DESIGN OF A HARVESTER APPROPRIATE FOR EGYPTIAN AGRICULTURE

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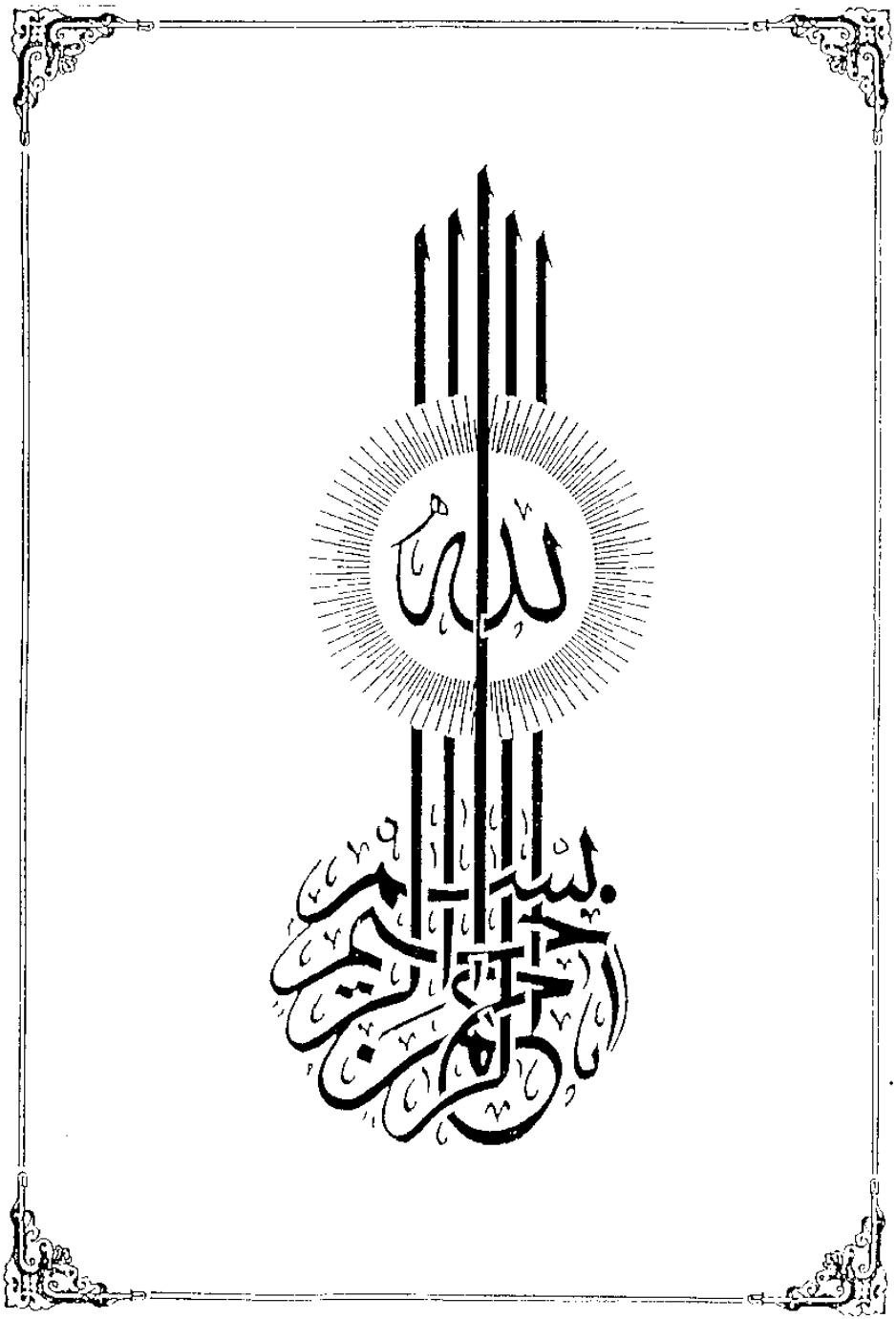

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CONTENTS

I. INTRODUCTION

Agricultural producers depend on machines to harvest and handle crops quickly and efficiently with a minimum labor requirements. Undoubtedly, the harvesting is one of the most labor-consuming agricultural operations. In Egypt, wide-scale mechanization of crop reaping has not prevailed so far (Nat. 5-yr. Plan for Mec., 1982-87).

