

**Bullock Drawn Engine Operated
HIGH CLEARANCE SPRAYER**

SUCCESS STORY



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BULLOCK DRAWN ENGINE OPERATED HIGH CLEARANCE SPRAYER

Introduction

Red gram (pigeon pea/Arhar/Tur) is an important food/cash crop grown mainly in Gulbarga, Raichur, Bidar and Bellary districts of north eastern part of Karnataka and the crop is also grown in other districts to a lesser extent. It is mainly grown under rainfed conditions. Cotton is another important cash crop of this area which is grown both under rainfed and irrigated conditions both under canal command areas (Upper Krishna Irrigation Project, Tunga Bhadra Irrigation Project, Malaprabha and Ghataprabha irrigation projects) as well as under well irrigation. In fact this area is famous for high quality and quantity of Aarahar production in the country.

These crops are highly susceptible to insect attack and are tall crops. At present, the farmers are generally using the available manually operated knapsack and motorized sprayers. A manually operated knapsack sprayer can cover 0.4 ha/6 hrs (1 acre/6 hours), a motorized knapsack sprayer can cover 1.2 to 1.6 ha/6 hours (3 to 4 acres/6 hours), as compared to that of high capacity self-propelled sprayers which can cover 6 ha/6 hours (15 acres/6 hrs). As the height of crop and its density increases with the stage of growth of the crop, the effectiveness of manually operated spraying decreases. For spraying of pesticides on crops like red gram and cotton, farmers are facing the problem of coverage of large area within a short period of time as the pest attack is a very serious problem in this region. Use of tractor operated sprayer in these crops is not very popular and also not feasible due to low ground clearance of these machines and boom height of the sprayer. Some of the farmers have found their own alternative remedy to the problem in the form of a motorized sprayer with two spray lances mounted on a local bullock cart and operated by three persons i.e. one to drive the bullock cart and two persons to use the spray lance on the two sides (facing backwards). This ensures higher area coverage, but the manpower requirement is higher and the spraying is not uniform.

The spraying operation is a labour intensive work which consumes more

labour hours and also drudgery. In view of controlling the pests and diseases, a bullock drawn engine operated high clearance sprayer was developed for tall field crops like red gram and cotton. The bullock power serves as a power source and the spraying operation is completely carried out by using petrol/kerosene operated engine which sprays through the nozzles fitted to the boom of the sprayer. The sprayer is having seven nozzles and covers large area within short period of time. The development of a bullock drawn engine operated high clearance sprayer will make mechanization of spraying more efficient and cost effective and help in timely completion of a critical operation like spraying of plant protection chemicals.

Description of bullock drawn engine operated high clearance sprayer

The bullock drawn engine operated high clearance sprayer was fabricated at College of Agricultural Engineering, Raichur. In order to increase the application rate, the sprayer unit was modified by fabricating a suitable width of spray boom with a number of nozzles along with the facility for nozzle adjustment. All the nozzles on the boom can be adjusted according to the row spacing and height of the crop. To develop the sufficient pressure for the sprayer, separate power source is provided by incorporating a petrol/diesel engine. The engine acts as a prime mover for operating the pump through v-belt pulley arrangement. The bullock power is mainly used for traction purpose and engine power is used for operating the sprayer unit.

Spray tank is fixed rigidly on the cart. It is made up of plastic material and the tank acts as a reservoir for the supply of chemical solution during the spray. The chemical should be thoroughly mixed in the appropriate concentration with water and should be filled in the tank. The chemical solution is drawn from the tank through the suction hose pipe of the pump which is fitted with strainer to avoid the dirt and other foreign material entering the pump.

The optimum operating pressure should be maintained for the discharge of chemicals in the form of fine spray through the nozzles. Thus, a

control valve is provided in the pump to maintain the required pressure. Two more valves are provided at the outlets of the pump to control the flow towards the nozzles. A pressure release valve is also provided on the pump. A pressure gauge is provided on the pump to display the adjusted pressure of the fluid to be discharged.

The power produced by the engine is transferred to the pump through v-belt drive. Pump starts working once it gets drive from the engine through the belt pulley system and the pressure will build up within the pressure cylinder of the pump. The solution will be sucked by the pump and throws it towards the nozzles through hose pipes with the pressure fixed by the operator.

