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Development of Mini Tractor Mounted Sweep Type Weeding Tool

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A B S T R A C T

Weeds are an important factor in the management of all land and water resources, but its effect is greatest on agriculture. It reveals that one third of the cost of cultivation is being spent for weeding alone. Weeding operation is the process of elimination of unwanted plants so that the regular crops can be grown profitably. Weeding is one of the important operations. Various methods are in use for weeding purpose. Availability and quality of matching equipment for small mechanical power sources is a major concerned in general and weeding equipment in particular. The same time farmer has to use different weeders based on crop specification, as on today weeding operation has not been mechanized in almost all the crops. Hence, keeping the above factors in view, an attempt has been made to develop a mini-tractor operated weeding matching tool for weeding operation of multi crop for intensive and commercial farming system in India which can save time as well as money.

Introduction

Weed is an everyday term usually to describe a plant considered undesirable. The word weed is commonly applied to unwanted plants in human-controlled settings, such as farm fields, gardens, lawns, and parks. Weeds compete with the beneficial and desired vegetation in crop lands, forests, aquatic systems etc. and poses great problem in non-cropped areas like industrial sites, road/rail lines, air fields, landscape plantings, water tanks and water ways etc. Weeds are an important factor in the management of all land and water resources, but its effect is greatest on agriculture. Weeds cause 45% of annual yield loss as compared to the disease 20%, insect 30% and pest 5%. Variant losses due to weeds are given as annual monetary loss of₹ 19800 million, in major crops ₹ 4200 million and in food grain 60 million tonnes.

Removal of weeds consumes 25% labour i.e. 900-1200 man–hour during the cultivation season. Average weeding cost by traditional method is nearby ₹ 945/ha out of the total cost of cultivation₹ 3000/ha for agricultural crop. Weeds control method includes viz. mulching, solarization, chemical, flaming, mechanical, sterilization, and crop rotation with its own advantages and disadvantages. Mechanical weeding proved to be better as it

keeps the soil surface loose providing better aeration and moisture conservation. The number of tractors in agriculture has increased. The tractors mostly used on Indian farms are available in range of 30 to 40 hp. The power requirement for weeding/ interculturing operation with tractor is only 10 to 15 hp.

Materials and Methods

This section deals with the design of a sweep type weeding tools for five different row to row spacing of crops such as sorghum (300mm), chickpea (450mm), maize (600mm), pigeon pea (900mm) and castor (1200mm).The various factors involved in the design consideration were operational safety, ease of operation and cost of production. The emphasis has been given on ease of operational adjustment with minimum maintenance.

This machine was basically designed for small and medium class farmers (having mini tractor) whose investment capacity is limited and having small size of land to work with limited period (Fig. 1–7).

Design consideration parameters

The following design parameters were considered during the development of sweep type weeding tool for various spacing of crop.

Power requirement of machine and source of power availability.
Functional requirements of machine and its inter-relationship of various components.
Ease of operation of various components.
Possibility of designing a multipurpose machine combining more than one function into a single machine.
Cost of machine and farmer's paying capacity.
Economy commensuration with its quality.
Adjustment of machine and its maintenance.
Suggestions and feedbacks from the users.
Other competitive product in the market.

Cultivator frame

The properly accepted and used rectangular frame of minitractor drawn cultivator as shown in Plate-1 was fabricated and used for the operation. Frame was made of mild steel flat and channel (C-section). It consisted of horizontal bars on which tynes could be mounted. The vertical hitching arrangement was provided for its easily hitching with the mini tractor.

Tynes

According to the requirement six tynes were fastened on the cultivator frame. Fabricated cultivator tyne is shown in Plate-2. Soil working tools were attached at the bottom part of tynes. Cultivator was basically provided with tynes made up of mild steel flat having carbon content ranging from 0.15 to 0.25 %.

Design of cutting tools

The performance of any weeding machine depends on the design of the cutting element (blade shape). Sweep type blade was selected to fix on mini tractor mounted frame. The performance of sweep blade was better than straight and curved blade with minimum draft force per unit working width and having highest performance index. There were three types of sweep blades attached to the frame according to requirements of crop spacing. The following blades were categories according to the width120 mm, 270mm and370mm.

