METHODOLOGY
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3.1. Profile of line study area:

3.1.1. Location:

Dindigul Anna, an inland District of Tamil Nadu, lies between 10 degree 3 minutes and 10 degree 48 minutes of North latitude and 77 degree 15 minutes and 78 degree 20 minutes of East longitude. Dindigul, the district, headquarters is 65 Km away from Madurai lying in the south east direction. The total area of the district is 6070.26 square Kms. The district consists of 3 divisions, 6 taluks, 14 blocks, and 358 revenue villages and the revenue administration of the district spreading over 2148 hamlets.

3.1.2. Rainfall:

The annual rainfall is about 850 mm which is below the average rainfall of the state. Regarding seasonal distribution the full benefit of the South West monsoon could not be realised because of the western ghats forming a barrier. North East monsoon is the mainstay for the district. The rainfall in the remaining two seasons namely winter and summer is not due to monsoonic winds and their quantum is insignificant. The rainfall distribution in Dindigul Anna district is given in Appendix III.

3.1.3 Soil Type:

Irugur series (Igr) is the predominant soil occupying 55.19 percent of the area followed by the Palaviduthi series (pvd) which occupies 11.60 percent of the area.

3.1.4 Agriculture and Land use:

It has been found that the net area sown and area sown more than once amounted to 42 percent and 1.42 percent of the total geographical area respectively. Dry farming is predominant in the district and the important wet tract, is located in Shannuinganadi and Kodavanar basins.
3.1.5 Crops:

Sorghum is the major crop being cultivated in large areas followed by groundnut under both irrigated and rainfed conditions in all the taluks, except Kodaikannal where potato is the major crop. The cultivation of these two crops is more under rainfed area than the irrigated area.

3.1.6 Animal Power:

Draught animals are the major source of power available to the farmers of this district. It is estimated that they provide 70 percent of the total draught power currently used in agriculture and the remainder is supplied by human labour and engines. The major breed found in the district is that of kankeyam. Apart from kankeyam breeds, other breeds commonly found are non-descriptive breeds.

3.2 Experimental seed drills and treatments:

Three bullock drawn seed drills were used in the test (Plate.1). Traditional method of sowing under rainfed conditions was taken as another treatment for comparison. Details of the seed drills are given in Appendix IV.

The field trials were conducted on the plots, laid out in a Complete Randomized Block Design with five replications. The land was prepared by a tractor-drawn cultivator. Farmyard manure at the rate of 15 t/ha was added during land preparation. Sorghum (SORGHUM BICOLOR) and groundnut (ARACHIS HYPOGAEA) were taken as study crops. Seed rate, recommended by the state Department of Agriculture was maintained for all the treatments. All inputs, except the method of sowing were similar for all the trials. The details of the field layout and the physical properties of the soil in the experimental field are given in Appendices V and VI Respectively.
PLATE 1. Experimental seed drills
3.3. Parameters used

Eleven selected parameters (Appendix.VII) were broadly considered important to distinguish the performance of the seed drills. A weight for each parameter is given in Appendix-VII based on its contribution in achieving the functions expected of the seed drill. The observations recorded for each parameter were given a rating depending on their importance within the value range of the observation. The rating for each parameter is given in Appendix .IX. The field lost data of seeding devices are given in Appendix .X.

On the basis of weights given for various parameters and rating of each parameter based on its qualitative importance, the overall performance index model was used as per method suggested by Senapathi et al., 1992.

\[ OP \ I = \sum \text{Wi Ri} \]

Where, \( OP \ I \) - Overall Performance Index of the seed drill

\( \text{Wi} \) - Weight of \( i \)th parameter

\( \text{Ri} \) - Rating of \( i \)th parameter based on its observed/calculated values.

Considering the factors taken for the evaluation of seed drills, the seed drill which had the highest performance index value was selected for further study.

3.4 Field performance test

The selected seed drill was tested in fields varying in soil and agroelmic conditions in order to evaluate overall machine performance, crop yield and cost-benefit use of the seed drill. The study was conducted in randomly selected villages of Dindigul Anna District. The locations of the villages are shown in fig .1. The experimental field was divided into two identical blocks. All inputs
FIG. 1 LOCATION OF STUDY VILLAGES
except, the method of sowing were similar in all the experiments.
The selected seed drill was tested for its performance for sowing sorghum and groundnut crops and was compared with traditional method of sowing of the said crops. At every stage during the study, data in terms of area coverage, seed rate required, plant population, number of bullock-diours, number of man hours involved for the operations were recorded for analysis. The prevalent wage rates at the time of sowing in the region were taken for the analysis of the cost of operation. (Sridhar et al, 1992).

3.5 **Farmers feed back on seed drill's performance**:

The feedback was collected from the farmers who used and those who observed the seed drill's performance in their villages for further improvement. The views of the farmers about the seed drill performance were given due consideration while designing the seed drill.

