DESIGN OF A CULTIVATOR APPROPRIATE FOR EGYPTIAN AGRICULTURE

By

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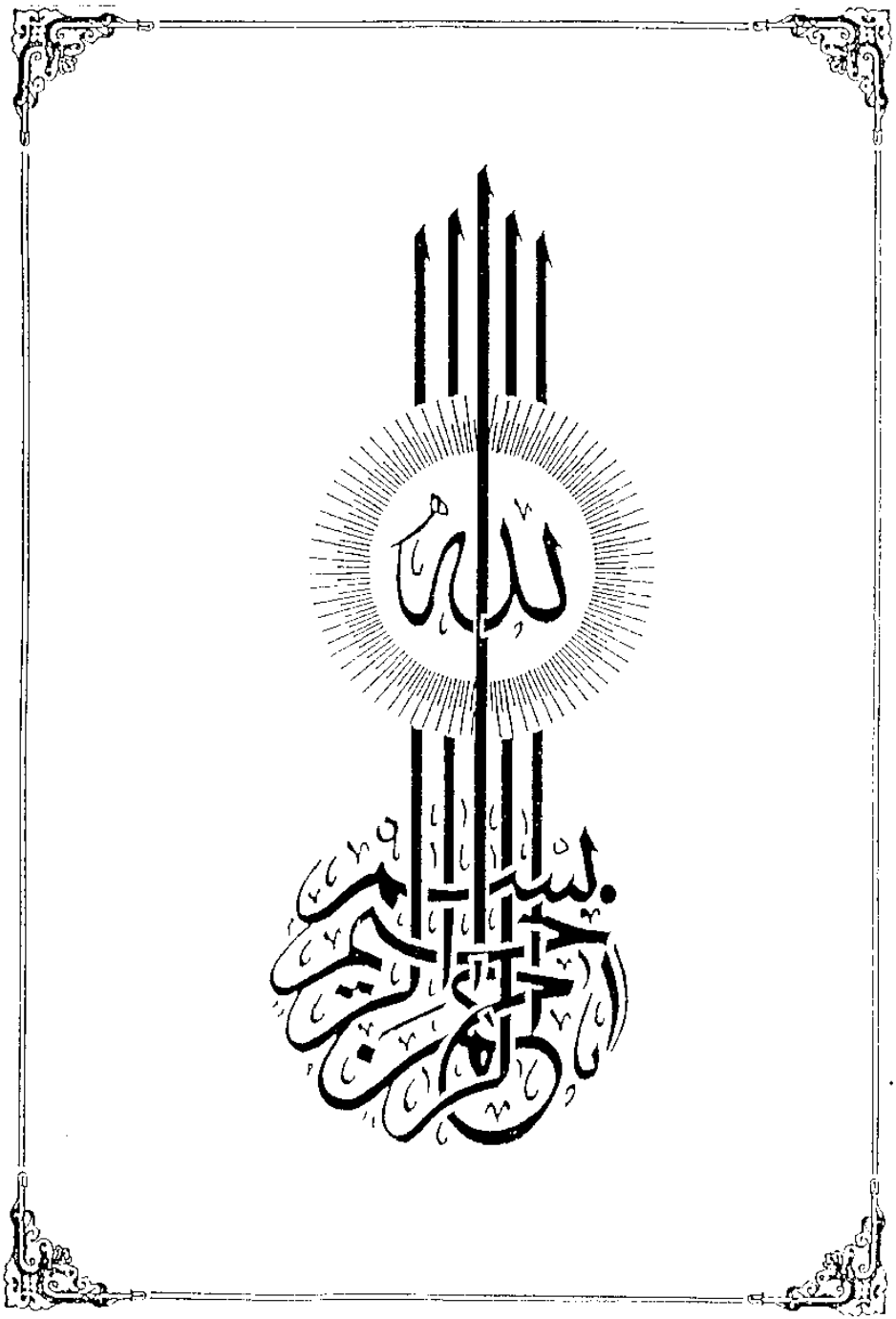
بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا إلا ما علمتنا
إنك أنت العليم الحكيم

IN THE NAME OF ALLAH, THE BENEFICENT,
THE MERCIFUL

They Said : " Be glorified we have no knowledge except that which you have taught us. Indeed you are the knower, the wise ".



