and planting procedures being used in the Middle East and other dry farming areas are often inadequate. Wooden or steel plows pulled by oxen leave the soil loose and subject to drying as deep as it is tilled. Weed control during the fallow operation is often incomplete or nonexistant. Little plant residue is left on the surface to protect the soil and maintain water infiltration rates.

In this part of the world it is common practice to remove all straw from the fields at harvest. The fields are then heavily grazed by flocks. Weeds which emerge in the spring are grazed until early summer when the fallow tillage begins. At the optimum time for wheat planting, the plow zone of the fallow field is frequently very loose and dry. The farmer has to cultivate a number of times before planting thus losing moisture that may have been stored. Farmers in these areas have learned that seed planted early in the fall in dry soil may be germinated by an early light rain, then dry out, and die. Thus they have adopted the practice of delaying planting until late fall when temperatures are cooler and rains more certain.

Much of the wheat is seeded by hand broadcasting. High seeding rates are used to help assure a good stand under the poor conditions. Sometimes the farmer plows the field, broadcasts his seed on the rough, loose soil, and covers it with a harrow or drag. Sometimes the seed is broadcast on the surface of the fallowed field and the wooden plow is used to cover the seed. In either case the seed is placed in loose soil subject to rapid drying rather than in contact with firm moist soil which would promote germination.

In Turkey, research has proved that 8-10 kilograms or less per decare is a satisfactory seeding rate if a proper seedbed is prepared.

Most of the farmers plant 14 to 24 kilograms of seed per decare. Based on the number of hectares of wheat grown in Turkey this excess seed used each year amounts to approximately 500,000 tons of wheat. Wheat yields in these areas are low for a number of reasons:

1. Poor summer fallow practice
2. Poor seedbed at planting time.
3. Delay of planting past optimum date.
4. Very poor planting methods for assuring germination and stand establishment.
5. Excessive soil erosion and low fertility.
6. Heavy infestation of weeds.

Improved Fallow System

The fallow system used successfully for the production of cereals in these semi-arid regions of the U.S. and other parts of the world include the following combinations of practices:

I. After harvest the land to be fallowed is in a condition to allow maximum infiltration and penetration of moisture to reduce erosion hazards during the winter months. This may or may not include a fall tillage operation such as chiseling, subsoiling or sweep plowing.

   One of the important aspects of the improved system is the storage of moisture in the soil profile from the late fall, winter and early spring rains for it is this moisture that when successfully held in the profile, during the fallow season enables early germination of the crop. Precipitation coming in the late spring and early summer, unless in large amounts, is of little value for the maturing crop.

II. Initial spring tillage at the proper time and depth is essential to conserve the maximum amount of soil moisture. This is accomplished by killing the volunteer cereals that may have germinated and controlling weed growth. In addition, the initial spring tillage operation establishes a moisture barrier (mulch) for the following operations.

III. A mulch of the proper depth is established that will hold the stored soil moisture during the fallow season until seed-

ing time. The preparation of this moisture barrier is of primary importance.

IV. Weed control and maintenance of the mulch is practiced during the spring and summer of the fallow season. This may require several tillage operations using a rod weeder or some other implement that will eliminate weed growth and maintain a surface mulch.

V. Use of the best available adapted variety which is capable of maximum production under such a fallow system.

VI. Preparation of the best seedbed possible, plant at the optimum rate, date, and row spacing to insure rapid germination and establishment of a uniform stand before cold weather begins.

VII. Fertilizing at the optimum rate and date (at planting and/or spring top dressing for maximum yield).

VIII. Control weeds during the crop growing season (fall and spring).

IX. Control insects and diseases when necessary (this may require seed treatment prior to planting).

The fallow system, to be efficient and economical requires soil of adequate depth and free from large and numerous stones. These criteria should eliminate a number of areas where cereals are now being produced in Turkey. Actually the poor soils will produce more feed for livestock under a permanent pasture program than they can economically produce in cereals under a dryland fallow systems.

By increasing cereals production on deeper soils many of the less productive soils can be returned to improved grazing lands. This results in more total animal forage, both from the cereal crop residue and from the improved permanent pasturelands.

CEREALS RESEARCH AND EXTENSION TRAINING PROGRAM

The adaptive research is continuing to be conducted cooperatively by the Wheat Research and Training Center supported by the Rocker-

feller Foundation, USAID/OSU and the concerned ministries of the GOT to determine the systems of soil management which will conserve the maximum amount of soil moisture and be most applicable to cereal production in Turkey from the point of view of economic and social costs.

Adaptive Research on State Farms and Topraksu

Under supervision of The National Wheat Research and Training Center preliminary tillage studies, using new and improved types of tillage equipment involving 36 different tillage treatment combinations are being tested on the State Farms at Polatlı, Altınova and Gözlü, and at Research Stations in Ankara. In addition to the tillage combinations listed, this project is designed to test the different types of equipment.

Time of Operation	Type of Implement	Depth of Tillage
Fall	1. Chisel	35 cm.
	2. Subsoil	50 cm.
Initial Spring	1. Sweep and Harrow	17-18 cm.
	2. Moldboard Plow and Harrow	18-20 cm.
	3. Offset Disc and Harrow	17 cm.
*First Summer Operation approximately 3 weeks following initial spring tillage (depending upon weather)	1. Rodweeder and Harrow	13-15 cm.
	2. Rodweeder-Sweep Combination and Harrow	13-15 cm.
	3. Sweep and Harrow	13-15 cm.
	4. Chemical Treatment Plus Minimum Tillage	10-12 cm.

*- Additional summer tillage treatments using 1, 2 and 3 listed under "summer operation" are applied as necessary for weed control and at a depth of 10-12 cm. This may include one to three additional treatments depending upon the weather.

**- The chemical treatment plus a minimum tillage includes establishing a soil mulch in the late spring at a depth of approximately 10-12 cm. by tillage. Any further weed growth is controlled by the use of chemicals.

These adaptive research tillage trails were initiated in the fall of 1969 at the four locations listed under the direction of Dr. Floyd Bolton,

now working with the Wheat Research and Training Center. Because of the two-year cycle in a summer fallow wheat production system, the first yield data was not collected until 1971. These research trials are being continued at the same locations so that data will be available each year. The first years results have been published in the USAID/OSU Progress Report on Summer Fallow Tillage Practices, June 1972.

In addition to the tillage research trials, a series of agronomic research trials were initiated in the spring of 1971 adjacent to the tillage plots. The leadership for the agronomic research trials is being carried out by the Wheat Research and Training Center. The results from the second year of tillage trials and first year of agronomic trials are tabulated and available through the Wheat Research and Training Center.

The agronomic research trials are designed to test the reaction of the newer high-yielding varieties under the improved cultural practices of a fallow crop sequence in the Central Anatolia region. These trials consist of the following treatments: planting dates, seeding rates, varieties, fertilizer rates, type of drill, fertilizer placement.

Adaptive Research on Farmers' Fields

Adaptive tillage research trials have been established on six farmers' fields in five provinces. The object of this activity is to test under field conditions on farmers' fields a refined set of tillage combinations using the data from the 1969 tillage research trials conducted on the State Farm locations and the Topraksu Experiment Station in Ankara.

The leadership for the adaptive research tillage trials on farmers' fields is provided by the USAID/OSU wheat team in cooperation with the Soil and Water (Topraksu) Directorate and the Wheat Research and Training Center.

These research trials were begun in the fall of 1971 with fall chiseling. The following is an outline of the 18 tillage combinations and the types of equipment being used and tested on farmers' fields.

Time of Operation	Type of Implement	Depth of Tillage
Fall	1. Chisel	35 cm.
Initial Spring Tillage	1. Sweep and Harrow	17-18 cm.
	2. Moldboard Plow and Harrow	18-20 cm.
	3. Offset Disc and Harrow	17 cm.

*First Summer Operation	1. Rodweeder and Harrow	13-15 cm.
approximately 3 weeks following initial spring tillage (depending upon weather)	2 Rodweeder-Sweep Combination and Harrow	13-15 cm.
	3. Sweep and Harrow	13-15 cm.

*- Additional summer tillage treatments using 1, 2 and 3 listed under "summer operation" are applied as necessary for weed control and at a depth of 10-12 cm. This may include one to three additional treatments depending upon the weather.

Yield data from these trials will be collected in the summer of 1973. However, since the initiation of the intensive adaptive research trials on the State Farm and Topraksu locations, the tillage and agronomic research programs have been established annually so that, even with a 2-year cropping cycle, yield data will be harvested and available each year once the initial cycle is completed. This will enable the technicians to refine and improve the practices more rapidly as the research data is available each year.

Training for Equipment Operation

In additon to the need for adaptive research tillage combinations to be conducted on farmers' fields, the basis for selecting the five provinces is to coincide with the assignment of the five sets of wheat production implements that have been imported through the Agricultural Development and Control Loan (086). These sets of equipment were designated for these specific areas by the GOT and USAID. It is expected that the province technicians who will be resonsible for this equipment will have a chance to gain valuable experience in operation and proper adjustment of this equipment to continue the research work being conducted in these areas.

Variety Trials

In addition to the tillage research programs established in the five provinces, a series of 50 wheat varieties will be tested under the soil and climatic conditions of these areas. The varieties will be planted

in the same locations as the tillage plots; thus, the necessary tillage operations were performed at the same time as the tillage for the research plots.

Weed Control

A weed control program designed to accomplish two main objectives is in progress.

First, since it has been demonstrated many times in Turkey that weeds reduce wheat yields from 10 to 50 percent or more depending upon several factors we are assisting in an education and demonstration program to encourage control of weeds. Some few farmers in the area are profiting from herbicide application. Nevertheless the great majority of wheat land suffers severely from weed competitions.

Secondly, we are encouraging and assisting in the development of an active, continuing research program to find the most effective herbicides and get them registered and available for use.

There is increasing evidence that *Bromus tectorum* and *Cynodon dactylon* will soon be major problems in Turkish wheat fields. Work is being initiated to develop programs for their control.

Summary

It should be remembered that the results of the adaptive research on farmers' field must be available before a full package of practices can be made available to farmers. A limited campaign for adoption of the new system is planned to start in the fall and winter of 1973 with seeding in the fall of 1974. This will be after the first harvest from the trial plots of farmers' fields and the third harvest from plots on State Farms and Topraksu Experiment Station. Evaluation of the harvest results from the limited campaign in the fall and winter of 1973 will be possible during the summer of 1975. This evaluation will be the basis of a general adoption campaign for the Anatolian Plateau in the fall and winter of 1975.

Extension Training - Goal

The goal of the training program is to help Turkey achieve sustained self-sufficient wheat production. The strategy is to provide the wheat farmer on the Anatolian Plateau the necessary information and production resources for optimum wheat production in the shortest possible time.

Objectives

The objectives are to help strangthen the communication link between research and extension, and train the extension staff to carry the latest research information to the farmers.

National Extension Wheat Specialists

The action plan to achieve the goal and objectives of training includes several functions. The primary function necessary to provide the communication link with research is the establishment of a National Extension Wheat Specialist (NEWS) team of four persons. This team should include an Agronomist, a Machinery Specialist, a Soils Specialist, and a Plant Protection Specialist (weed control). This NEWS team should be assigned as soon as possible from appropriate Directorates to the National Extension Service, but their offices should be at the National Wheat Research and Training Center. This will provide a day-to-day working relationship with the wheat research staff. The NEWS team will be responsible to convert the latest approved research results into a form that can be understood and used by farmers. Another important responsibility is to serve as the action team in training and support to the Region and Province Wheat Specialist teams. These responsibilities will be coordinated by the Ministry of Agriculture Wheat Project Manager and spend a major part of their working time in the field. This field work consists of helping the Regional and Provincial Wheat Specialists conduct training programs for the County Agents and Village Technicians and farmer adoption campaigns.

Pre-Service Training

Another function of the action plan for training includes the pre-service training of all extension service staff prior to being assigned to a specific position. This function is now in the planning stage and should be initiated as soon as possible. One pre-service training center should be established in each of the twelve Extension Service Regions.

In-Service Training

A third function of the action plan is the in-service training of research and extension staff for farmer training. This function is divided into three phases.

Phase I includes the training of National and Province Wheat Specialists in Research and Extension methods. This training is in two parts. The first part consists of academic training in the fundamentals of technical wheat production and communication skills. The second part is the practical field training, using the demonstration plot as a means of providing a working knowledge of each step in improved summer fallow wheat production.

Phase II includes the training of County Agents and Village Technicians in improved wheat technology, communication skills and campaign methods. This phase also includes establishing demonstration plots in each of the Wheat producing counties in the 25 priority provinces in 1973. A team of training specialists from Ankara should visit each province as a follow-up to Phase I to assist in planning training prorams in the provinces.

Phase III includes the training of farmers and the adoption campaigns for wheat production. The information for this campaign activity for 1972 will emphasize improved seedbed preparation, using locally available tillage equipment, high-yielding varieties, optimum fertilizer use and weed control. The main teaching tool for this phase is the series of flip charts being developed and other visual aids, such as color slides, 8 mm movies, hand-out leaflets, and posters.

Out-of-Country Training

The fourth function of the training action plan involves the coordination of out-of-country training of participants. The emphasis for this training will be to prepare selected individuals as "teachers of teachers" for the cereals project. This training is planned in other countries to include academic training and practical field training at CIMMYT in Mexico and the U.S. or other similar places.

Long-Range Plans

Plans for training in wheat production and campaign methods in the future provide for a continuation of the 1972 improved conventional system campaigns in additional provinces each year until 45 wheat producing provinces have been trained.

At the same time the conventional system campaigns are in progress, a parallel campaign program is planned in only five provinces where

the new summer fallow moisture conservation system is being developed. The first of these limited campaigns will not be initiated until after the harvest of the research and adaptive research trial plots have been completed in the summer of 1973. The evaluation of this harvest information will provide the basis for recommending a "Package of Practices" in the soil moisture conservation summer fallow system. If research results continue to be as favorable as at present, a limited campaign can be conducted in the fall and winter of 1973.

A campaign to expand the adoption of the soil moisture conservation system to the entire Anatolian Plateau is not planned until after the harvest in 1975 of the results of the limited farmer campaign in five provinces initiated in 1973. At this time harvest results will also be available for analysis from three harvests from adaptive trial plots on farmers' fields and five harvests from the research trials on State Farms and Research Stations.