3.6. **Design and development**:

3.6.1. **Hopper**

Hopper was designed to contain more capacity of seed materials which helped cover more area to save time lost due to refilling. The seed hopper capacity was calculated based on the quantity of the material to be filled in the hopper at a given bulk density (RNAM, 1991).

\[ V = \frac{Q}{P} \]

Where, \( V \) = volume of hopper in cum
\( P \) = bulk density of material in kg/cum
\( Q \) = hopper capacity in kg

Further, \( V = A \times L \)

Where, \( A \) = area of cross section in sqm
\( L \) = length of box in m
Based on the time taken for refilling and the area covered, the hopper capacity was increased. The design calculations are given in Appendix XI

3.6.2 Cut-off lever and power transmission system:

The position of the cut-off lever and power transmission system was shifted from leftside to rightside of the operator without affecting the equilibrium of the unit in order to operate the lever effectively as well as convenient by the farmer. Selected onthropometry were taken from the local operators for confirming the necessity of shifting.

3.6.3 Drive sprocket:

An additional drive sprocket (16 teeth) was attached to the supporting frame of the hopper in order to vary the spacing between seeds which depend upon the varietal character.

In the seed metering assembly the additional sprocket (16 teeth) was connected with other two sprockets (16 teeth and 10 teeth) by bike free-wheel chain thus enabling a 3-speed drive reduction in the order of 1:1.6, 1.6:1.6 and 1.6:1. Laboratory test was conducted as per the Indian Standard Test Code for seed-cum-fertilizer drill (IS : 6316-1971) for the collection of seed at different speeds of travel/rate setting/transmission ratio for different groundnut varieties. The observations were recorded.

3.6.4 Hopper inclination and seed rate setting:

Laboratory test was conducted as per the IST to arrive at the position of the hopper inclination and seed rate setting for groundnut and sorghum. Field tests were conducted to select a suitable metering speed for obtaining proper spacing which varied for different varieties of groundnut. The observations of seed collection per metre length of row and spacing between the seeds were recorded. Tractor drawn leveller was used as in the place of sticky belt method for varying the speeds of travel and the uniformity in metering was observed on the levelled surface (Plate 2).
PLATE 2. Seed spacing uniformity test in levelled field conditions
3.6.5 Furrow closer:

The length of furrow closer which was made up of m.s.squarebar was increased conveniently so as to cover the seeds and compact the soil over the placed seeds effectively.

The effect of furrow closer on seed coverage at different speeds of travel was recorded.

3.6.6 Transport wheels:

Transport wheels and its components were designed as per the design procedure given by Rernacki et al., 1972. The details of the design calculations are given in appendix XII.

3.6.7 Beam:

A beam is made up of Galvanized Iron Pipe. Its length and tliameter were designed as per the norms described by Khurtni and Gupta ,1993. The design procedure is explained in appendix XIII.

3.6.8 Fabrication:

The seed hopper was fabricated by using metal sheets of 1.5mm thick which were suitably reinforced all round the edges to a height of 10cm (Drawing 1). Top and front side covers with keel arrangements were provided. The details of the fabrication of other component are shown in Drawing II and III.

3.7 Comparative field performance evaluation of bullocks while using seed drill:

A study was conducted to investigate the performance of bullocks while using seed drill in terms of speed and power developed as a function of their body size, duration of work and draft (Gajendra Singh et al,1989). Three pairs of bullocks were selected two from Graded Kankeyani, one of the famous draft breeds in South
TITLE 1- IMPROVED SEED DRILL
MAIN FRAME ASSEMBLY

DRAWING NO.- II

ALL DIMENSIONS ARE IN MM
India and one from the non-descriptive breed which is found common in the study area. The experiment was conducted on a well-ploughed field. The draft, speed, respiration and pulse rate of the bullocks were measured while using the improved seed drill in the same season on consecutive days without much variation in the climate and the readings were documented. (Plate 3).

3.8 Field evaluation of improved seed drill:

The fabricated seed drill and the selected seed drill were tested for groundnut and sorghum crops under rainfed conditions and compared over the traditional method of sowing at different locations in the farmers’ field. In each case the amount of energy utilisation in drilling the seeds and seed distribution efficiency have been determined and grain yield on the experimental fields has been observed (Senapathi et al., 1989). The seed drill which recorded the highest rating in overall efficiency is recommended to the farmers of Dindigul Anna District, Tamilnadu, to sow the groundnut and sorghum seeds under rainfed conditions.

3.9 Cost of operation:

The economics of the bullock drawn seed drills observed as efficient under field conditions was calculated in relation to the traditional method of sowing (Shridhar et al., 1992). The total costs and benefits at different levels of annual utilisation for the seed drills were calculated and recorded. (Anon, 1988).

3.10 Farmers’ feedback on improved seed drill

A questionnaire (Appendix XIV) was prepared to elicit necessary information for evaluating the performance of improved seed drill under field condition. Then the questionnaire was administered to the farmers who had used or observed the operation of the seed drill and the results were documented.
Graded Kankeyam and Local Bullocks used for field test of ISD

Physiological Observations of the Bullocks used by a Veterinarian

PLATE 3. Comparative Performance of Bullocks while using ISD
3.1.1 Extension workers' feed back on improved seed drill:

The extension workers in the district Viz., Officials from the Department of Agriculture, Agriculture Engineering; and Krishi Vigyan Kendra; tested the field performance of the improved seed drill and evaluated it through a questionnaire (Appendix .XV) supplied to them.

Note: For convenience of reference, CIAE model I seed-cum-fertilizer drill is mentioned as CIAE, TNAU improved seed drill as TNAU, Enati Gorru as GORRU and Improved seed drill as ISD, throughout this presentation.