APPROVAL SHEET

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CONTENTS

I. INTRODUCTION

Soil cultivation is very important because of weed control, which may save a yield loss of up to 40%. However, there are other objectives for cultivation which are:

1. Retention of moisture by:
   a. Killing of weeds.
   b. Loose mulching on surface.
   c. Retaining rainfall.
2. Developing plant food.
3. Aeration of soil to allow oxygen to penetrate soil.
4. Promotion of activity of micro organisms.

The problem is magnified by the scarcity and rising expense of hand labor, since cultivation so far depends heavily on human skill and selectivity.

Weeds may also be killed by herbicides. Weed killers are of two basic types: selective and non-selective. Non selective weed killers must be used carefully because it may kill all plants which include the crop itself. Recently, the trend is toward reducing the use of herbicides because of their pollution effect.

Objectives of appropriate technology are: (1) proper functioning, (2) economy, and (3) suitability for the present technical stage and maintaining the operators safety. The inappropriateness in Egypt of the imported cultivators is generally due to poor economy, and difficulty of operation and maintenence.

A rotavator appropriate for the Egyptian farming was constructed to overcome the above mentioned difficulties, and satisfy the following requirements:

1. Small unit and self propelled.
2. Light weight and causes no appreciable soil compaction.
3. All tillage is performed in one pass.
4. Soil amendments can be incorporated.
5. High operation rate.
6. Possibility of local manufacture and ease of repair and maintenance.
7. Safe operation.
8. It needs a single operator.
9. The furrower can be adapted to reshape the furrows after cultivation.
10. Speed reduction is by chain-sprocket box generally suitable for Egyptian manufacture.
11. Four-rotor arrangement is possible for orchard cultivation, while two-rotor arrangement is possible for inter-row cultivation.
12. Units can be used in other diversified operations such as furrowing, spraying and threshing.

The prototype of the rotary cultivator was designed and constructed in the Agric. Mechanization Division, Ain Shams Univ. to meet the above requirements.

An experiment was designed to compare between different ways of combating weed growth, including the use of rotavator,

manual weeding, using herbicides, mowing, and comparison with blank control.

Measurements included: energy, rate of operation, cost, and effectiveness in weed control.

II. REVIEW OF LITERATURE

1. HISTORY OF DEVELOPMENT:

The first implement used for control of weeds in crops was probably a hoe. Later, the Egyptians developed a crude looking cultivator that was pulled by one man and guided by another, Wilkinson, et al. (1977).

Early in the eighteenth century; Jethro Tull invented the horse hoe. Parallel-tilling gangs were used in 1851 and the first horse-drawn riding-cultivator was invented in 1856. At the beginning of this century the cultivator was beginning to resemble the present day models.

In 1920 the walking spring tooth cultivator and the riding disk cultivator were used on farms. The first integeral-mounted cultivator for tractors was developed about 1925; the gangs were lifted by manually operated levers. Power lifts for cultivators were finally developed in 1933.

Culpin, et al. (1981) stated that most rotary cultivators used in Britain have L-shaped blades which are normally mounted with three right-hand and three left-hand blades per flange; but coarser work may be done by using only two right- and left-hand blades per flange.

2. APPLICATION OF CULTIVATION:

Awady (1985) mentioned that cultivation is very important in weed control, which may save a yield loss of up to 40%.

The objectives of seedbed preparation operations is to kill weeds through suitable tillage and then soil particles reduction to the optimum size with the secondary tillage equipment. However, Hunt (1973) warned that most of the secondary tillage operations are as advantageous to weeds as to the seeded crop. He, then proposed that a good seedbed must be such that weed growth is discouraged. As a compromise, Hunt (1973) recommended that soil particles should be reduced to a size that leaves a rough surface which dries out rapidly in order not to germinate weed seeds.

3. TYPES OF CULTIVATORS:

Wilkinson, et al. (1977) stated that the cultivators are classified according to whether they are trailed, or mounted.