Summary

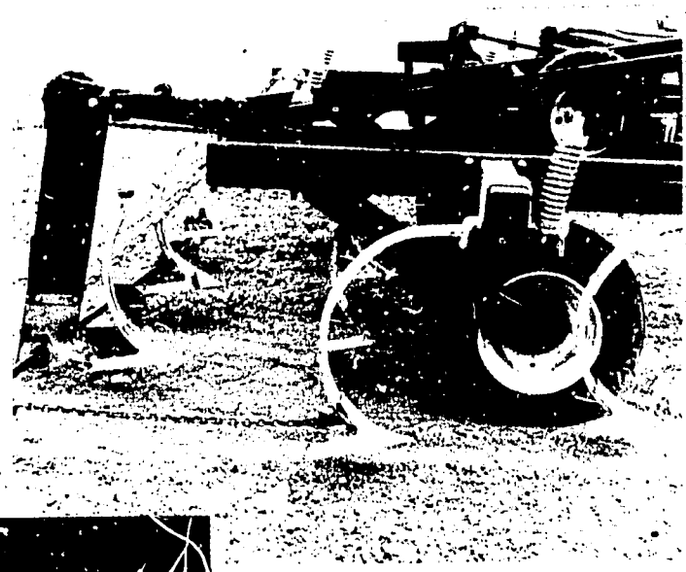
We have very briefly described the soil tillage and agronomic research programs being conducted by the National Wheat Research and Training Center.

Based on the results from that program an adaptive research and demonstration effort on farmers' field is underway supported by the OSU/USAID wheat team.

Concurrently a training and education program is in progress, supported by both of the above groups. This program is designed to include national level specialists, province, county and village level technicians and result in farmer education compaigns for the adoption of improved technology as it is developed.

We believe that this approach to the problem including research, training and education will result in increased cereal production in Turkey.

Use of fertilizers



Use of new or improved tillage and seeding equipment

Use of new and improved varieties of seed

Soil moisture conservation (improved summer fallow tillage)

Use of pesticides and herbicides

In the narrative section of this report we indicated that the USAID/OSU cereals teams' primary emphasis for increased cereals production has been directed toward the following. The continuation of the research and adaptive research projects now underway to develop a mulch/fallow system, utilizing new and special techniques and the development of an effective extension and farmer education program covering the following items as pictured on this page.

FALLOW FARMING ILLUSTRATIONS

The following pages illustrate some of the machines used in fallow farming systems. They depict successes and failures and illustrate the reasons for the results achieved with the various implements.

As experience and research results indicate these machines may be modified or different ones developed to achieve optimum soil conditions.

Figure 1

Figure 1 illustrates the ideal soil surface. This type of surface mulch produces an excellent seedbed and will conserve moisture. This was prepared by 4 tillage operations. One initial tillage operation in the spring and three follow-up operations during the summer.

Figure 2

When summer fallow has been prepared properly, a mulch will have been established to a depth of 12-13 cm. When the mulch is removed, the soil profile will be firm and moist. The darker area just below the rule in this figure illustrates the moisture level. Note the very fine soil particles located in the lower portion of the mulch. The operation of the summer tillage equipment tends to sift these fine particles downward. This helps prevent the loss of moisture during the hot, dry summer months.

The following pictures show some of the problems inherent with the traditional summer fallow system practiced by many of the Anatolian farmers in Turkey.

Figure 3A

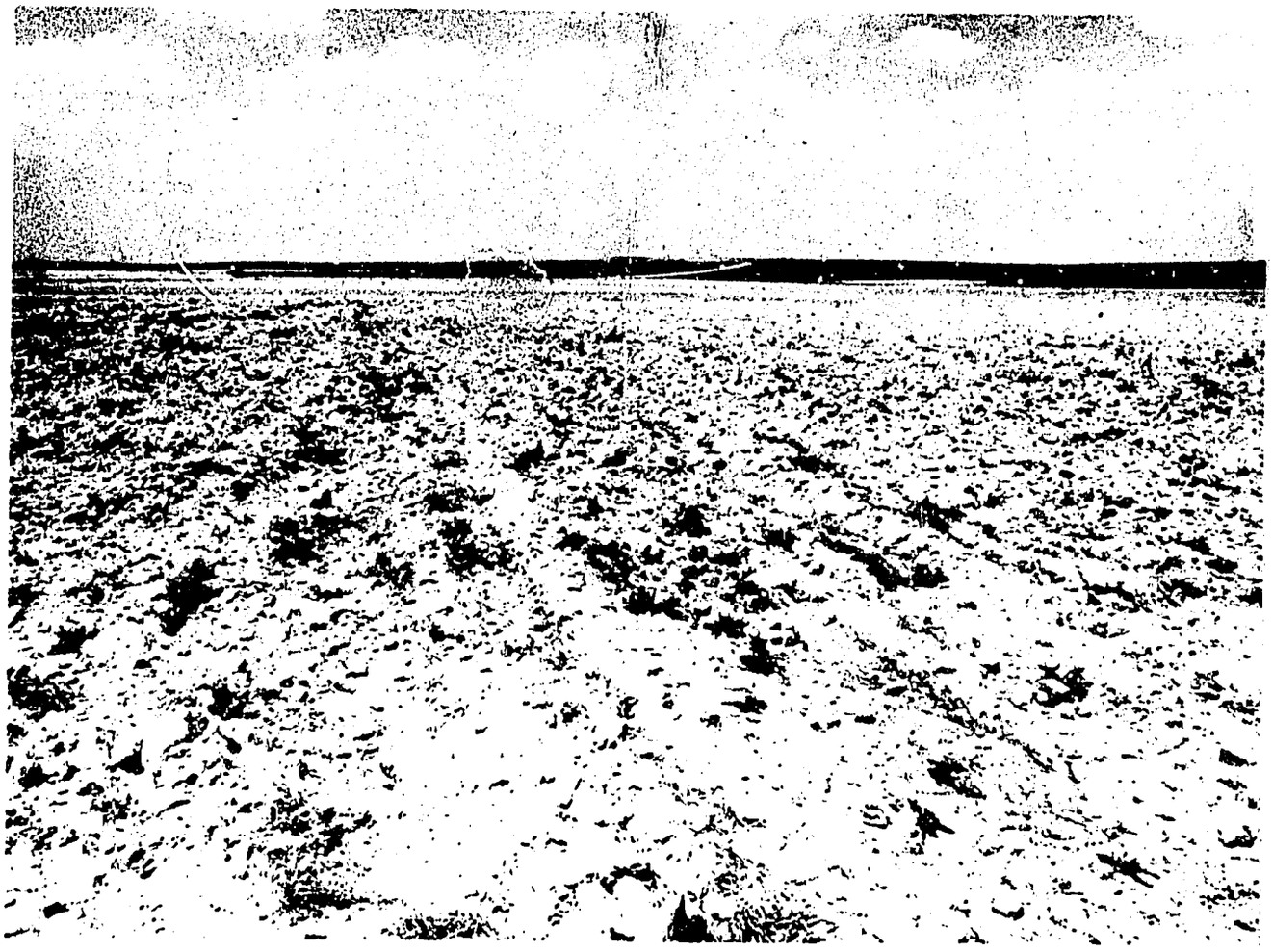


Figure 3-A shows summer fallow that will not conserve moisture because of lack of weed control. The weeds act as water pumps and any moisture that may be in the soil profile will be used by the weeds.

Figure 3B

This creates further problems such as in figure 3-B. As weed growth occurs, sheep or cattle graze the field for forage. This creates some compaction in addition to the loss of moisture.

Figure 3C

Figure 3-C illustrates one of the types of summer fallow that has been created by tilling the soil at the wrong time. This leaves the fallow very rough, losing moisture and the farmer will have to till again prior to seeding. Leaving the soil in this condition throughout the summer not only loses moisture but prevents the farmer from preparing a good, uniform seedbed. With this type of seedbed the Anatolian farmer will have to use from two to three times the seed that is necessary if a good seed bed is prepared. If the lower seed rate were used over the entire Anatolia, there would result a saving of up to 500,000 tons of wheat per year. Seed planted under these poor conditions germinates slowly, not uniformly, and the farmer is required to plant late in order to ensure germination from the late fall rains. When the wheat plant develops under these conditions, root development is slow, and the plant depends upon the later spring rains to produce a crop. Yields are lower. This accounts for the erractic production of wheat in this country (figure 4).

Figure 4

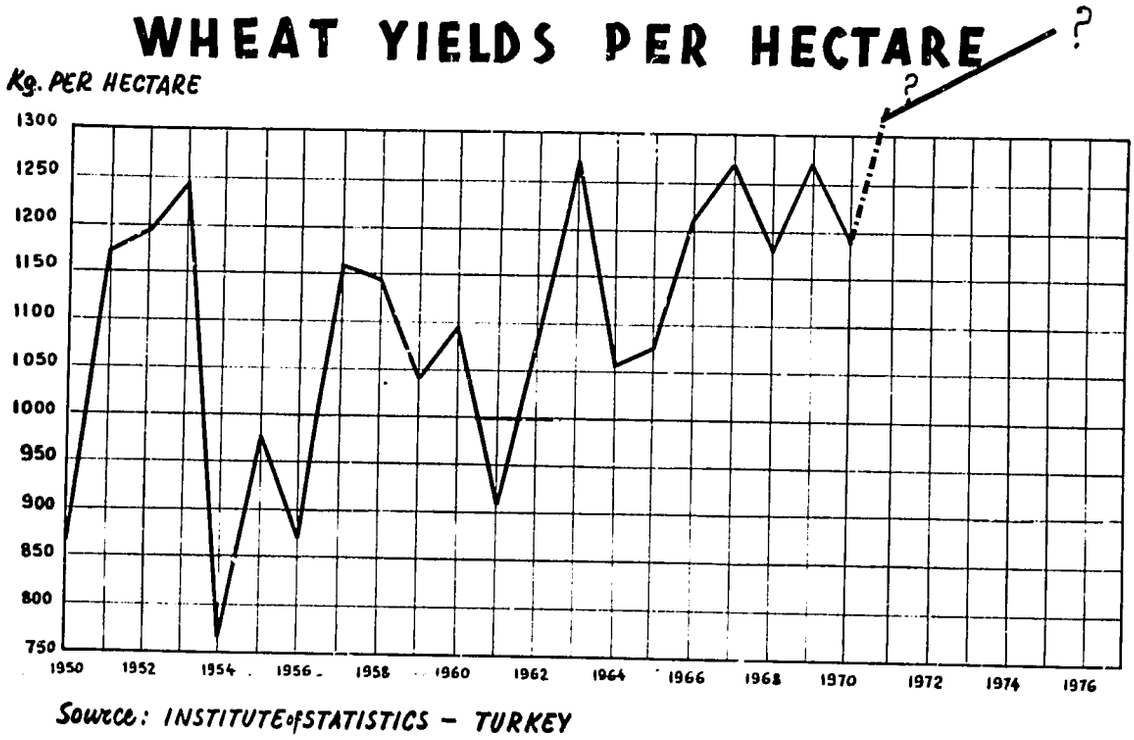


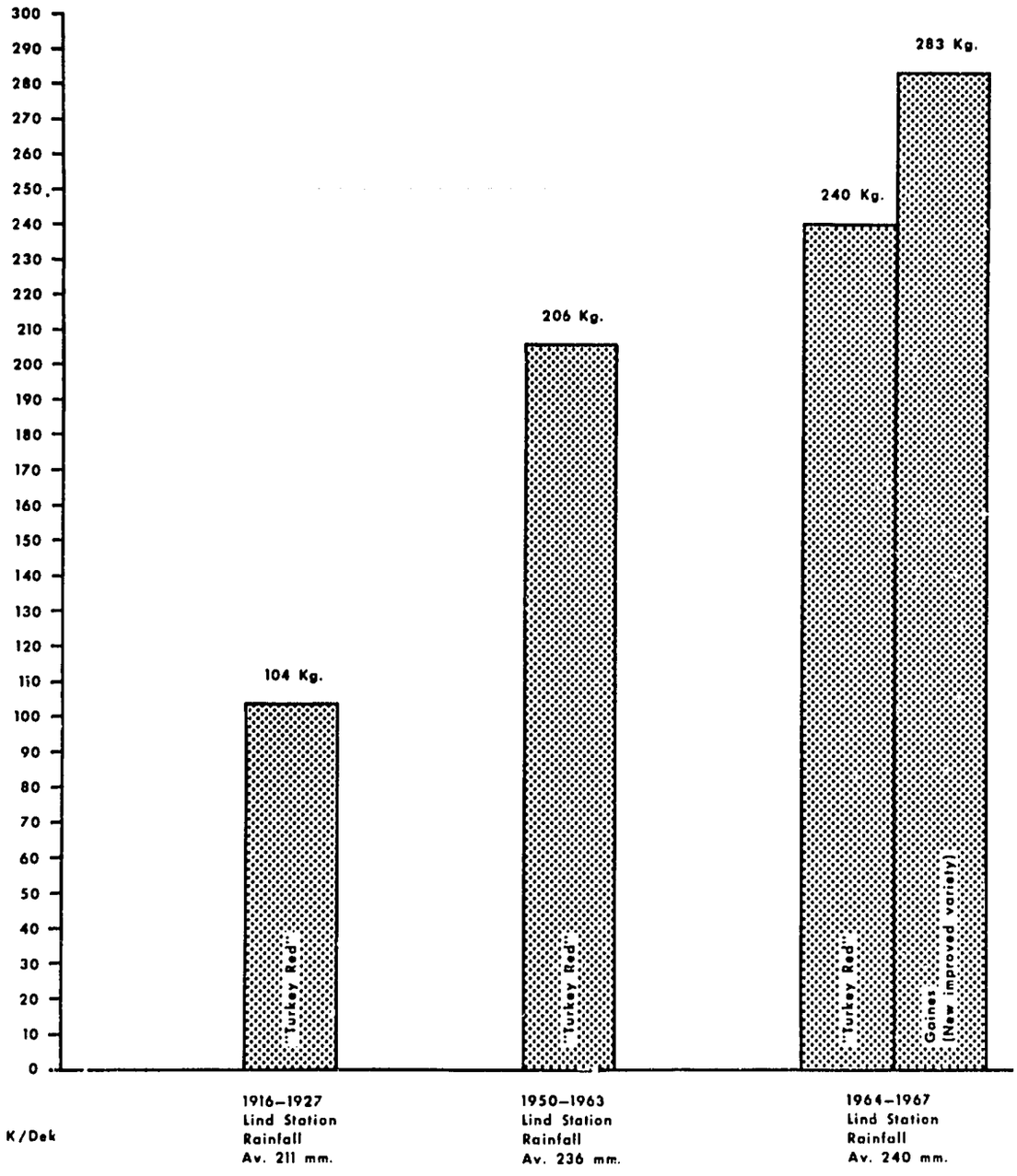
Figure 4 depicts wheat yields per hectare in Turkey over a 12 year period. The erratic production is largely due to the dependence upon the fall and spring rains. If the fall rains are early and the farmer has the seed in the ground the wheat plant germinates and gets off to an early start. Then if the spring rains are adequate and timely particularly in April and May, the production is above average, represented by the peaks on the chart.

This combination of favorable weather is very undependable and does not occur during the average year. Normally less favorable weather factors prevail and the wide range of yields as represented on the chart is the result.

The objective of the efforts to develop a new system of wheat production is to reduce the wide annual fluctuations in yield be insuring a more constant soil moisture condition. When this is achieved, new varieties, higher rates of fertilizer and other yield improving practices can be employed to raise the average annual yield per decare.