Design of cutting blade

The cutting width of sweep type tyne were found by using the formula,

$S_c = Z_f + Z_p$

W= Zf = Sc-Zp

Where,

S_c = Crop spacing, mm
Z_f = effective soil failure zone, mm
Z_p = protection zone, mm
W = Width of sweep, mm

Let the crop protection zone (Z_p) be 180 mm (90mm x 2).
[Protection zone is depending upon the plant types, numbers of days and growth of plant. Protection zone was provided on both side of the crop].

Conceptual design of machine

[i] Sweep design
[ii] Implement design for different crop spacing

For 300mm crop spacing

There were total six blades were required for weeding in six rows at a time and all blades were 120mm in width for weeding in 300mm crop spacing. In this spacing of crop the effective width of blade was 120mm in a row and protection zone for crop was 90mm on both sides.

Fig.1 Sweep adjustment between two rows

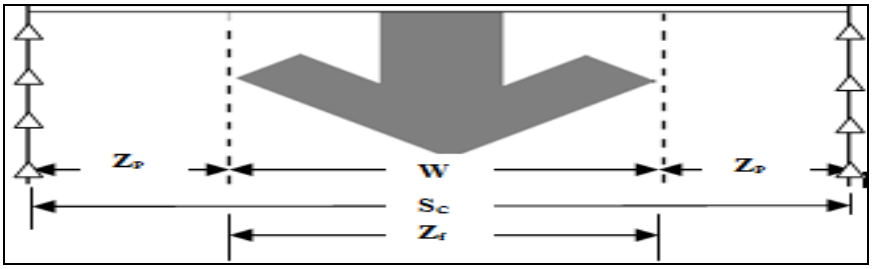
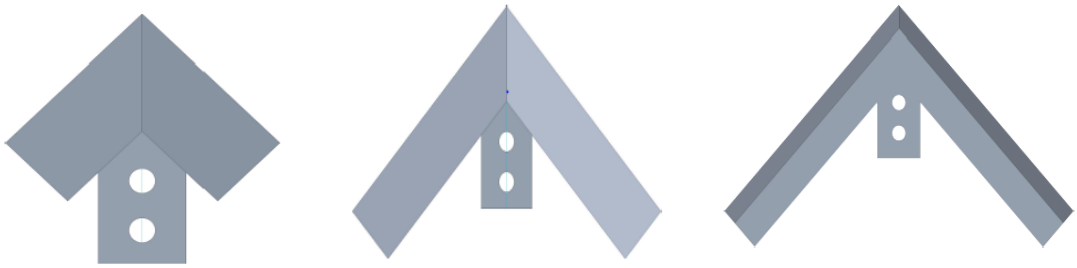