A high percentage of the agricultural land in Egypt is devoted to cereal crops (2.4 million feddans), in addition to forage crops (0.5 million fed.) (Awady, 1987). All the cereal and forage in Egypt must be harvested by the end of May to start cultivating a new crop by the beginning of July. The shortage in hand labor in Egyptian farms has become a pressing problem in the recent decade. This problem is mainly ascribed to the increasing workers migration from the rural areas to other sectors of increased income. This shortage, in turn, has increased the costs of production in the field of agriculture.

The Egyptian arable area is mostly fragmented. More than 50% of the farms are of less area than 5 fed. (CAPM, 1980). The small sizes of land holdings cause certain difficulties in using tne big and medium sizes of agricultural machinery.

The total costs for harvesting Egyptian crops mechanically are lower than the traditional methods (MOA, 1982), as eminent from the following table:

CROP	TOTAL COST LE/FED.	
	Mechanical	Traditional
Wheat	7.66	41.7
Rice		
Reaping	15.6	42.0
Threshg.	17.5	40.0
Rice		
hvstg.	69.0	111.0
Combining	38.4	----

In the Egyptian agriculture, the use of big machinery is inappropriate for the following reasons:

(1) It needs high technical experience, for operation and maintenance.

(2) High capital requirement,

(3) Low field efficiency in small holdings, and losses of straw are high on irregularly furrowed soils.

To overcome such problems, appropriate harvesting systems have a good potential. Studies and investigations must be carried out on appropriate machinery in order to adapt and develop under the local conditions.

The objectives of this work are overcoming hand-labor shortage and reduction of cost and crop losses during harvesting, which accounts for up to 30% at present. The design of a small rotary harvester is evaluated. The prototype was constructed in the Workshop of the Agricultural

mechanization Division, Faculty of Agriculture, Ain Shams University. The equipment was tested in the following operations: (1) lawns mowing, (2) cotton-stalk cutting, (3) weed control, and (4) cereal crops harvesting. The evaluation included studies on: forward speeds, rates of operation, efficiencies, cutting force, cost, and vibrations.

II. REVIEW OF LITERATURE

1. History of development:

Miller (1902) stated that the development of the mower for cutting hay was closely associated with the development of the reaper. The first machines were used to cut either grain or grass. William F. Ketchum was the first to put mowers on the market as a machine distinct from the reaper. Ketchum's most important patent was filed July 10, 1847. The cutter-bar of an endless chain of knives was soon abandoned and Hussey's rigid bar substituted. Cyrenus Wheeler obtained a patent Dec. 5, 1854, on a machine that featured two drive wheels and a cutter-bar joined to the main wheels. A patent was granted to Cornelius Aultman, on July 17, 1856, containing basic principles of mowers, such as the ratchet-pawel drive. By 1860, the mower was considered a practical machine. Horse-drawn mowers were first used with tractors about 1910. Tractor-mounted mowers were available about 1930.

Stone and Gulvin (1967) said that the field mower is designed to cut forage crops not grown in rows, that is crops spread uniformly over the ground. It is very useful in clipping tall growth or weed from pastures. Almost every American farmer has a mower. One of the first developments was Bailey's mower of 1822. The cutting mechanism was a series of scythe blades laids horizontally on circular frame-work. The rotating blades were driven from the left drive wheel through a series of cogs.