Table 1: General specifications of bullock drawn engine operated sprayer

Sl. No.	Particulars	Details
1	Overall dimensions	
	a) length (mm)	3,900
	b) width (mm)	1,240
	c) height (mm)	2,120
	d) weight (kg)	305
2	Power source for spraying	3 hp engine
3	Power source for pulling of cart	A pair of bullock
4	No. of nozzles	7
5	Diameter of wheel (mm)	1,230
6	Ground clearance (mm)	920
7	Width of wheel (mm)	70
8	Adjustable boom height range (mm)	400 to 1650
9	Boom length (mm)	5200
10	Wheel tread (mm)	1200
11	Tank capacity, lit.	200 to 500
12	Pump	HTP
13	Type of nozzle	Hollow cone
14	Pressure range (kg/cm ²)	0-70

Calibration of spraying equipment in the laboratory

The main purpose of pesticide application technique is to cover the target with maximum efficiency and minimum efforts to keep the pests under control as well as minimum contamination of non-targets. The method of setting the sprayer to ensure the even distribution of determined quantity of pesticide over the desired area is called calibration. The volume of spray solution required varies with the stage of the crop growth. The volume of spray will have to be adjusted accordingly in order to ensure adequate coverage of target.

The bullock drawn engine operated high clearance sprayer was tested in the laboratory to assess the discharge rate, volume of spray, swath width, cone angle and pressure requirement. In the laboratory, the functional components of the sprayer were checked for leak in pipe lines and to get uniform spray pattern over the entire swath width. The calibrations of sprayers have been carried out in the laboratory for pre-fixing of dosage requirement of chemical solution for cotton crop.

Performance of bullock drawn engine operated high clearance sprayer

The field trials on spraying for cotton and red gram crops were conducted with three replications and three treatments during kharif seasons in the research farm. In the experimental plots of cotton and pigeon pea crops, the preliminary data pertaining to crops such as rows spacing, plant to plant distance, height of crops, were measured. For spraying operation, the recommended chemical solution as per the plant requirement was prepared separately in a tank. The chemical solution is thoroughly mixed and the same solution is poured into the chemical tank of spraying machine and also filtered it. For cotton crop, the wheel adjustments were carried out in accordance with rows spacing of the crops. The field performance of sprayer was carried out in an area of one hectare of cotton crop and pigeon pea crop separately. In order to provide the protection for operator, the protective clothes, hand gloves and face cover glass were utilized to avoid any harmful effects for the operators. During the trials, the data on speed of operation, swath width, draft, fuel

consumption, discharge rate and power output were measured and noted for both cotton and red gram crops separately. The physiological response of bullocks and behavioral symptoms were observed during work-rest schedule before and after spraying operation. The cost of operation for this sprayer has been worked out.

The field trials were carried out under work-rest schedule to assess the physiological response of bullocks for developing fatigue scores within limits. The biometric parameters of cotton crop and pigeon pea crop in the field were measured and presented in the Table 2.

Table 2: Biometric parameters of cotton and pigeon pea crop

S.No.	Parameters	Cotton Crop			Avg	Pigeon pea Crop			Avg
		R ₁	R ₂	R ₃		R ₁	R ₂	R ₃	
1	Variety	B.T. Cotton				TS-3R			
2	Height of crop, mm	1210	950	1250	1137	1550	1580	1630	1587
3	Crop standing period, days	110	110	110	110	105	105	105	105
4	Spacing of crop								
	a) row to row, mm	916	925	920	920	920	915	917	917
	b) plant to plant, mm	615	618	605	613	615	610	616	614
5	Research plot, ha	1	1	1	1	1	1	1	1
6	Number of branches, No.	42	44	43	43	52	55	58	55

The cotton crop (variety: B.T. cotton) planted at row spacing of 900 mm with plant to plant distance in a row of 600 mm was selected for the trials. The average height of crop was 1137 mm at crop standing period of 110 days. The recommended dosage of chemicals are Monocrotophas of 3 ml/ltr, Magmix of 10 gm/ltr and 19:19:19 of 10 gm/ltr and the chemical solution is prepared with clean water in a separate syntax tank.

The pigeon pea crop (variety: TS-3R) planted at row spacing of 900 mm with plant to plant distance in a row of 600 mm was selected for the trials. The average height of crop was 1587 mm at crop standing period of 105 days. The pigeon pea crop is infested with pest at tender leaves and plant

also attained the flowering stage. The economic threshold level of pest incidence is marginally less.

Field performance of bullock drawn engine operated sprayer

In the field trials, the wheel tread of bullock cart was adjusted to suit the row spacing. The minor adjustments at yoke and engine side were made before starting the trials. The recommended chemical solution is prepared separately for one hectare land and stored in the tank. The chemical solution is poured into the chemical tank (500 ltr capacity) by filtering it through filter to avoid any foreign materials which may block the spray nozzles. The operator covered the face with glass shield and hand gloves and protective cloths were used to cover the whole body. The entire crop canopy area is measured and the spraying operation is carried out in side by side method. A view of the bullock drawn engine operated sprayer is shown in Fig 1. The data related to bullock drawn engine operated sprayer for spraying on cotton and pigeon pea is presented in Table 3.