Figure 5

YIELDS ON "TURKEY RED" WHEAT VARIETY SHOWING EFFECT OF IMPROVED AGRONOMIC AND TILLAGE PRACTICES DURING 50 YEARS OF CONTINUOS RESEARCH *



* Dryland Research Station Lind, Washington

Figure 5 is a graph showing research information compiled by the Dry Land Research Station in Lind, Washington, located in the U.S. Pacific Northwest where the summer fallow system that has been

developed in that area has been successful since about 1940. The graph shows that Turkey Red, a variety which originated and was grown in Turkey, produced about 104 kg./decare from 1916 to approximately 1940. The system used in the Lind area prior to 1940 was very similar to the system being practiced by the Anatolian farmer today. About 1940 the improved summer fallow system was developed. Moisture was conserved during the fallow year by applying certain tillage practices at the right time, seed was planted early into moist soil and the plant did not have to depend as heavily upon the fall and late spring rains and as a result yields were doubled. Then in the early 1960's, with the addition of fertilizers and herbicides, yields from the same variety were increased again by about 34 kg./decare. With the development of new higher yielding varieties (HYV) the yields increased another 43 kg./decare. It is important to point out that the most significant increase occurred from the development of a moisture conserving fallow system. By getting the plant started early, it could better utilize the early spring rains and it did not have to depend upon any late spring rains to produce an average crop. The use of herbicides, fertilizers and HYV's are also important but the responses from these inputs would not be nearly as significant as depicted on the graph without the improved fallow system. It is a package of practices or inputs that make this system successful, and the most important input is the moisture conservation technique. It is for these same results that the OSU/USAID wheat research team is working in Turkey. The Team believes, from the research conducted thus far, that a system can be adapted under Turkish conditions which will result in yield increases similar to those that have been attained in the Pacific Northwest of the United States.

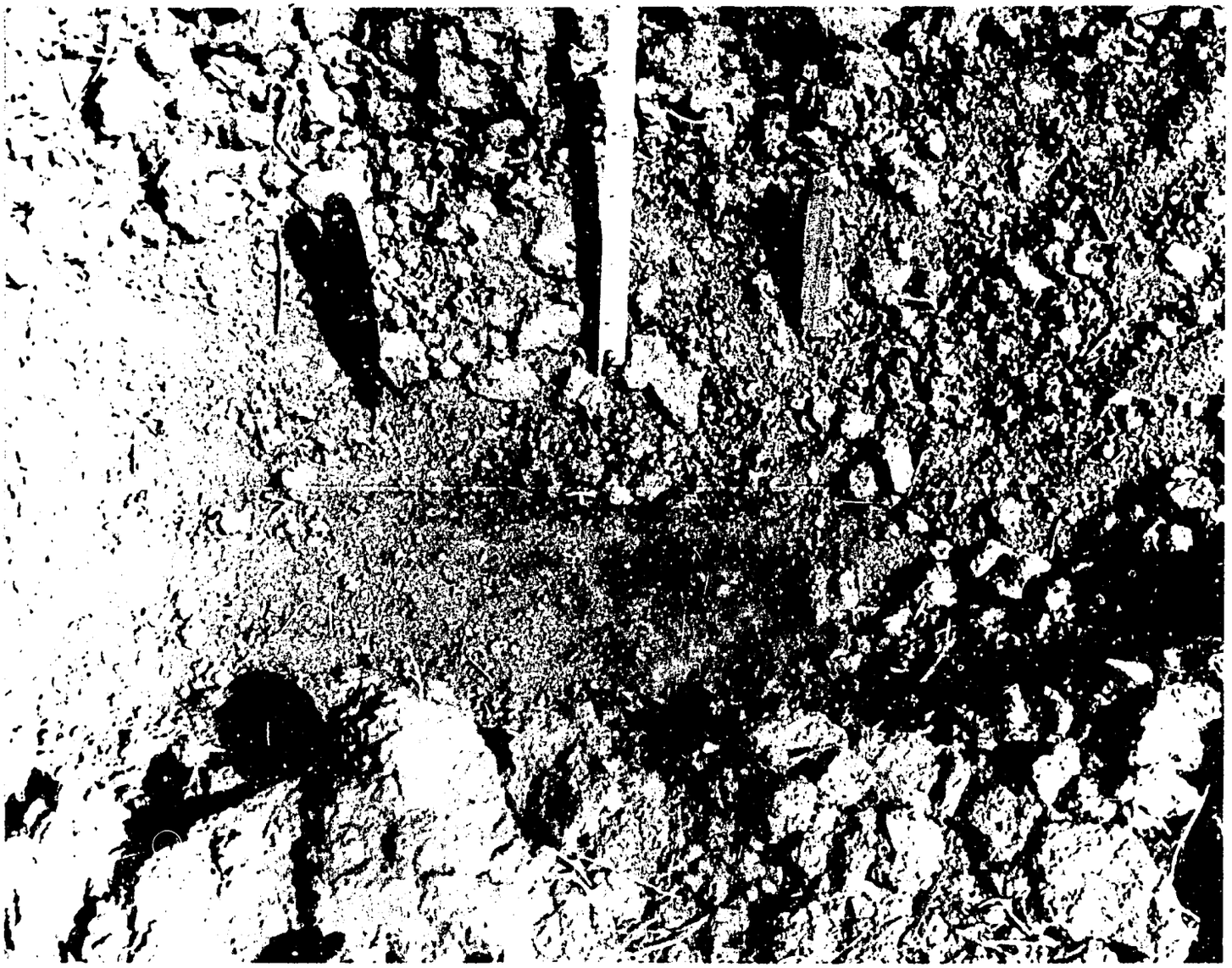


Figure 6

Figure 6 illustrates a soil profile which is considered a poor mulch. The depth of this mulch is about 12 cm., the same as in figure 2. The difference is the size of the soil particles. A mulch, as pictured above, with much larger soil particles and hard clods will not hold moisture for any length of time. During the hot summer weather there will be rapid loss of moisture and thus there will not be enough moisture close to the surface to allow early seeding. This condition was caused by tilling the soil too late in the spring. The soil was too dry at time of tillage and the equipment was unable to break the soil into small particles and form a proper mulch. Subsequent tillage will help but a considerable amount of moisture loss has already occured. Tilling the soil at the proper time is one of the most important aspects in developing a good mulch and holding the moisture throughout the fallow year.

Figure 7

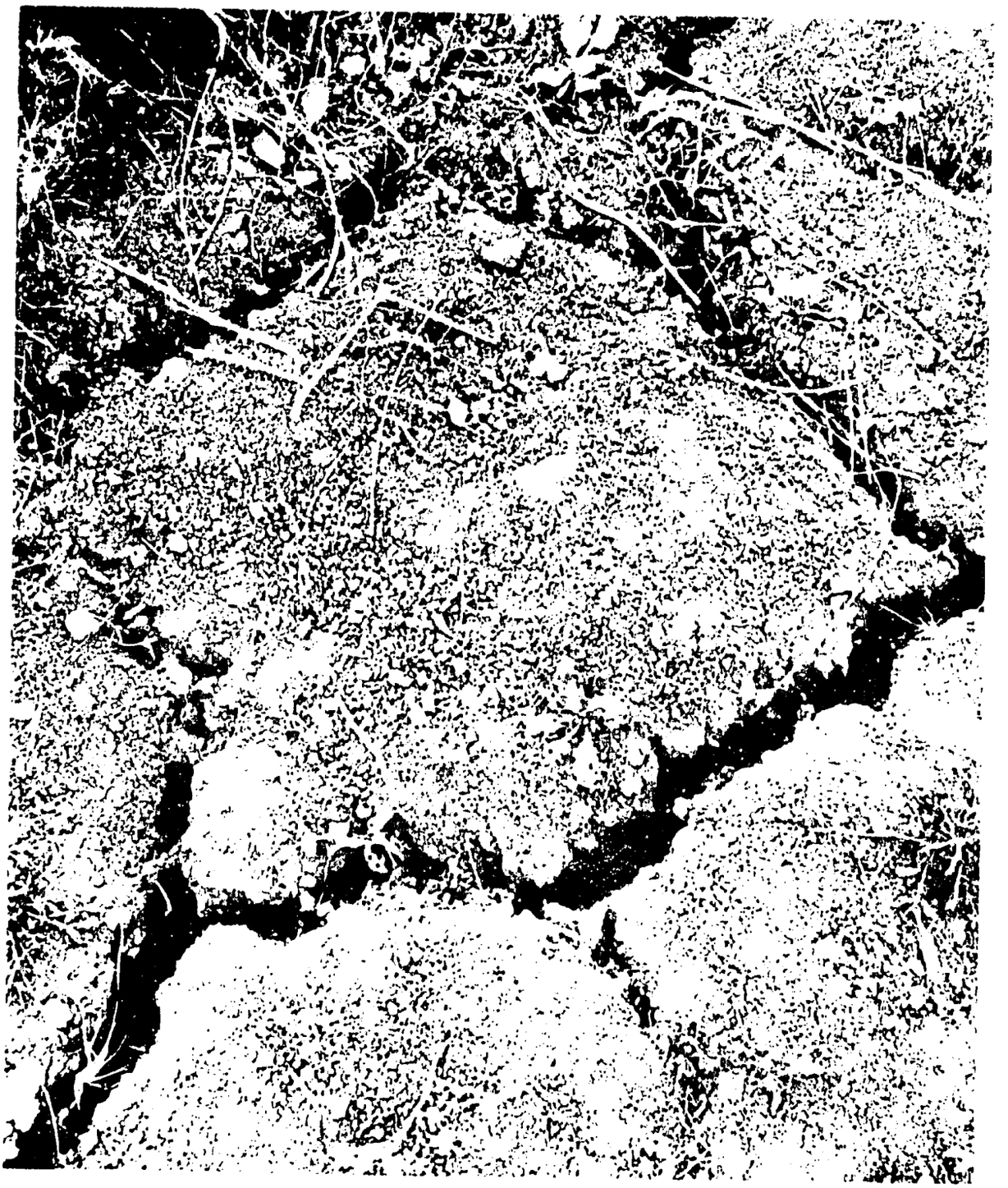


Figure 7 illustrates what happens when the farmer waits too long in the spring for initial tillage. The soil has been allowed to dry out and large cracks appear. There is no moisture stored from this type of fallow system. When the farmer does till this land it will appear as the seedbed in Figure 3.C.

Figure 8

When the soil is allowed to dry out well below the depth of tillage, such as is figure 7, and then tilled, very large clods are formed which are almost impossible to break up with any further tillage. Timing is very important in preparing a good seedbed in the heavy clay soils in Turkey. If this soil had been tilled earlier when there was still some moisture in the soil profile, the tillage implements would have broken down these large clods and a good seedbed and mulch could have been formed.

Figure 9

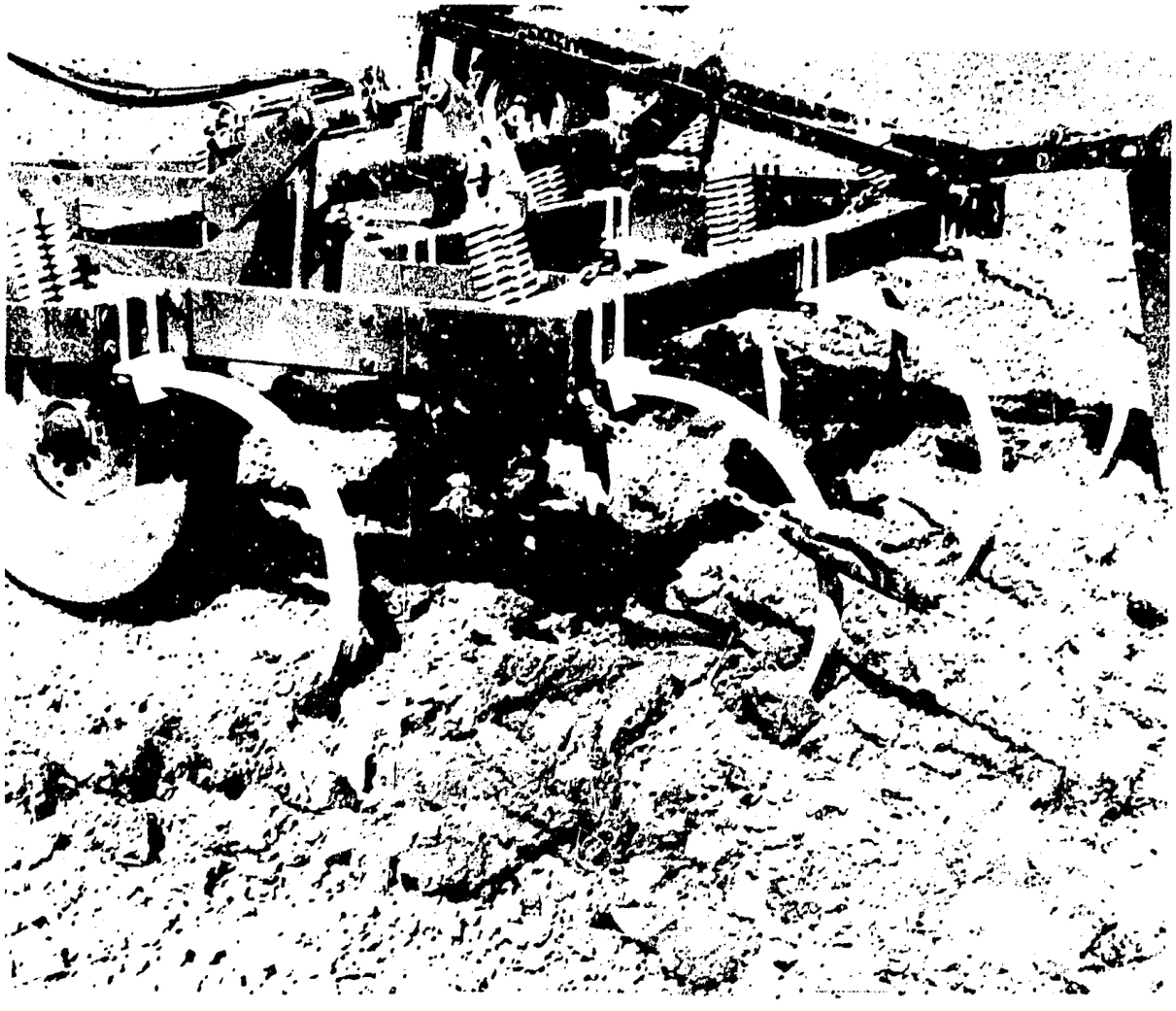
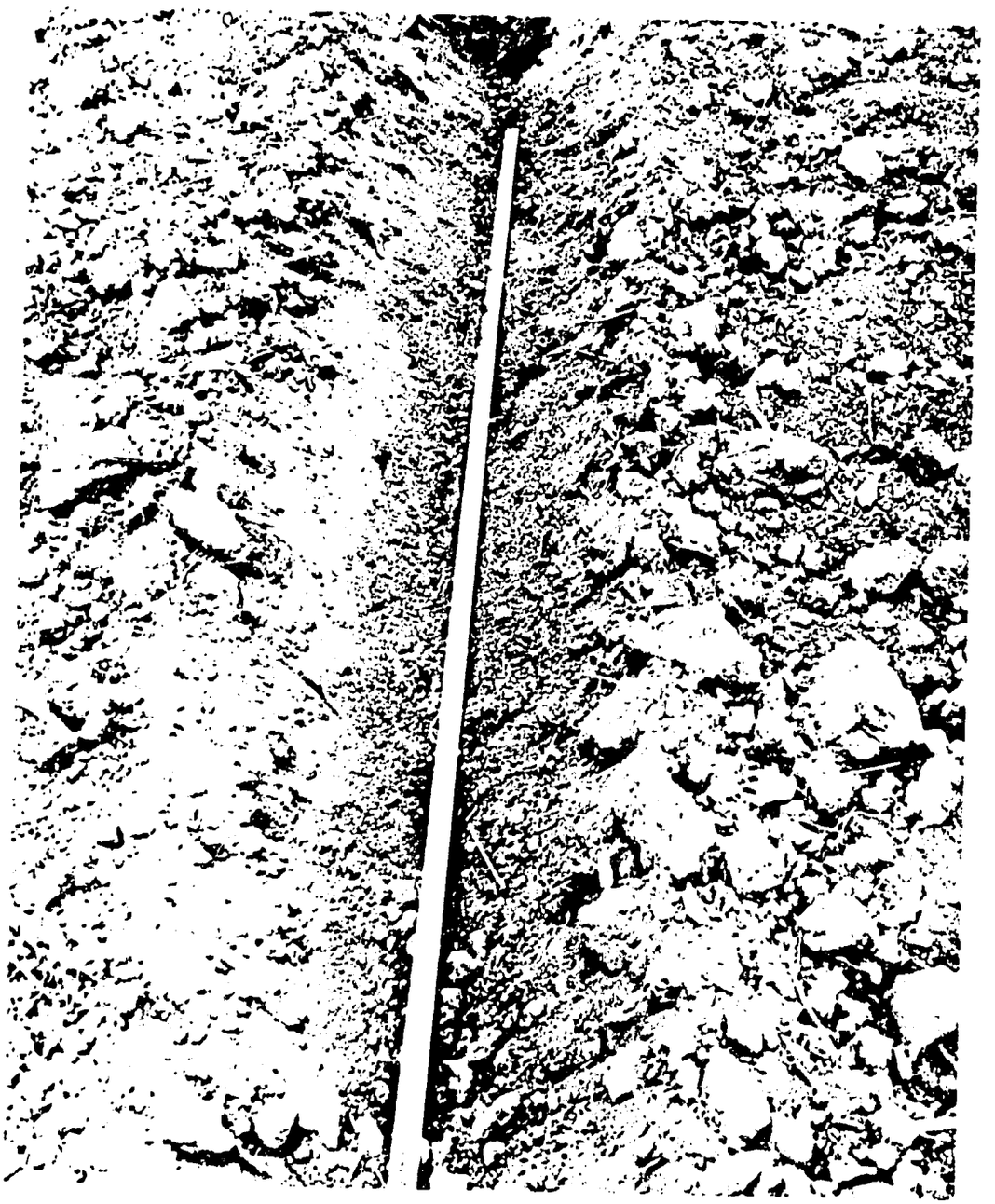