1. Mounted cultivators. Such types are carried either at the front or rear of the tractor. Front mounting means a head of the operator or the rear tractor wheels, even though a part of the cultivator may be carried behind the rear wheels to eliminate the wheel marks. Rear mounted cultivators are usually attached to the tractor through the hydraulic linkage, giving good lift-control and quick attachment. But many operators do not like to look behind frequently to see how the rear-mounted cultivator is operating. Supposedly, this is not needed if the front axle guide is kept over one row.

2. Trailing tiller using dragbars and rigid shanks. This type is not mounted but it must trail on its own wheels. That is the case with field cultivators. It is easy to attach or detach this type when the tractor is used for some other purpose.
3. Row-crop cultivators. Some types of cultivators are not used to cultivate row crops but to till and mulch field crops. Thus there are row-crop cultivators and field cultivators. Rear-mounted types can be used for both purposes; front-mounted types are usually used for rows only; trailing types can be used for row or field cultivation.
4. Trailing field cultivators. These types are often called chisels. If they are quite heavy and their ground equipment is capable of going quite deep, they may be called plows, although they do not till like inversion plows.

The lift-up or mounted tiller usually has one or two tool bars across the tractor behind the rear wheels. The ground equipment is attached to these bars.

The field cultivator may be of the "dragbar" or of the "rigid-frame" type. The dragbar type permits the teeth to rise over uneven surfaces. On the rigid-frame type, the teeth or standards are fastened directly to the frame.

Field cultivators or tillers are often used for pasture renovation, summer fallowing, and stubble

mulching. Several models are really sub-tillers, capable of heavy-duty work.

5. Trailing row-crop cultivator. This type is called the lister cultivator because it can follow bedded rows made by the lister planter. Two wheels guide each row unit along the bed ridge. Each wheel has "tuck and gather" (toe-in) so the tilling unit does not climb the ridge. Reasonably parallel rows are required. Up to five rows are sometimes tilled at one trip across the field.
6. Rotary tillers. Richey, et al. (1961) stated that this type consists of a series of pointed spring teeth or L-shaped blades mounted on a horizontal shaft and rotated so as to cut down against the soil as the tool advances. Soil is thrown up behind and is usually confined by a hood unless it is desired to allow noxious weed roots to settle on the surface to dry up and die.

   Garden tractor sizes of rotary tillers are most popular because of the convenience of once-over preparation of small garden plots and in nursery and greenhouse work. The larger tractor-powered models are little used for general farming because of the high-power consumption compared with conventional soil preparation.
7. Flame cultivators. Richey, et al. (1961) stated that these types are generally used at the rear of the tractor in conjunction with a conventional front-mounted cultivator. From 2-4 gal. (8-17 L) of LP gas are usually required per

acre (4047 m^2). A special fuel tank is required along with the necessary gages and valves, a vaporizer to change the fuel from liquid to gas, a pressure-regulator control valve, special fuel lines and fittings, and special burners with flat-spray nozzles.

4. METHODS OF CULTIVATION:

Richey (1961) stated that there are many ways to cultivate soil such as: (1) uprooting the weed, separating its roots from the soil, and exposing them to die., (2) cutting off the stem just below the ground surface, as is usually done with deep-rooted weeds, (3) smothering the aerial parts of the weed by covering with soil, (4) flame cultivators direct a flame into the row near the ground from each side to kill small weeds. The theory of flaming is not to burn the weeds but to apply enough heat so that the liquid in the weed cells expands and ruptures the cell walls, causing the plant to gradually wilt and die, and (5) weed-controlling chemicals are valuable adjuncts to conventional cultivation, and preemergence spraying of the row has been helpful in controlling weeds in the row.

5. CULTIVATOR COMPONENTS AND DESIGN:

Yatsuk, et al. (1980) described the principal components of a "miniature rototiller". Fig. 1 consists of a gasoline engine "1" supported on wheels "11", intermediate shaft "2" with a clutch, control mechanism "3" placed on the controlling levers, connecting shaft "5", cutter drum, protective