Fig.2 Conceptual design of different types of sweeps



(a) Sweep-I (120 mm) **(b) Sweep-II (270 mm)** **(c) Sweep-III (370 mm)**

Fig.3 Sweep arrangement for 300 mm row spacing with 120 mm blades

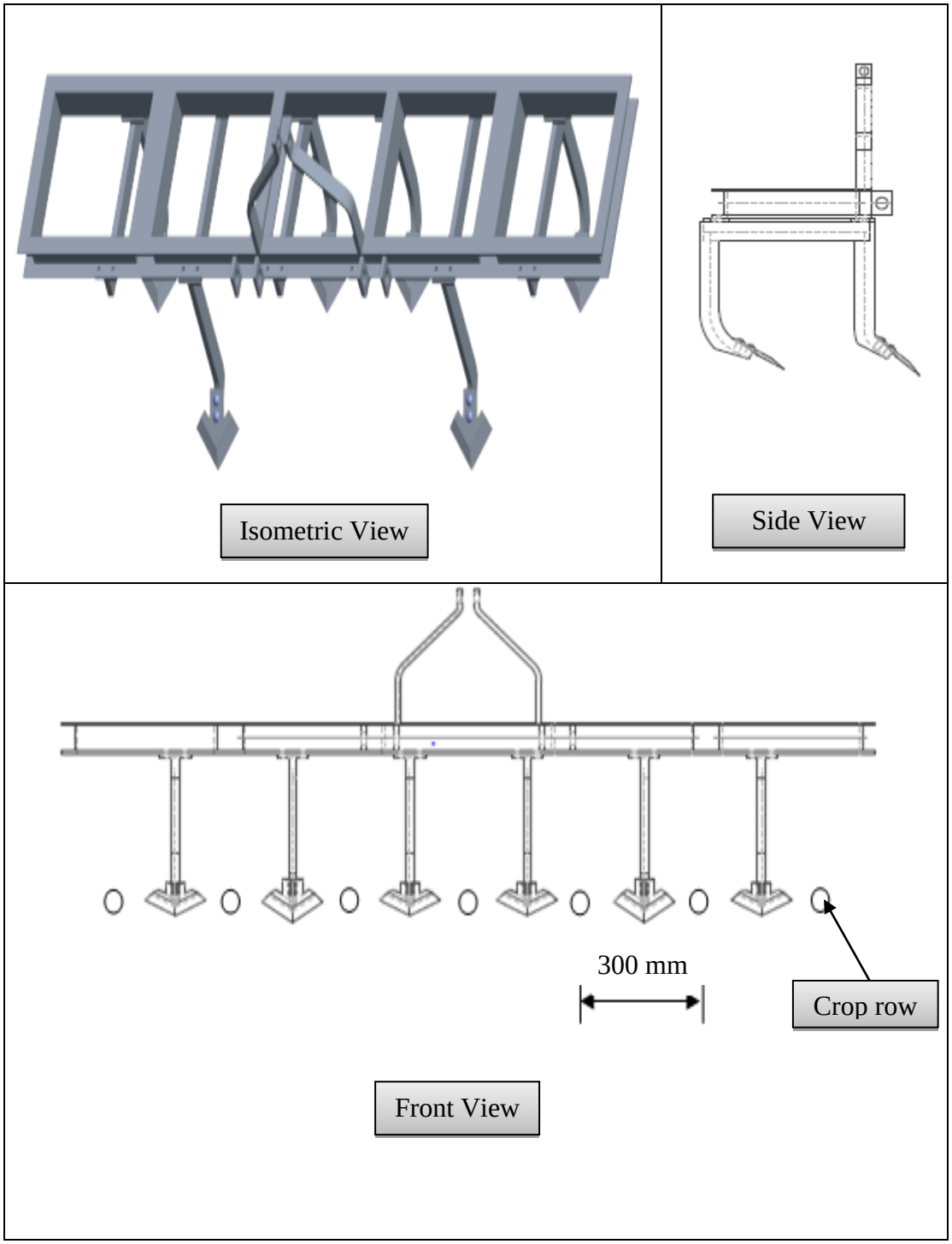


Fig.4 Sweep arrangement for 450 mm row spacing with 270 mm blades

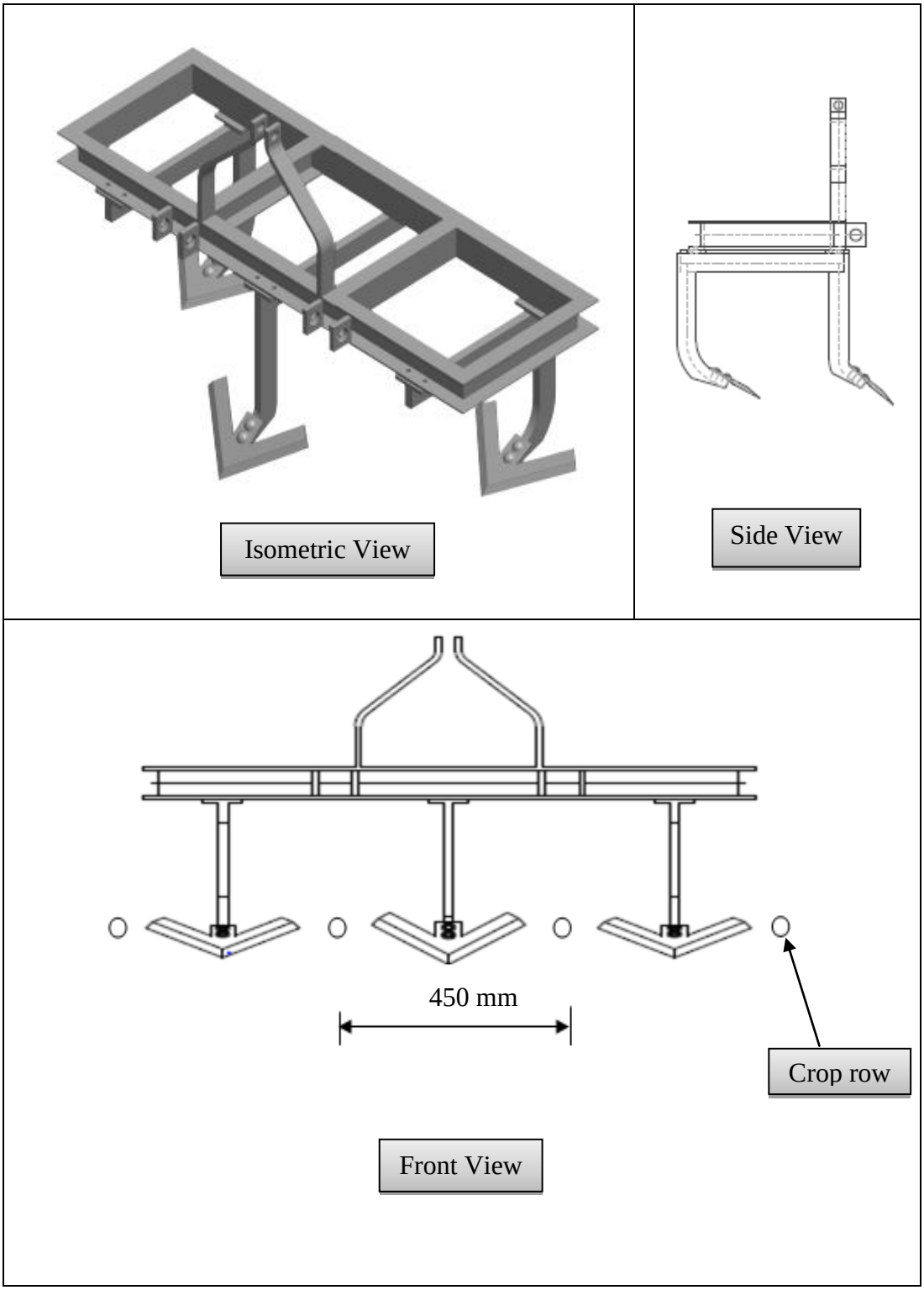


Fig.5 Sweep arrangement for 600 mm row spacing with 120 / 270 mm blades

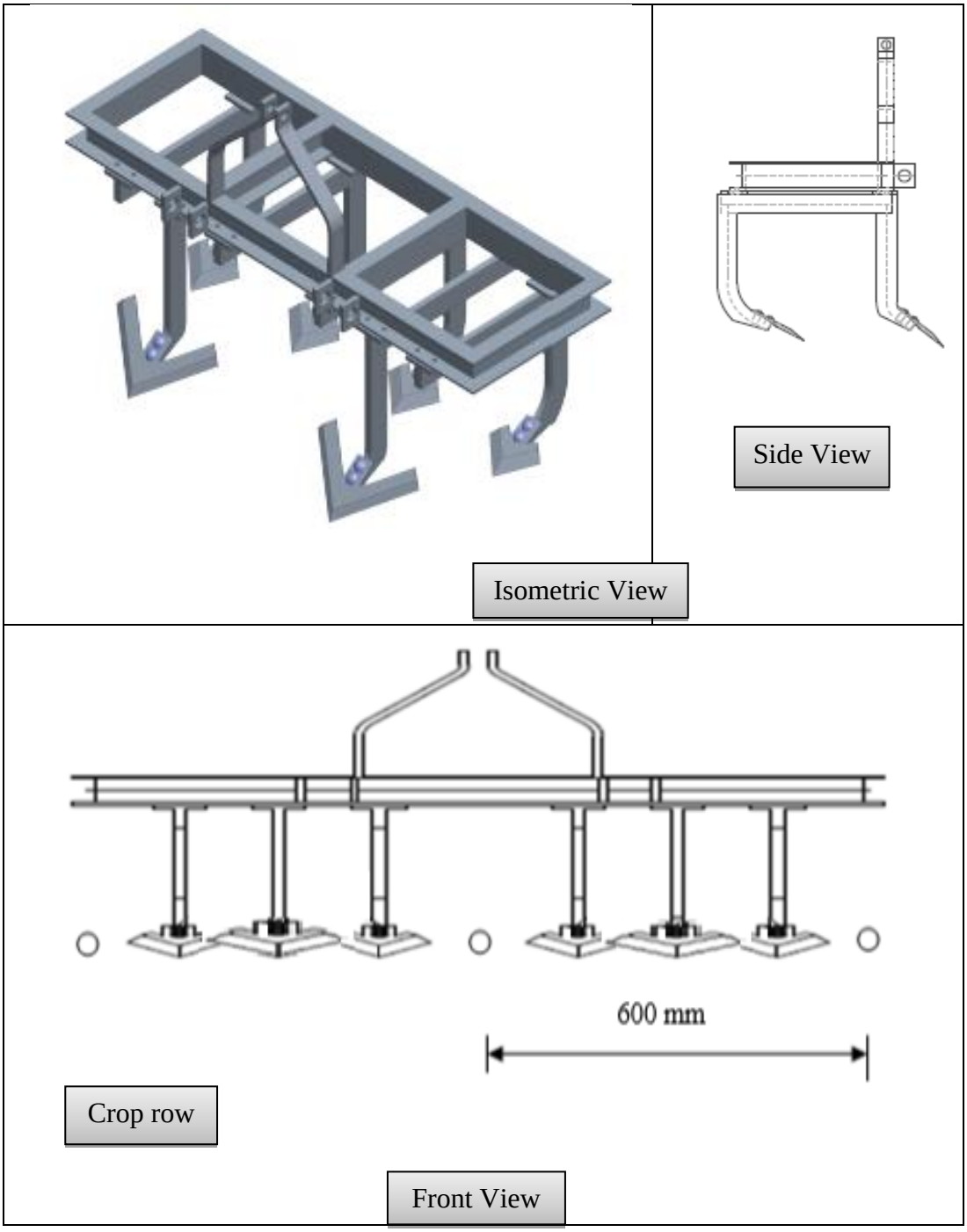