Fig. 1: Functional testing and Working of bullock drawn engine operated sprayer in pigeon pea crop

The sprayer is capable to cover 6 rows at a stretch on boom length of 5200 mm over which 7 hollow cone spray nozzles were fixed. The boom height is adjusted in accordance with height of crop. The working of bullock drawn engine operated sprayer is shown in Fig 1 and 2. During field trials, it was observed that uniformity in spraying was achieved as the bullock power is utilized only for traction

purpose. The bullock drawn engine operated sprayer worked satisfactorily during the field trials.

Table 3: Field performance of bullock drawn engine operated sprayer for cotton crop in the research farm

S. No.	Parameters	Cotton Crop			Average	Pigeon pea Crop			Average
		Value				Value			
		R ₁	R ₂	R ₃		R ₁	R ₂	R ₃	
1	Variety	B.T. Cotton				TS-3R			
2	Row spacing, mm	916	925	920	920	920	915	917	917
3	Plant to plant, mm	615	618	605	613	615	610	616	614
4	No. of rows covered				6				
5	Swath width, mm	4500	4575	4570	4548	4500	4575	4570	4548
6	Boom length, mm				5200				
7	Operating pressure, kg/cm ²				20				
8	Discharge rate, lit/h	710	715	695	707	698	715	710	708
9	Speed of travel, kmph	2.85	2.81	2.91	2.86	2.68	2.82	2.72	2.71
10	Draft, N	784.80	735.75	833.85	784.80	784.80	686.7	735.75	736.0
11	Field capacity, ha/h	1.22	1.18	1.21	1.20	1.17	1.19	1.20	1.18
12	Power output, kW	0.63	0.58	0.69	0.63	0.60	0.55	0.57	0.57
13	Quantity of chemical solution per ha, ltr/ha	581.96	605.93	574.38	587.42	596.6	600.8	591.7	596.4
14	Fuel used				Petrol				
15	Fuel consumption								
	a) In ml/kW-h	725	682	645	684.0	720	665	640	675.0
	b) In Ltr/ha	1.34	1.30	1.20	1.28	1.33	1.34	1.15	1.27

Cost of operation and labour requirement for spraying

The cost of operation and labour requirement for spraying has been worked out and presented in Table 4.

The data revealed that, the cost of operation per hour for cotton crop is Rs. 130.56 per hour. The financial saving of 54.40 per cent was observed over local method. The bullock drawn engine sprayer worked satisfactorily as the discharge rate can be maintained easily and with lesser cost of operation (Rs. 108.80/ha). The labour requirement in man-hr per hectare was 12.83 for bullock drawn engine operated sprayer. The labour saving of 71.28 per cent was observed over the local method of manual spraying.

Table 4: Cost of operation and labour requirement for spraying on cotton and pigeon pea crop

S No.	Particulars	Cotton Crop	Pigeon pea Crop
1	Cost of machine including cart, Rs.		75,000
2	Fuel		Petrol
2	Power source		Pair of Bullock
3	No. of labourers required including operator		2
4	Cost of operation:-		
	a) In Rs/h	130.56	135.62
	b) In Rs/ha	108.80	114.90
5	Percent of financial saving over the local method	54.40	37.67
6	Labour requirement man-h/ha	12.83	12.85
7	Percent of labour saving over the local	71.28	71.28

Also, the cost of operation per hour for Pigeon pea Crop is Rs. 135.62 per hour. The financial saving of 37.67 per cent was observed over local method. The bullock drawn engine sprayer worked satisfactorily as the discharge rate can be maintained easily and with lesser cost of operation (Rs. 114.90/ha). The labour requirement in man-hr per hectare was 12.85 for bullock drawn engine operated sprayer. The labour saving of 71.28 per cent was observed over the local method.

Physiological response of bullocks and fatigue score for bullock drawn engine operated sprayer for cotton crop

The fatigue score for bullocks developed by Upadhyay (1987) has been used to assess the physiological response of animals such as respiration rate (RR), Pulse rate (PR) and body temperature (BT). The physical behavioral symptom of animals was also observed to develop fatigue score. These data together with the performance of sprayer in the field gave the relation between work load on bullocks and spraying operation. The data pertaining to physiological response of bullocks and fatigue score for bullock drawn engine operated sprayer is presented in Table 5.

From the table it is observed that the fatigue score of 4 and 2 have been found during first hour of operation and subsequently the fatigue score increased to 16 and 17 at the end of fourth hour of spraying operation. The physiological response of bullocks is found to be within the limits.