Figure 9 again illustrates the importance of correct timing of tillage operations. Tilling the soil when there is too much moisture in the profile may cause as many problems as when tillage is too late. If the soil profile is too wet, the implements will cause very large clods to be formed. As these clods dry out they become very hard due to the high clay content, and it is impossible to break them down into small enough particles for proper seedbed or mulch to hold the moisture.

This report stresses the importance of timing the tillage operation in the preparation of a mulch which will hold moisture in the profile during the summer. Research is beginning to indicate an important factor: that tillage at the proper time may be more important than the specific tillage implement used. So long as the implement being used performs the required operation in developing or maintaining a mulch then the time of the operation may be more significant than which implement is used.

Figure 10

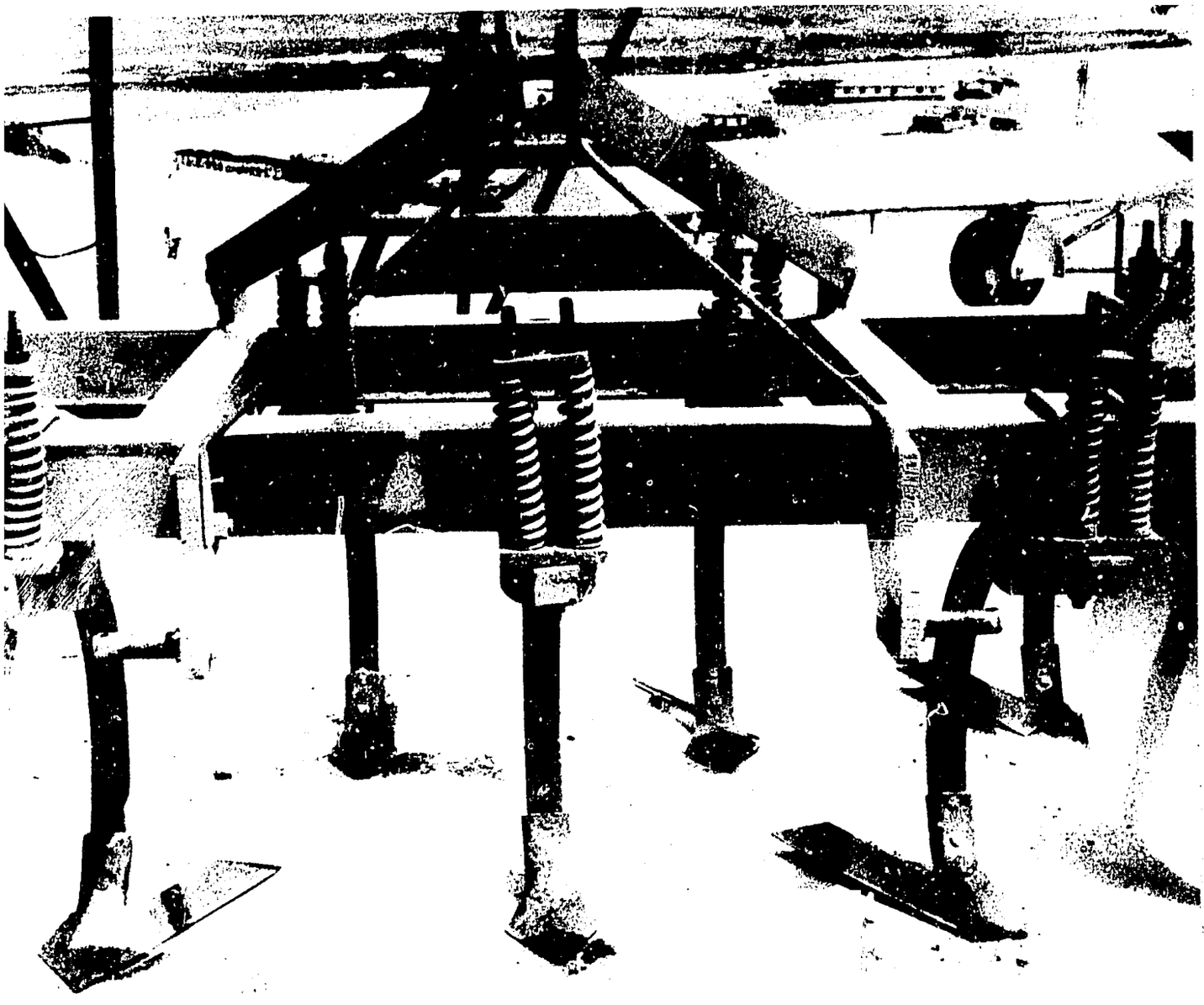


A field that has been tilled at the right time with equipment properly designed and correctly adjusted will produce a uniform seedbed as shown above. Here the mulch, which is 10-12 cm. deep, has been scraped away to show that the seedbed is firm and level. There should be no ridges or humps under the mulch and the seedbed should be composed of uniform-sized soil particles.

Figure 11

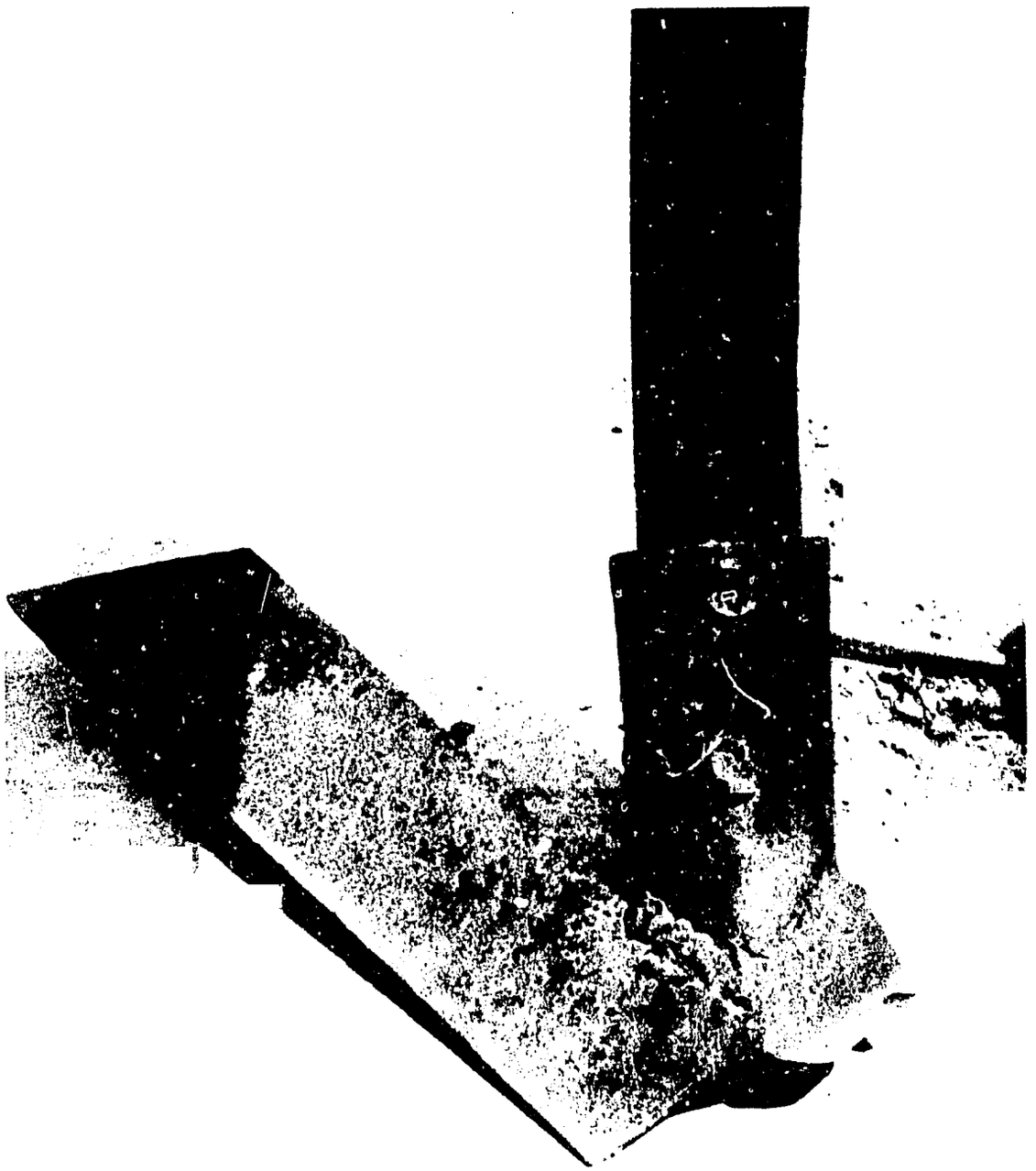
A poor seedbed will result if tillage equipment is improperly designed or incorrectly adjusted for operation. The unsatisfactory seedbed shown above resulted from a broken sweep being used. Note the hard ridges that cross the seedbed at the bend in the tape measure. Note also that the knife does not penetrate this ridge as deeply as does the second knife placed further along the seedbed. If a rodweeder is to be used in this field, it will not give satisfactory results because of the ridges in the seedbed.

Figure 12



Implements that are not maintained correctly, such as the sweep plow shown above, will also create an uneven seedbed. This sweep plow will leave hard, untilled ridges under the mulch similar to that shown in figure 11.

Figure 13



When this implement was used the tractor driver never looked back or bothered to check his implement to see if all the sweep blades were attached. Using the implement with many of the sweep blades broken will cause ridges similar to those shown in figure 11. If all the sweep blades had been attached, each blade would overlap the one next to it and these ridges would have been broken down. If a rodweeder is used following this sweep plow, it will not be able to do the job it was designed to do.