Fig.6 Sweep arrangement for 900 mm row spacing with 270 mm blades

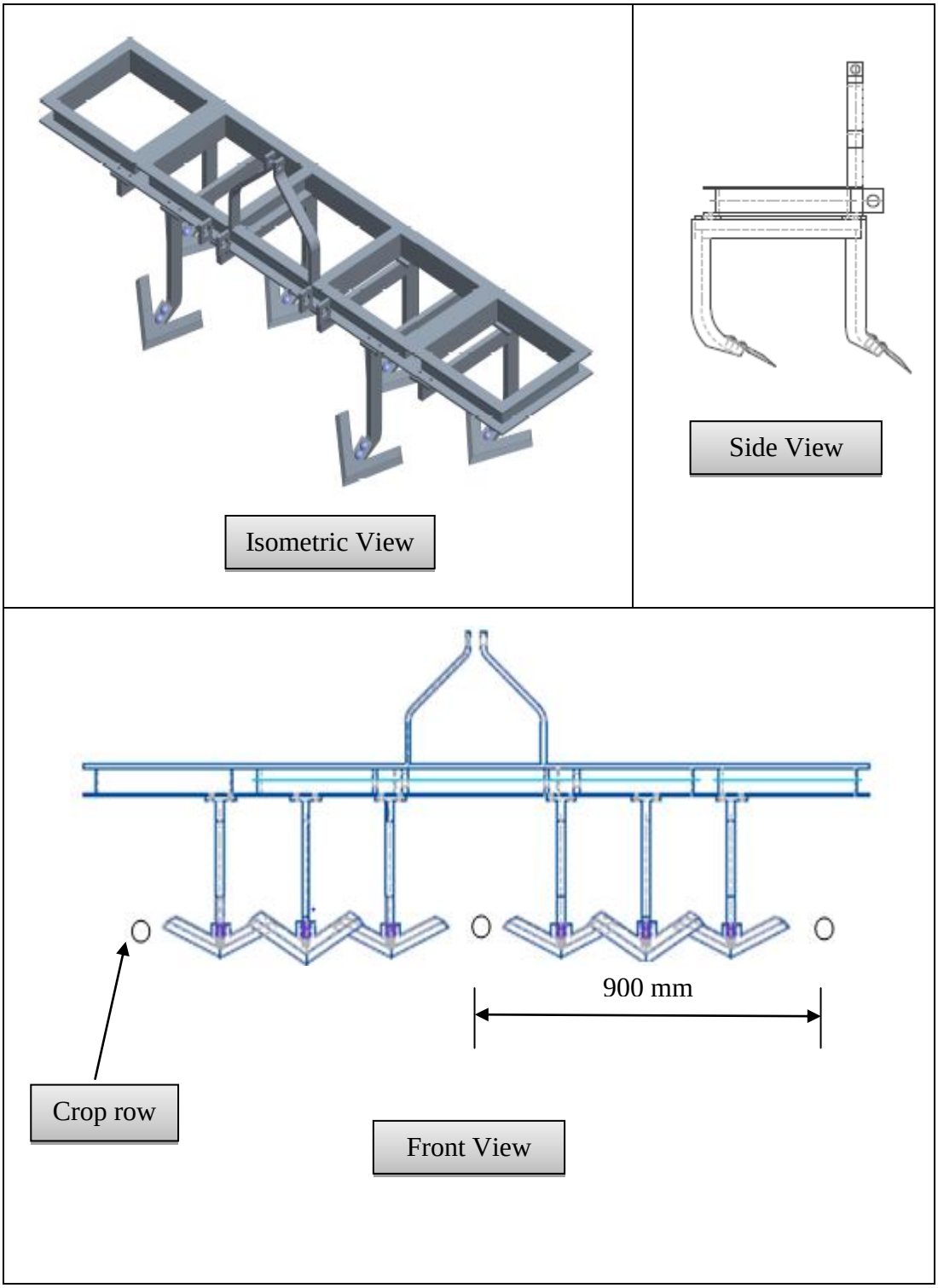


Fig.7 Sweep arrangement for 1200 mm row spacing with 370 mm blades

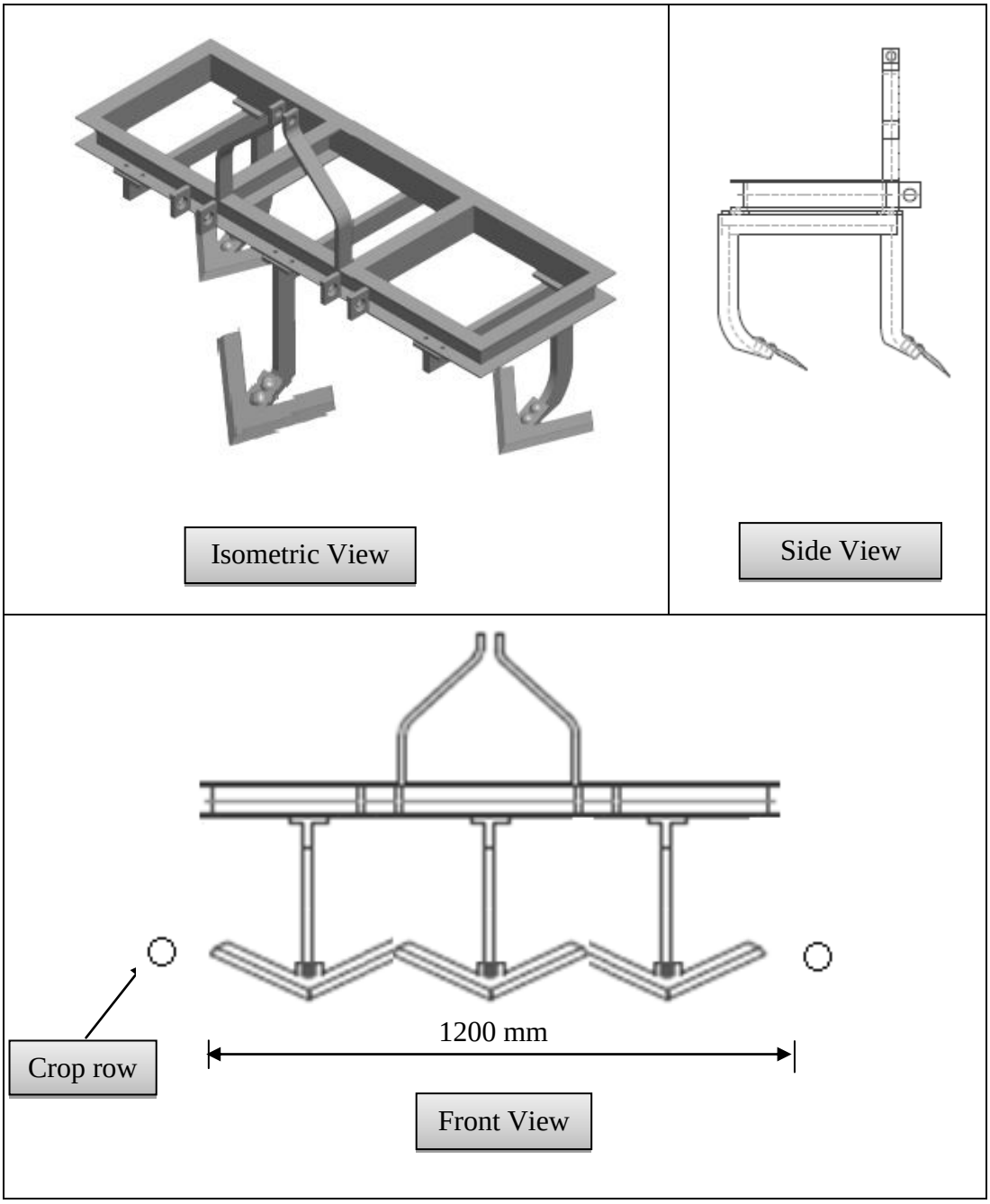
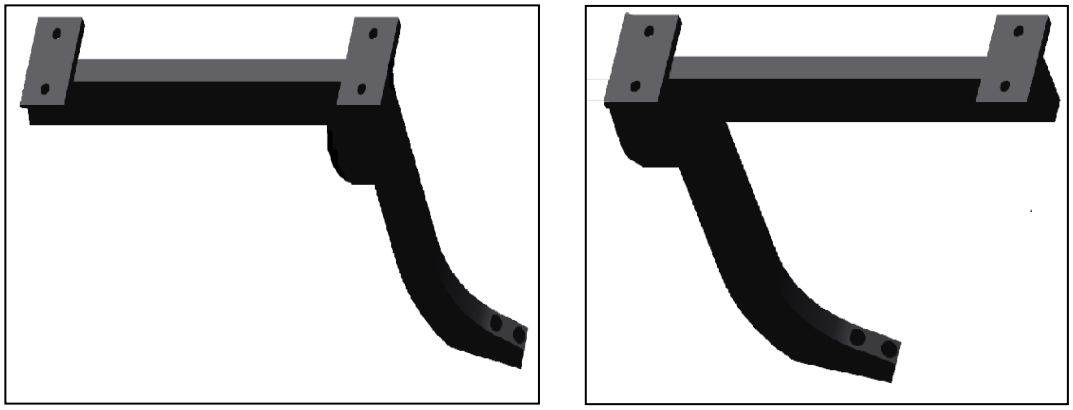


Plate.1 Cultivator Frame

Plate.2 Rigid Tyne of Cultivator



(a) Front tyne (b) Back tyne

Plate.3 Developed weeding tool with frame

For 450mm crop spacing

There were total three blades were required for weeding in three rows at a time and all blades were 270mm in width for weeding in 450mm crop spacing. In this spacing of crop, the effective width of blade was 270mm in a row and protection zone for crop was 90mm on both sides.

For 600mm crop spacing

There were total six blades were required for weeding in two rows at a time. Therefore, two blades were 270mm width and four blades of 120mm width required for weeding in 600mm crop spacing. In this spacing of crop, the effective width of blade was 420mm in a row, overlap (two times) between two blades was 45mm and protection zone for crop was 90mm on both sides.

For 900mm crop spacing

There were total six blades were required for weeding in two rows at a time and all blades were 270mm in width for weeding of 900mm crop spacing.

In this spacing of crop, the effective width of blade was 720mm in a row, overlap (two times) between two blades was 45mm and protection zone for crop was 90mm on both sides.

For 1200mm crop spacing

The total three blades were required for weeding in a row at a time. Therefore, all blades were 370mm in width for weeding in 1200mm crop spacing.

In this spacing of crop, the effective width of blade was 1020 mm, overlap (two times) between two blades was 45mm and protection zone for crop was 90mm on both sides.

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