The scythes were automatically sharpened by a whetstone fixed above them. The principle of the reciprocating knife and slotted finger guards was patented by Obed Hussey in 1833. The principle that he and Cyrus McCormick separately developed is still being used on our present-day machines. Tractor-drawn and mounted mowers were developed after 1930. Practically all of these machines have no gears in the drive mechanism, and none is driven by the mower wheels. Ample tractor power makes it possible to use cutter-bar as long as 9-feet. In 1953 a hydraulically driven mower appeared.

2. Mower classification:

Michael and Ojha (1966) classified the mowers depending upon the source of power used as follows:

(1) Animal-drawn mower which has the following main parts:

a) Cutter-bar to cut the crop and separate it from the uncut portion.

b. Power transmitting unit to receive and transmit motive force.

c) Frame to support moving parts.

d) Wheels for transport and for operating the cutting mechanism.

e. Auxillary parts to lift and drop the cutter-bar.

The power transmitting unit consists of main axle, gears, crank shaft, crank wheel, and pitman and the main axle receives power from one of the transport wheels.

(2) Tractor-drawn mowers:

a) Trailed type.

b) Semi-mounted type.

c) Mounted type.

These types of mowers are operated by the power take-off shaft.

Culpin (1975) classified the mowers dpending upon sort of the knives motion as follows:

I. Reciprocating motion, in this case, the final drive to the knife usually consists of a crank shaft running at right-angles to cutter-bar, and carrying at its end a heavy flywheel and a crank-pin to which the "pitman" or connecting rod is attached. This converts rotary motion to reciprocating motion, by means of dynamically balanced devices. Conventional pitman drives normally operate at crank speeds of about 800-1000 rpm.

II. Rotary motion, are those which have knives rotating about a substantially vertical spindle. Rotary mower used for conservation are of these types:

a) Drum mowers; driven from the top, by a shaft and gears or by V-belts. The blade carriers on drum mowers may be inclined downward, with the result that if a blade strikes an immovable obstruction the arm can not pivot backwards and upwards, so providing a clearance of 4-in or more.

b) Disc mowers; which have the cutting mechanism driven by spur gears housed in a slim casing below the knives. The typical transmission system incorporates a primary v-belt drive, with transmission to the discs themselves via a train of spur gears running in an oil bath.

c) Flail mowers; the term "flail mower" is normally applied to mowers employing a horizontally arranged shaft with swinging cutting blades rotating at high speed in a direction opposite to that of the tractor wheels. Knives may be mounted on the cylinder in a variety of ways.

d) Orchard mowers, used in cutting grass and it is necessary to keep the grass short, but not to collect it.

Smith and Wilkes (1983) classified the mowers with tractor according to the way they are attached to the tractor into the following types:

I. Trailed mowers which can be easily attached to and detached from the tractor drawbar, and power may be transmitted by gears, chains or v-belts.

II. Integral rear-mounted mowers which are direct-connected to the tractor, thus all the weight of the mower is on the tractor and the power is transmitted directly or indirectly by v-belt from the power take-off to the pitman shaft, and no gears or universal joints are required.

III. The semimounted mower which is similar to the integral mounted one and is mounted on the three point hitch but has a wheel behind to support part of the weight of the mower.

IV. The side or centrally-mounted tractor mower in which the cutter-bar is mounted on the right hand side of the tractor between the front and rear wheels. This arrangement makes it easy to use power lifts and power is usually taken from the power take-off by v-belts and transmitted to the knives through shafting, gears, and pitman.

3. Knife harvesting characteristics and cutting force:

Cutting stalks differs from cutting metals by shearing, for stalks are mostly fibrous materials and the splitting of the fibres is a very important part of the cutting process. The nature of forces developed during cutting operation and the knives response to these forces make it difficult to evaluate the harvesters performance.

Kepner (1952) reported that the average cutting force during the cutting portion of the stroke may be at least as great as the maximum inertia force of the knife and should be expected to cause vibration effects of considerable magnitude in a single knife machine. Moreover, he found that the average cutting force was directly proportional to the feed rate.