Figure 14

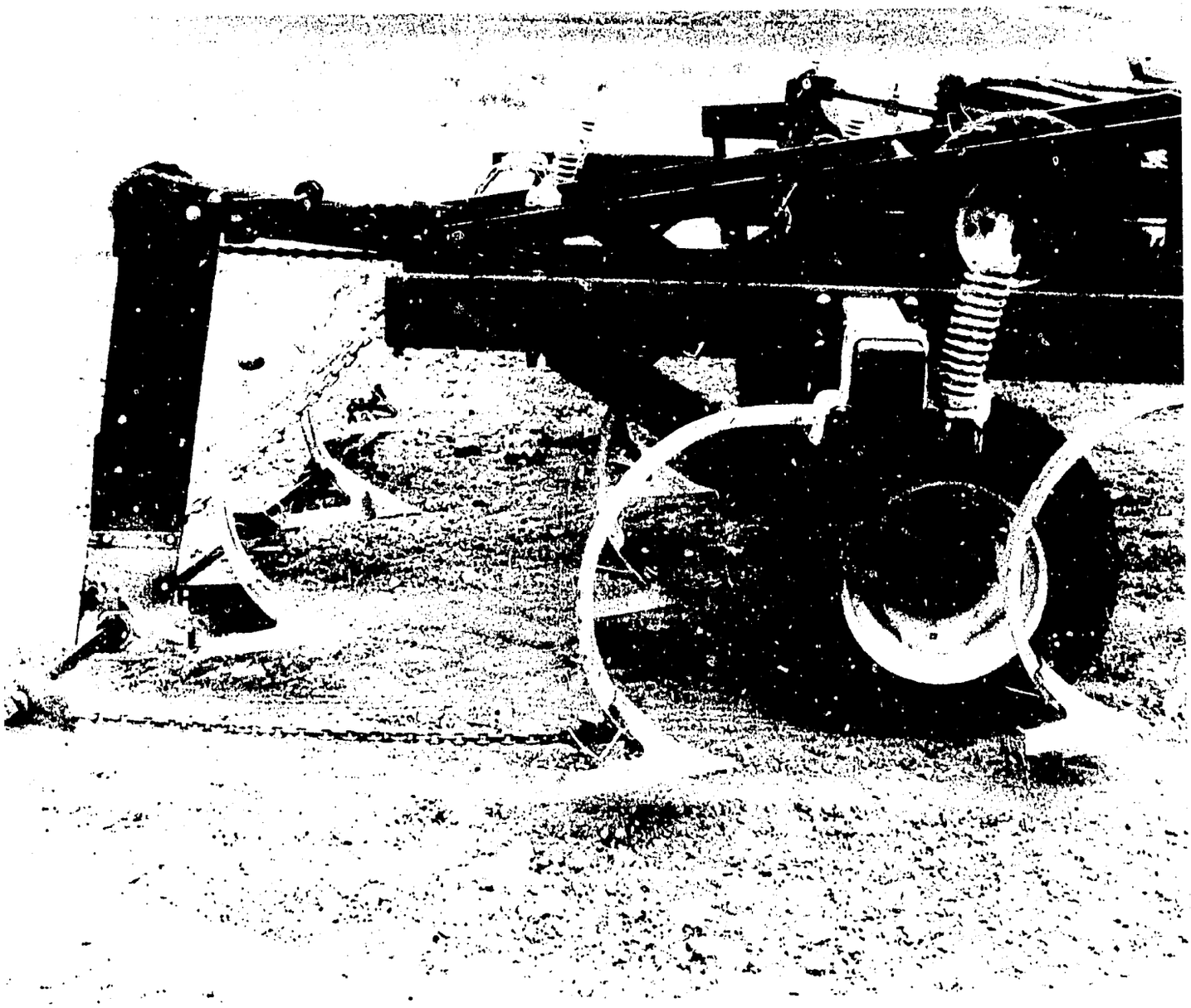
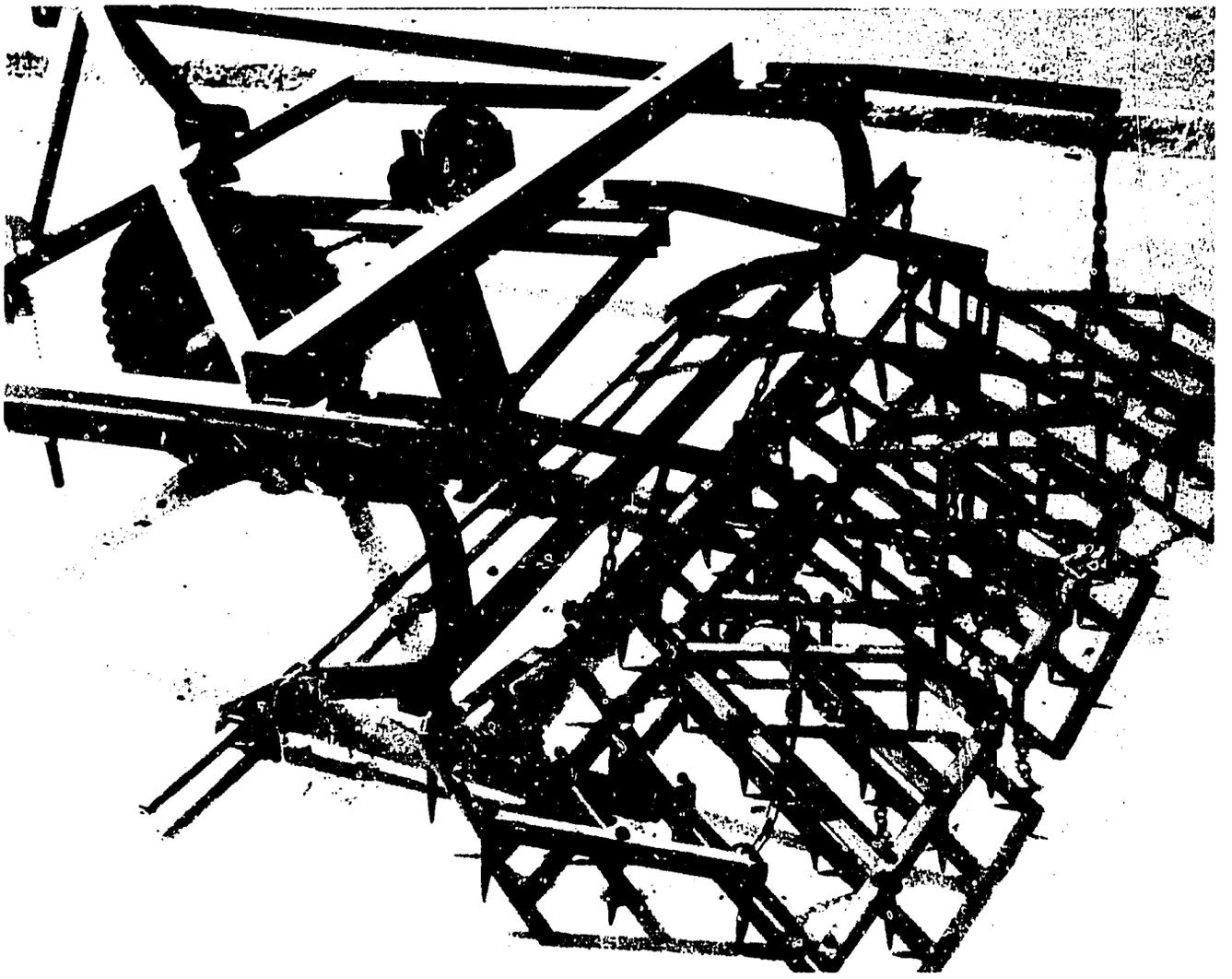


Figure 14 illustrates equipment that is properly maintained, in good working order and adjusted correctly. If sweeps are broken then they should be replaced immediately, not at the end of the day. The farmer should have some replacements with him so that this can be done in the field.

Figure 15



This rodweeder does not have a set of gauge wheels, therefore it cannot be properly adjusted for depth. If the rodweeder is tilted from one side to the other, the center drive wheel will not keep the rod in the ground at the proper level or depth. All rodweeders should not be condemned based on unsatisfactory experience with a poorly designed machine. A rodweeder, when properly designed and operated, will do a good job in weed control and preparation of a mulch and seedbed in Turkey.

Figure 16

A properly-designed three point hitch rodweeder with gauge wheels will do a good job of weed control as well as formation of a mulch and seedbed. This is particularly true if the initial spring tillage operation has been performed correctly. If the seedbed has ridges as shown in figure number 11, then the rodweeder cannot perform the job it was designed to do.

Figure 17

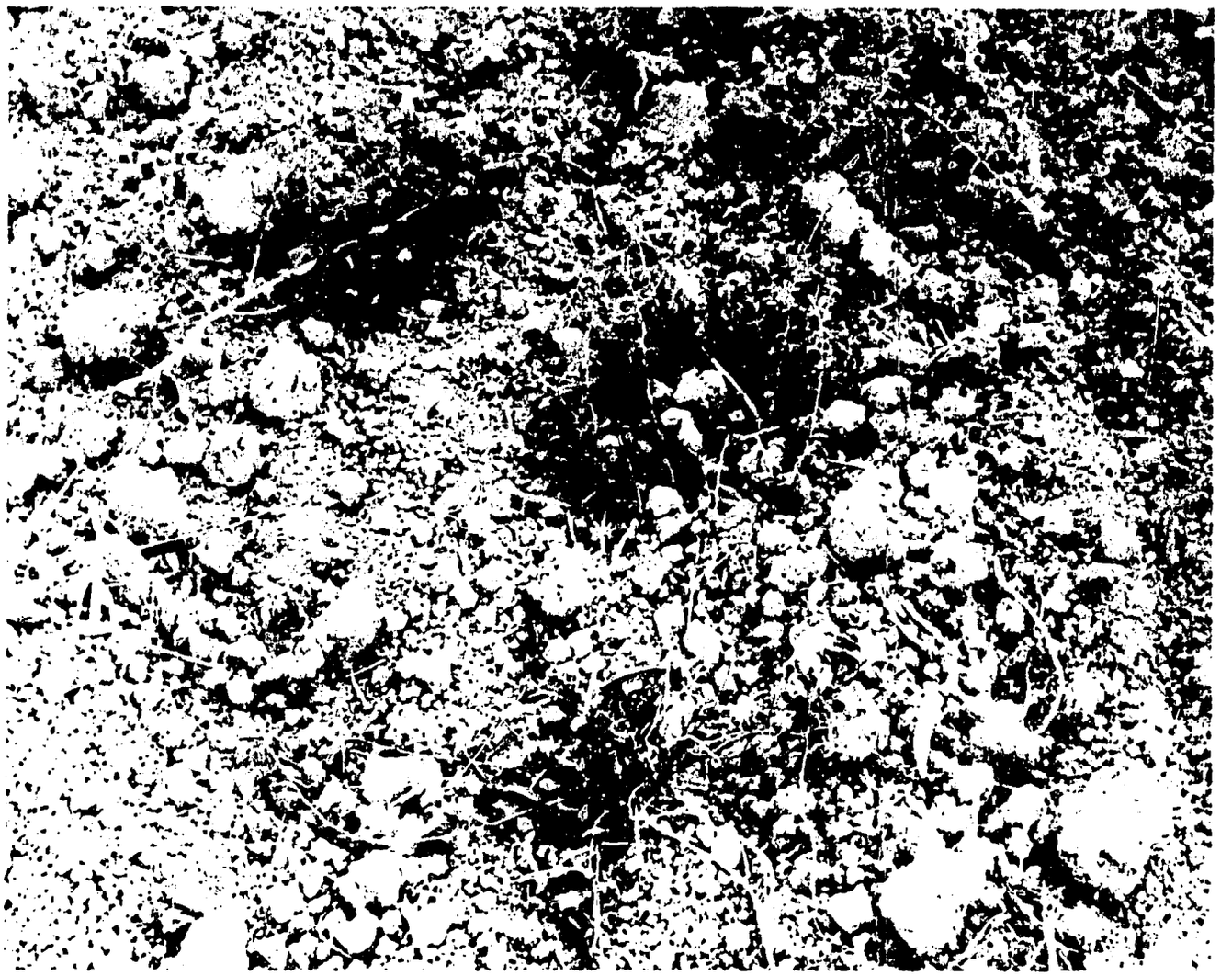


Figure 17 illustrates the effect of the action of the rodweeder. The primary function of the implement is to control weeds during the summer fallow tillage operation. However, when the rodweeder is used it also firms up the seedbed and will sift the finer soil particles downward. With the finer soil particles being sifted downward, a dust mulch is established. This forms a moisture barrier so that a minimum of moisture is lost from evaporation. When the smaller soil particles are sifted downward, the larger ones are left on top. This also helps to prevent excessive wind erosion. The specific action of the rod as it is pulled through the soil literally rolls the weed, including the root system, out on top of the soil. With the root system exposed as pictured above the weed dries up very quickly.

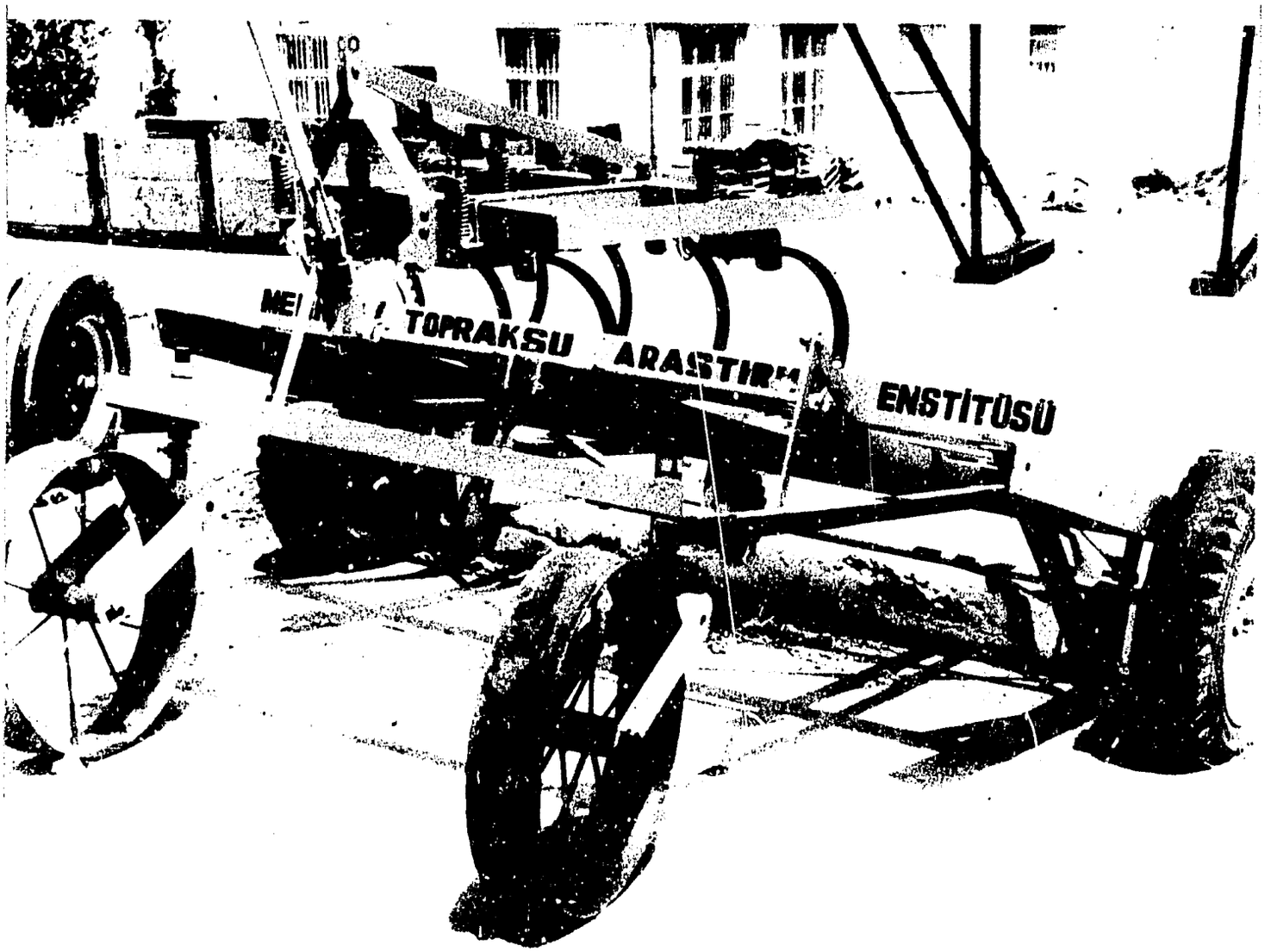


Figure 18

The rodweeder pictured in figure 18 was manufactured in Turkey. It is a pull-type implement designed similarly to rodweeders used in the Pacific Northwest of the United States. This implement is satisfactory in that it has a set of adjustable gauge wheels and will operate with some degree of uniformity. One of the biggest problems facing local manufacturers of tillage implements for dry land wheat production is the shortage of hard steel. This is particularly important in the manufacture of the blades for the sweep plow. Soft steel wears out or breaks very fast. Specially hardened steel is also required for producing the bearings that hold the rod in the rodweeder and for the rod itself if the machine is to last for several seasons.