Table 5: Physiological responses of bullocks and fatigue score for spraying in cotton crop using bullock drawn engine operated sprayer

Breed of bullocks	: Khillari	Ambient temperature	: 31°C
Operating pressure	: 20 kg/cm ²	Relative humidity	: 64%
Draft	: 785 N	Sunshine condition	: Bright and Clear
Work-rest-schedule	: 1 hr W - ½ hr R - 1 hr W - ½ hr R - 1 hr W - ½ hr R - 1 hr W (4 working hours)		

Sl. No.	Parameters	Working hours							
		LB	RB	LB	RB	LB	RB	LB	RB
1	Physiological parameters of bullocks – Before work								
	Respiration Rate (RR), (Breaths/min)	28	22	31	24	32	25	33	28
	Pulse rate (PR) (Beats/min)	36	32	36	33	38	34	40	35
	Body Temperature (BT)°C	37.2	36.5	38.1	37.2	38.2	37.3	38.4	37.4
2	Physiological parameters of bullocks – After work								
	Respiration Rate (RR), (Breaths/min)	36(0)	32(0)	47(1)	42(1)	53(2)	56(2)	67(2)	58(2)
	Pulse rate (PR) (Beats/min)	44(0)	40(0)	48(1)	44(1)	52(1)	48(1)	62(2)	56(2)
	Body Temperature (BT)°C	37.7 (1)	37.1 (1)	38.6 (1)	37.8 (1)	39.2 (2)	38.4 (2)	39.3 (2)	38.4 (2)
3	Physical behavioral symptoms								
	Frothing	(1)	(1)	(2)	(2)	(2)	(2)	(2)	(2)
	Inhibition of progressive movement	(1)	(0)	(2)	(1)	(2)	(2)	(2)	(3)
	Leg un-cordination	(0)	(1)	(1)	(0)	(1)	(2)	(2)	(2)
	Excitement	(1)	(0)	(0)	(0)	(2)	(1)	(2)	(2)
	Tongue protrusion	(0)	(0)	(0)	(0)	(1)	(0)	(2)	(2)
4	Total fatigue score	(4)	(3)	(8)	(6)	(13)	(12)	(16)	(17)

Note: LB = Left Bullock, RB = Right Bullock

Large scale demonstration of bullock drawn engine operated sprayer in the farmers field

Large scale demonstrations of bullock drawn engine operated sprayer for spraying on pigeon pea and cotton crop were conducted in several villages of Raichur district, for popularization and commercialization. In view of the acceptance by the farmers, the fabrication and sale of such sprayer is identified with commercial manufacturer of sprayer and the sprayer has also been included in the subsidy scheme of the state government through which the farmers can purchase the sprayer at fifty percent of its cost.



Fig. 2: Demonstration of bullock drawn engine operated sprayer for pigeon pea crop

Popularization of Bullock Drawn Engine Operated High Clearance Sprayer

For popularization of bullock drawn engine operated sprayer, a number of training programmes and field demonstrations were conducted. In Raichur district, the manufacturers, farmers and village artisans were selected in different villages to create awareness, easy handling of sprayer, care and maintenance, sale and service of sprayer. During training programme, the scientific group of Raichur centre educated the farmers on safety aspects to be followed during spraying operation. The safety aspects like use of apron, hand gloves, washing of hands after spraying and controls to be used in the sprayer to avoid any dangerous situations.

Benefits of machine over existing system

- a) The sprayer is capable to cover large area within short period of time and the discharge rate is adjustable, the nozzles are adjusted in a boom length according to the row spacing of the crops.
- b) For tall field crops such as cotton, red gram the spraying is more feasible due to less damage caused to the crop due to its high ground clearance and lesser wheel thickness.
- c) One skilled operator and one labour are required for carrying out the spraying operation. The spraying is carried out automatically by moving the cart in the field crops. The discharge rate of

chemical solution can be adjusted easily by regulating the control valve.

- d) The bullock drawn engine operated sprayer is capable to cover larger area in lesser time, than the local method of spraying by which the cost of operation is very less and also there is greater uniformity in spraying.

Commercialization

Two commercial manufacturers of sprayer have been identified for sale and service of sprayer to the farming community. The bullock drawn engine operated sprayer is included in the subsidy scheme of 50 percent of cost of sprayer in department of agriculture, Government of Karnataka. Training programmes were conducted to the commercial manufacturers, village artisans and farmers for further promotion, adoption and commercialization on large scale to the farming community. The centre has applied for patenting the technology with the appropriate authorities.

List of manufacturers of bullock drawn engine operated sprayers

S. No.	Name and Address of Commercial manufacturer	Remarks
1	M/s. Sudha Agro Industries, Sindhanur Road, MANVI. (Dist Raichur)	The subsidy of 50% of cost is provided by the govt. to purchase the sprayer
2	M/s. Varsha Associates, Mrutyunjaya compound Chitradurga	The subsidy of 50% of cost is provided by the govt. to purchase the sprayer.