Figure 19

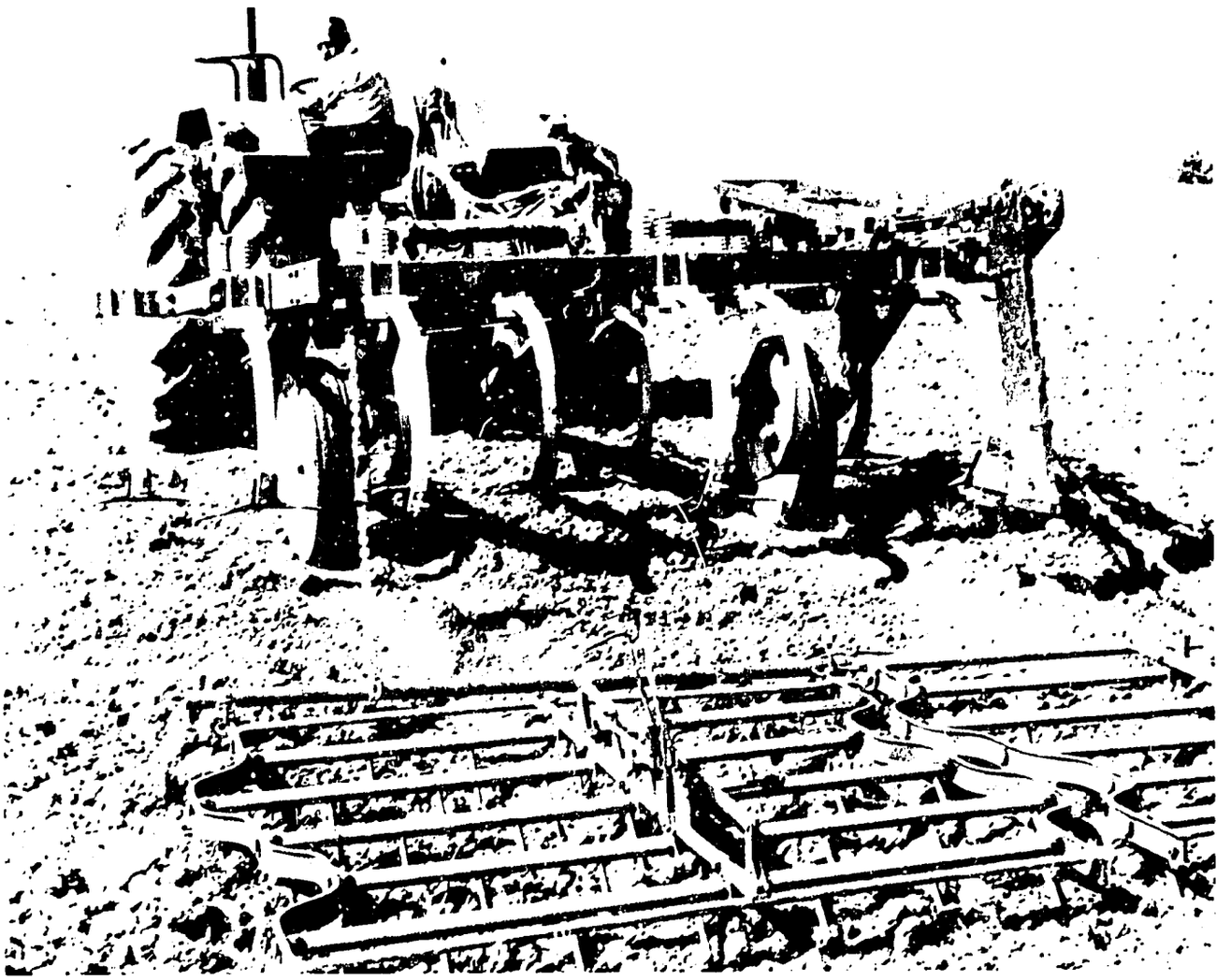
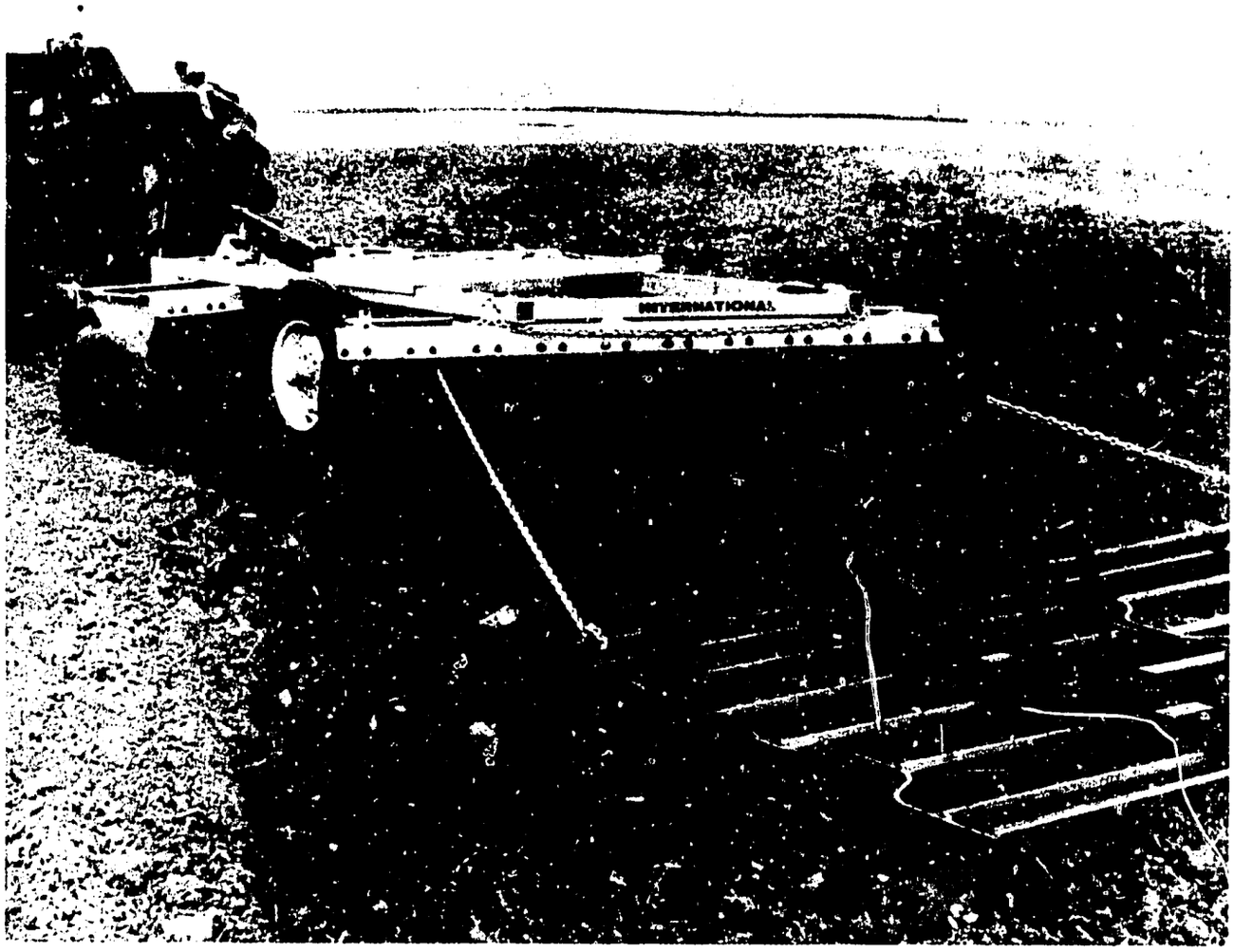


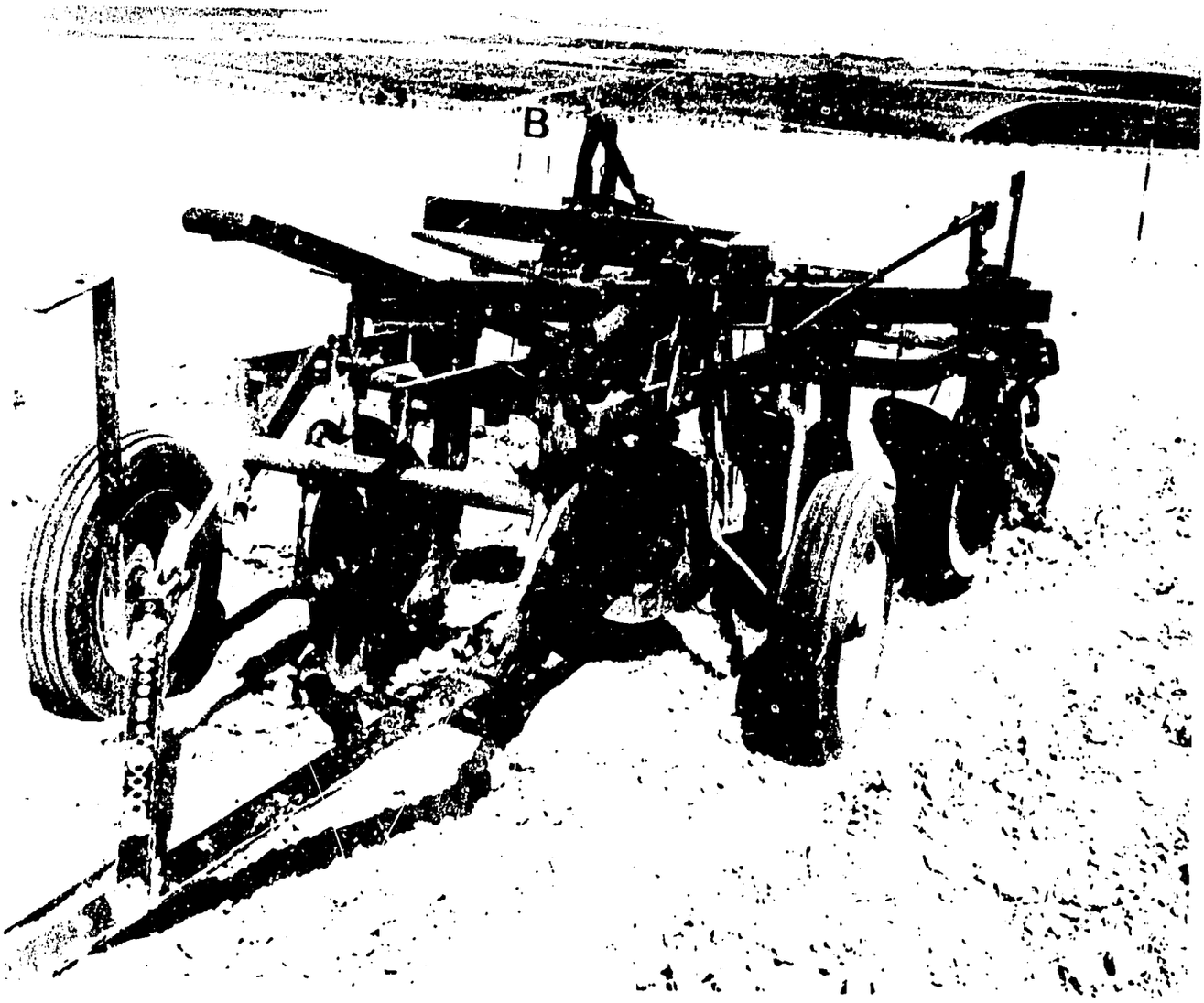
Figure 19 shows a sweep plow with harrow attached. This combination is used for research trials. This implement appears to be quite versatile, having the capability to perform many jobs of tillage. It can be used for fall chisel, initial spring tillage with sweeps and summer tillage for weed control. Research information to date indicates that this implement combination is just about as good as the other implements or combinations being tested.

Figure 20



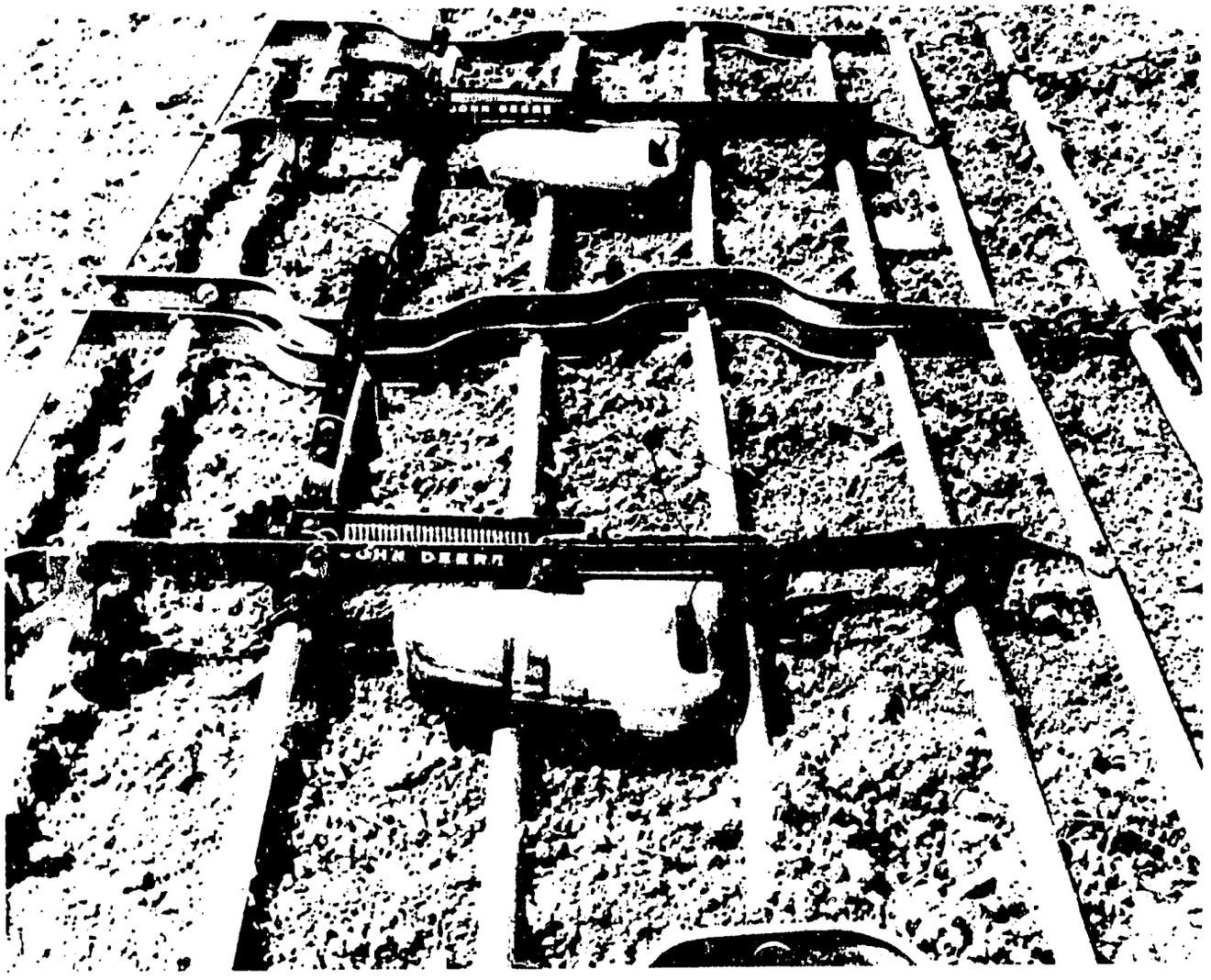
The offset disk(figure 20) is relatively new to Turkey. Research teams are experimenting with this implement as one possibility for replacement of the moldboard plow. It has a higher horse power requirement than the moldboard plow used in Turkey but it is faster and appears to do as good a job in initial tillage. It does not turn the stubble under as the plow does but mixes the stubble with the soil. At the present time this implement cannot be adapted successfully to a three point hitch because of the weight of the implement. In order to operate satisfactorily, this implement must be fairly heavy; therefore it is being used as a pull-type implement.

Figure 21



The moldboard plow (figure 21) is a very popular implement, used extensively on the Anatolian plateau.

Figure 22



The spike tooth harrow (figure 22) with adjustable teeth is simple in design, but has proven to be one of the most important tillage implements for preparing a seedbed. It is attached to every spirng and summer tillage implement. In the first few tillage operations weights are added. As the mulch and seedbed are formed and the clods are broken up, the weights can be removed. The weights used in this picture are regular tractor weights. We may find that subsequent summer tillage may not need the harrow attached.

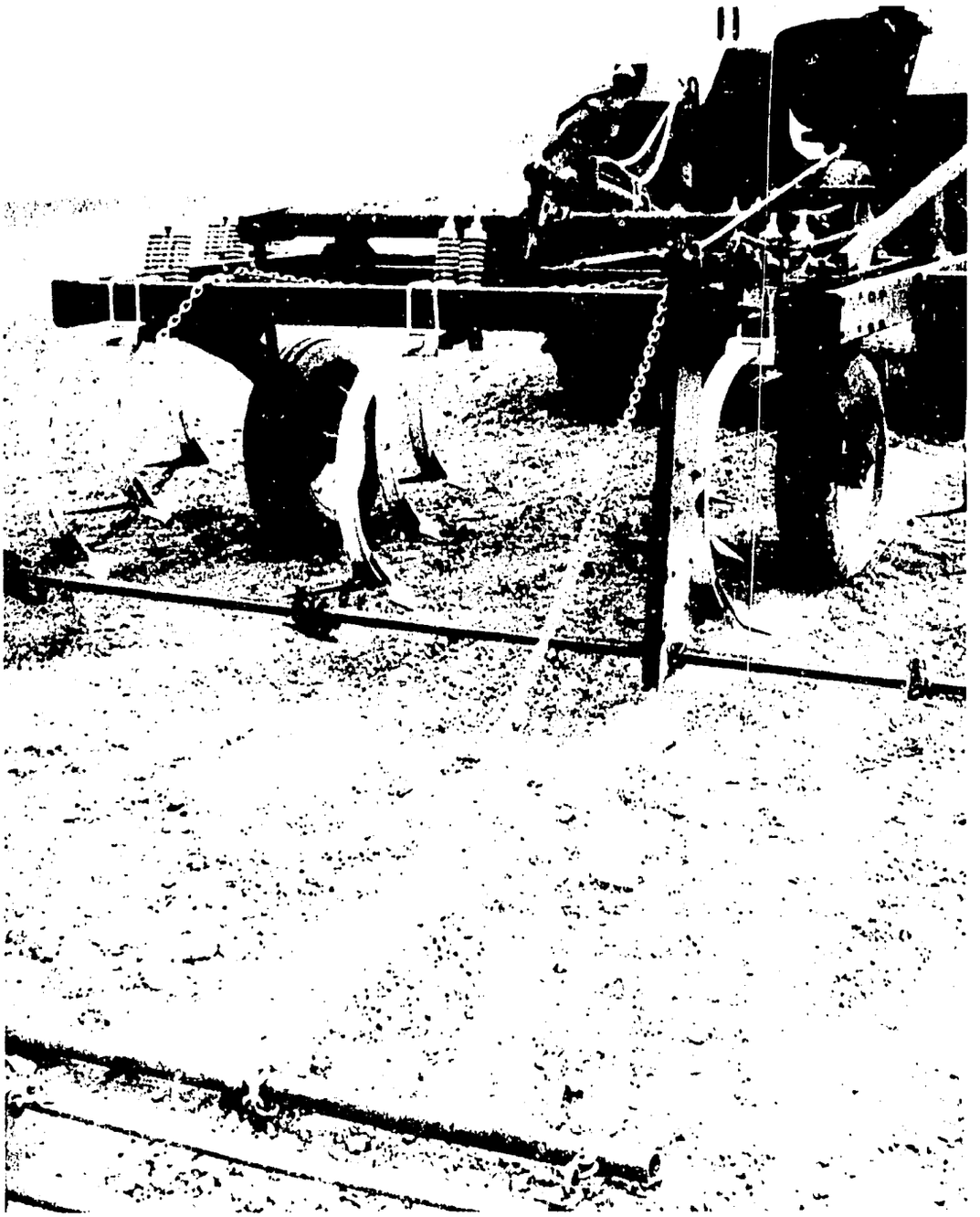
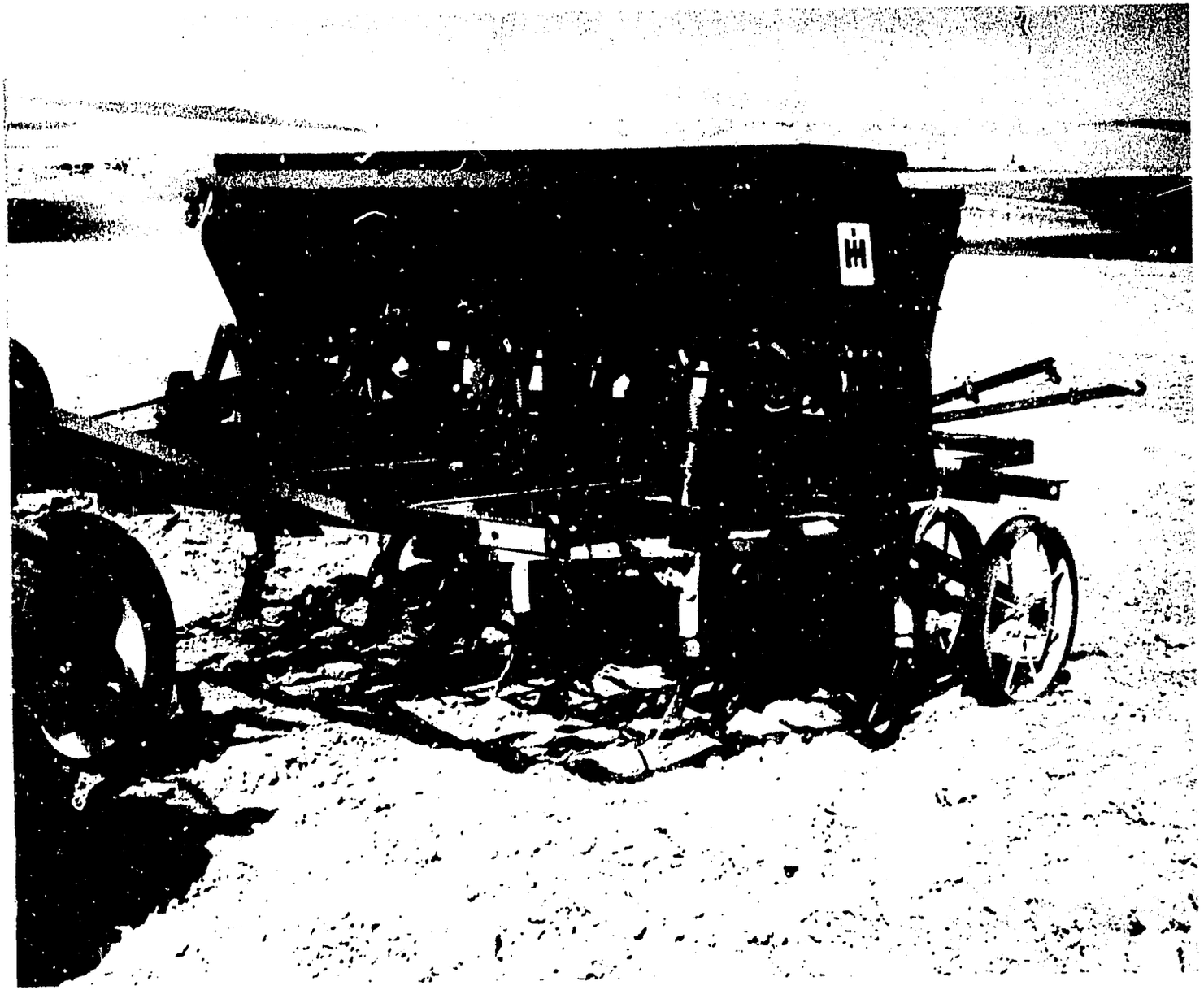


Figure 23

The sweep plow is also a very versatile implement. If research indicates that the rodweeder has a place in the tillage practices, the attachment pictured here (figure 23) can be adapted. Experience in tillage research trials indicates that repeated rod weedings excessively compact the seedbed and decrease the thickness of the mulch. Sometimes it becomes impossible for the rodweeder to penetrate to the desired depth. This is particularly true when a number of rodweedings are required throughout the summer. The sweep rodweeder combination (above) makes penetration possible.

Figure 24



The deep furrow drill (figure 24) is used specifically to reach moisture at a depth of 12 or 15 cm. This type of drill is used extensively in the Pacific Northwest for the type of summer fallow system employed. This drill is also being used on the adaptive research trials in Turkey and has been used on some State farms on the Anatolian plateau.

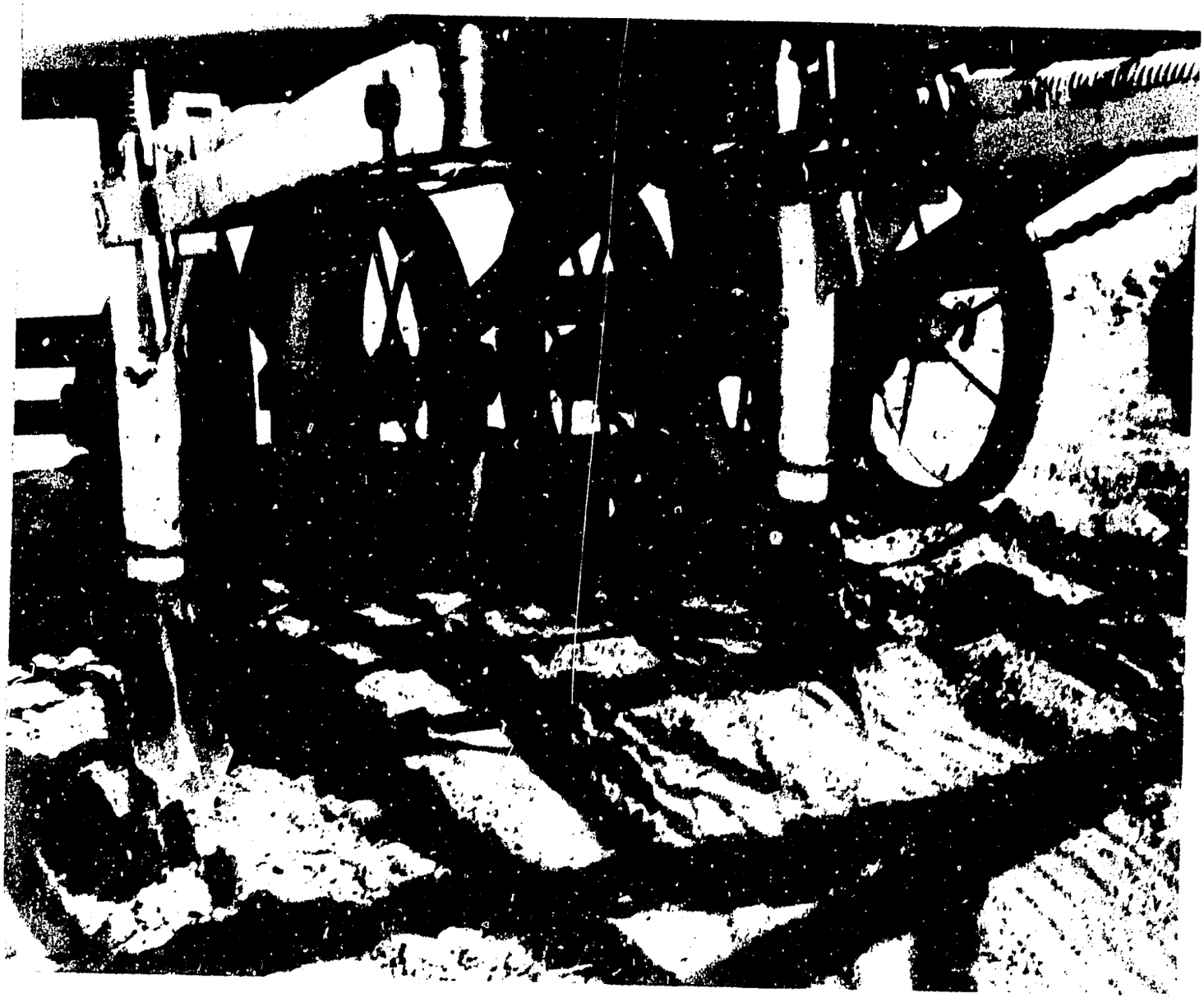


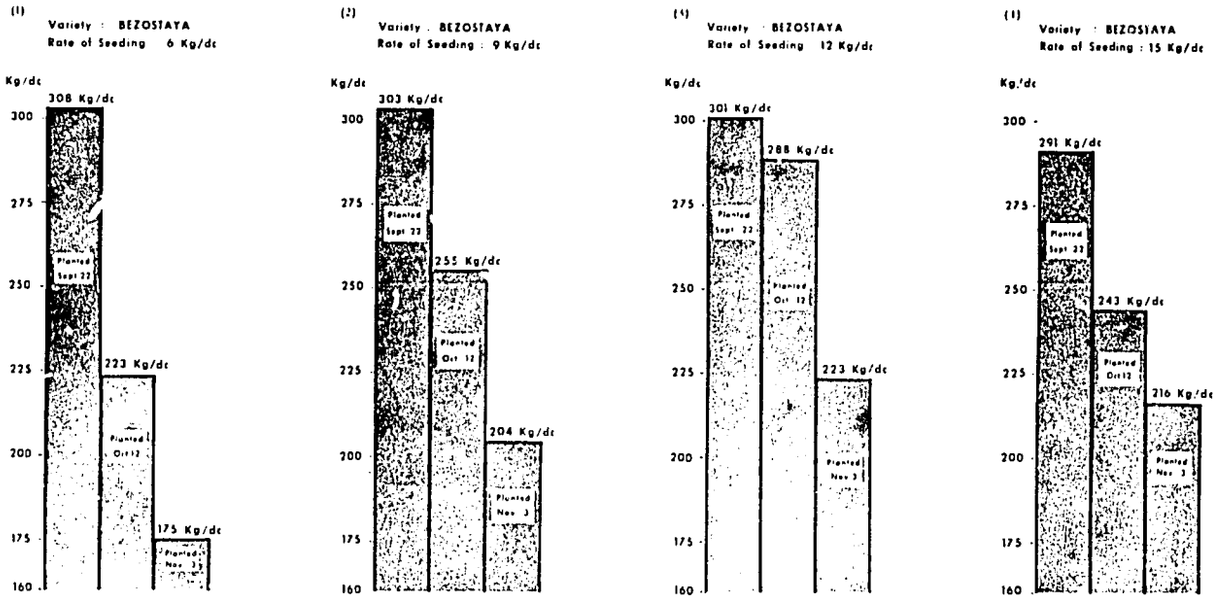
Figure 25 shows a close-up of the shovels or points of the deep furrow drill. There are a number of different shovels that can be attached to this drill. The shovel on the left is used for normal deep furrow seeding when the seedbed is in good condition and there is no problem of soil penetration. The shovel on the right is used when the seedbed is compacted and the normal shovel will not penetrate to the depth desired.

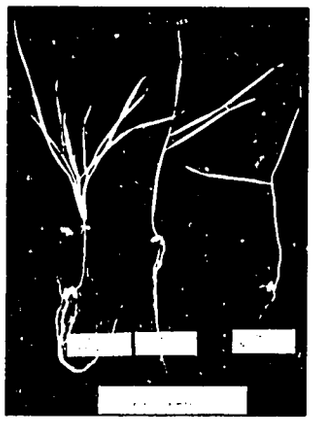
Figure 26

When adequate moisture is stored in the soil profile through a successful summer fallow system, wheat can be planted early into this moisture and the crop can get off to a good start prior to the late fall rains. This crop of wheat was planted in mid September, and by mid November the root system and top growth were well developed and ready to go into winter. No rain had fallen prior to the time this picture was taken. The difference in yield can be two to three times that of the present system depending upon the moisture situation in the spring.

DATE AND RATE OF PLANTING TRIAL

Plantings were made during the fall of 1971 and the data collected following harvest in July of 1972





This type of system is being researched in Turkey. If adequate moisture can be stored at a depth of 12 to 15 cm, the seed can be placed in this moisture early in September and have enough moisture to emerge. This stored and residual moisture will keep the wheat plant growing from 45 to 60 days without any additional rain. Thus a wheat crop can be planted and not have to depend upon early fall rains. The root system can develop before the plant goes into winter dormancy and when spring comes the plant has developed enough so that it can take more advantage of the winter and early spring moisture. The wheat crop under this system is then not dependent upon the late April and May rains to produce.

These pictures illustrate the success of conserving moisture and the early development of a good root system. This is really what the new system is all about.

The pictures show plants taken from the same date of planting trial. The samples of the wheat plant were collected on December 3, 1971 and April 28, 1972, showing root and plant development. These plants were collected from the plots seeded at the rate of 9 kg./decare. The yield data of this particular seeding rate is illustrated in graph number 2 above. Note the increased root development from the early seeding date. This early development contributes to the increased yield as depicted by the graphs. One other important point is that the lower seeding rates planted early will produce as much yield as the heavier seeding rates.

The graphs above were developed from data from the Agronomic and tillage research trials being conducted in Turkey by USAID/OSU and the Wheat Research and Training Center. The graphs show the yields of Bezostaya seeded at four different dates. Rates are given in kilograms per decare.

January 1973

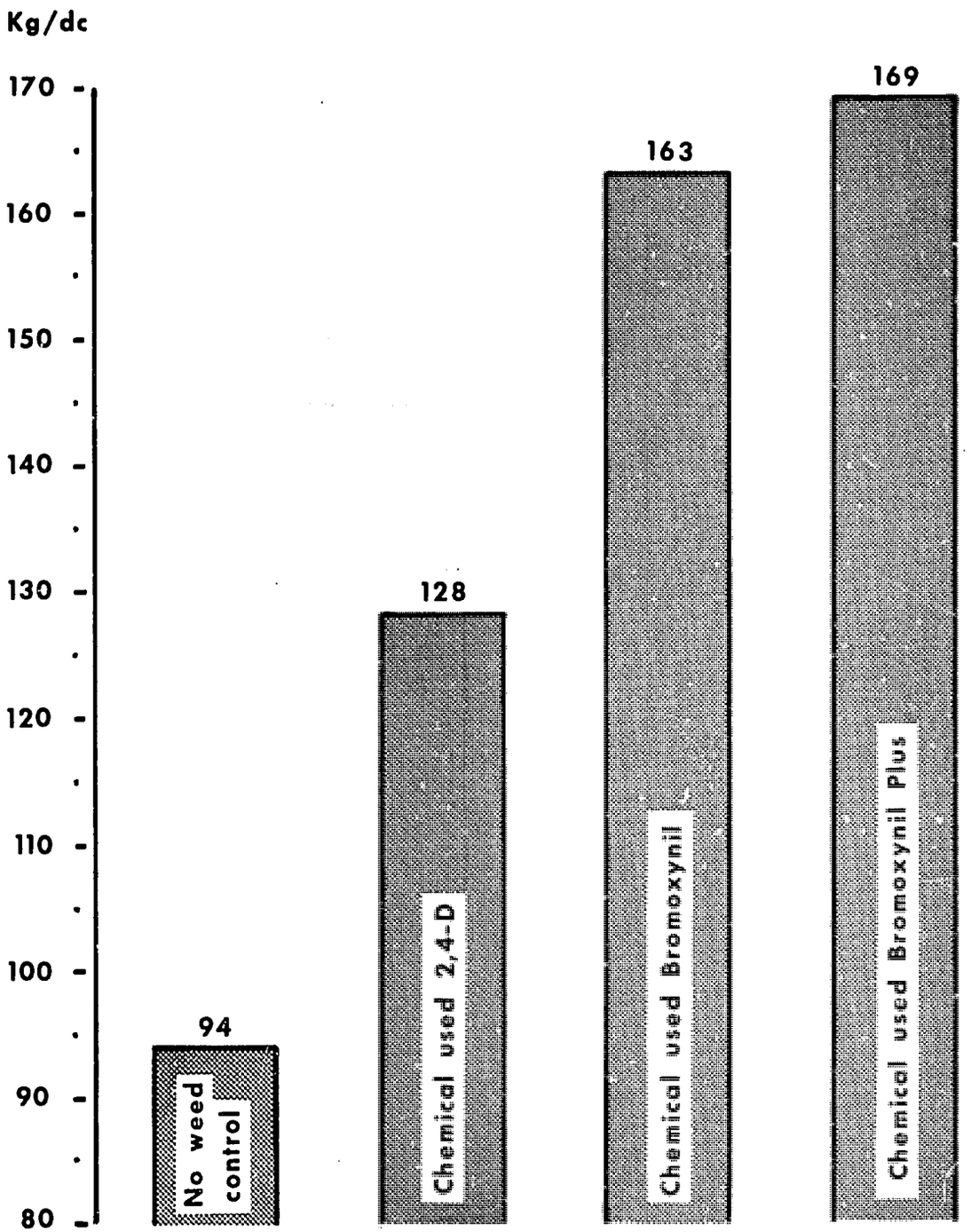
Figure 28

Research has proven that wheat yields can be increased from 10 to 30 percent if weeds are controlled. One of the most important factors in getting satisfactory results with the Phenoxy herbicides used in Turkey, such as 2,4-D and 2,4,5-T, is to apply these chemicals to the weed on the basis of the size of the wheat and not the temperature.

When the wheat plant is at the 3 to 5 tiller stage of growth it can usually withstand these chemicals with a minimum amount of injury. When the wheat plant is at this stage of growth the weeds are usually very small and thus can be controlled much easier. In many cases when the wheat plant is at this stage of growth the temperature is not the most ideal for the herbicide to kill all of the weeds. Also there are probably some weeds that haven't germinated yet, but this is the time when the small weed and the wheat plant are competing for the moisture and nutrients. This is also one of the most critical stages of the wheat plant because it needs the moisture and the nutrients. If the weeds that are growing at that time can be controlled and competition for moisture and nutrients is eliminated, the wheat plant will actually produce more kilos per decare. This is more successful than waiting for all the weeds to germinate as a result of higher temperature. To grow more wheat rather than just to kill more weeds is the real purpose of weed control. Many instances are observed in Turkey where the farmer waits too long, because of the temperature factor, to spray his wheat. The farmer may kill more weeds but produce less wheat. If the farmer had the choice, which would he want?

Figure 29

USE OF HERBICIDES INCREASE WHEAT YIELDS IN TURKEY



Data from test areas showed that control of weeds by use of herbicides increased yields significantly. Yields from trial areas are pictured on the graph. These plots were in fields farmed under the traditional system; not an improved fallow system. This data was compiled by the USAID/OSU Wheat Research Team from trials conducted at the Ankara Topraksu Research Station in 1972.

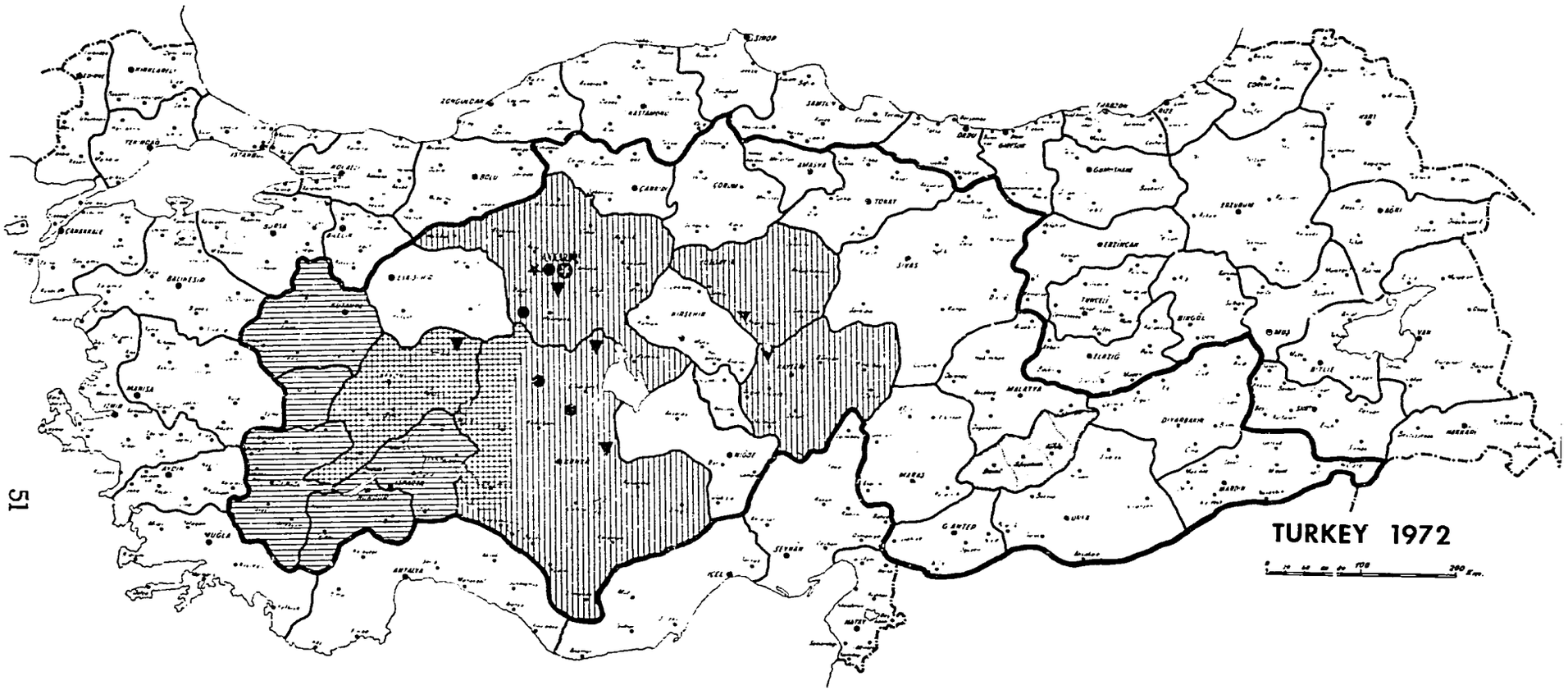
Figure 30

Working with teams of Turkish counterparts the OSU/AID Wheat Research team has established adaptive research trials in 6 different locations on the Anatolian Plateau, where dry land wheat is produced. Many farmers have shown a high degree of interest in this wheat project.

Whenever the team works in one of the 6 areas many farmers come to watch and ask questions concerning the research work. In some of the areas the farmers are notified ahead of time and several bus loads of farmers will be on hand to watch the operation of the equipment.

Figure 31

DRY LAND WHEAT PRODUCTION PROJECT



Designates the 25 priority provinces designed for special emphasis by MOA in the dry land wheat production campaign.

5 pilot provinces designated by the MOA. These provinces will receive the 5 sets of wheat production tillage equipment under the 086 loan.

This designates the seven poppy provinces. Two of the seven, Konya and Afyon are part of the 5 province pilot program.

Location of the 4 National Extension Wheat Specialists

★ Location of the Wheat Research Specialists

▼ Location of the 6 adaptive wheat research tillage trials on farmers fields. These trials were established in the fall of 1971 and are continuing.

● Location of 4 adaptive wheat research tillage and agronomic trials on state farm locations. These were established in 1969 and are continuing.

This area is not included within the 25 province campaign.

The research and educations programs that have been conducted on the Anatolian Plateau are shown on the map. This map depicts the areas where research and adaptive research on farmers' fields are located. In addition, it outlines the priority provinces where increasing cereal production is being emphasized through intensive educational training and demonstration programs.