

## ***DESIGN CRITERIA AND CONSIDERATIONS***

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The travelling Spray Booms are movable systems and can easily be transferred from one field to another towed by a tractor. The most convenient size the farmers are using is the ones with flow discharge of 25–35 m<sup>3</sup>/h at 3.0–4.5 Bars operating pressure (connecting pressure), 35–50 m wetted strip width and area covered per position 0.8–1.5 ha, 10–12 hours of operation with total precipitation 40–50 mm irrigation depth. One irrigation machine can easily cover 25 ha with supplementary irrigation during the winter months. This practice is usually applied in cereals during drought periods. Each model can be modified for variable flow and irrigation strip width by the replacement of the sprayers of the boom.

### ***Area, and Topography***

The area should be a plain agricultural field of regular shape. The system can be towed and moved to a next position nearby and so on (Figure 9.5). The Spray booms can operate on uneven ground, however, level lands are recommended and uniform sloping fields with slopes up to 1 percent. Undulating topography may produce a lot of difficulties especially where runoffs occur.

**FIGURE 9.5 - Towing the compact machine.**



### ***Soil***

The soil should be of medium texture with high infiltration rate >15 mm/hour good internal drainage and water holding capacity.

### **Water availability**

The source of water can be a tube-well, a river, a small water tank. The system can be fed with water from hydrants placed at various points on the farm plot boundaries. The water pressure should be adequate for the system normal operation and in any case not less than 3.5 Bars. Otherwise a booster pump is needed, to delivering the flow at the required pressure connected directly to the system inlet. The system inlet will be connected to the hydrant or the pump outlet through a quick coupling flexible hose. For every Spray boom position a hydrant is needed. The water source should be as near as possible too the field.

### **Water quality**

The water should be clean and free from suspended solids and other impurities, of normal pH 6.5 to 8.4, with no salinity hazard, sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS should not exceed, if possible, 1 500 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, Boron content < 0.7 mg/l, Chlorides <200 mg/l, Nitrates (NO<sub>3</sub>) < 100 mg/l and low content Bicarbonates (HCO<sub>3</sub>).

### **Kind of crops**

The field crops to be grown, among others, under Spray boom irrigation and their growing season are the same as with the Center pivots as follows:

- *Winter Crops:* Wheat, barley, mid-October/mid-November (sowing) to May/June (harvest), Chickpeas, March (sowing)–June (harvest), Lentils, May (sowing)–June (harvest).
- *Industrial Crops:* Soybeans, March/April (planting)–October/November (harvest). Maize, March/June/July (planting)–July/October (harvest), Sunflower, March (planting)–June (harvest).
- *Other Crops:* Leafy Vegetables, early spring; Potatoes (spring, autumn); Watermelons March/June–July/October (harvest); Groundnuts, April–Sept.; Lucerne, perennial.

### **SPECIAL CONSIDERATIONS AND IRRIGATION SCHEDULE**

It must be underlined that this system is completely different from the conventional sprinkler irrigation systems as it is concerned with the intensity of irrigation water application. In the conventional stationary

systems the rate of precipitation ( $P$ ) is determined by the soil infiltration rate and depends on the sprinkler discharge ( $m^3/h$ ) and the sprinkler spacing ( $m$ ) along the line and between the lines. The depth ( $D$ ) of water application (irrigation dosage) is determined by the irrigation schedule and depends on the hours of operation. E.g. when the precipitation rate ( $P$ ) is  $12\text{ mm/h}$  and the operation hours  $3.5$  then the depth of irrigation application ( $D$ ) is  $12\text{ mm/h} \times 3.5\text{ h} = 42\text{ mm}$ .

In the travelling spray booms the rate of precipitation  $P$  is nearly identical to the depth (quantity) of water needed per unit of area per irrigation. This quantity is applied at once, like in the surface methods and not for a given a span of time (duration of application). In other words the area irrigated simultaneously is limited to the small area wetted at each moment by the boom sprayers, which along the travel deliver the whole amount of water needed. Then the intensity of precipitation is very high and ranges from the 50 percent to 100 percent the depth of irrigation application. It is obvious that run-off and water paddling is unavoidable in many fields of moderate and low infiltration rates, despite the manufacturers/suppliers opinion. The irrigation water dosage cannot be applied partially like with the Center Pivots by repeated travels, as it is not practical to the farmers.

The higher the retraction speed of travels the lower the depth of water application and vice-versa. Other important factors are the area covered per shift and the operating hours of the system. So, for the calculation of the irrigation program the following two formulas can be used, (1) for the determination of the retraction speed and (2) for the area irrigated per shift (setting):

$$S = \frac{Q \times 1000}{WD} \quad (1)$$

$$A = \frac{WSH}{10000} \quad (2)$$

where:

- $S$ , retraction speed meters/h,
- $Q$ , system flow  $m^3/h$ ,
- $W$ , irrigation strip width meters,
- $D$ , depth of irrigation mm (irrigation dosage)
- $A$ , area per setting ha and
- $H$ , hours of system operation

For the irrigation program the users of the spray booms can use the above formulas, or make use of the suppliers tables prepared for this purpose (Table 9.1). These tables contain the calculated depth of water application at various retraction speeds of the boom, based on the system flow and the irrigated strip width.

**TABLE 9.1 - Example performance table for boom retraction speed and precipitation**

System flow m <sup>3</sup> /h	Strip width meters	Depth of irrigation application per setting			
		20 mm	30 mm	40 mm	50 mm
		Retraction speed m/h			
17.5	50	17	12	9	7
30	50	30	20	15	12
37	50	37	25	18	15
45.9	50	46	31	23	18

The figures of the table are calculated by the use of the above given formula (1) for the retraction speed determination.

The system is recommended for deep-rooted crops with irrigation dosage of around 40 50 mm. The use of the right sprayers with fine drops at the right size and distribution is of major importance, as the very small drops are drifted by winds and distort uniform application pattern, whilst larger drops may have impact on the soil surface and influence the infiltration rate.

### ***COST***

The cost for a complete traveller spray boom system varies according to the size of the unit. The general characteristics for a relatively moderate size machine are, 25 40 m/h system water flow, 3.0 3.5 Bars connecting pressure, 75 mm flexible HDPE hose 300 m length, 50 meters effective wetted strip, 1.5 ha average area irrigated per setting. For this unit the cost is approximate US\$12 000.

### ***ADVANTAGES***

- Automated complete irrigation system in a compact movable unit.
- Irrigation efficiency 80 percent
- Considerable savings in labour
- Fine precipitation improves soil structure
- Simple to handle

- No pipe networks installations within the field (Figure 9.6)
- Gives the farmer practical solutions to many irrigation problems
- Ideal for supplementary irrigation of large and remote fields (Figure 9.7)

**FIGURE 9.6 - Spray Boom in operation.**



## ***DISADVANTAGES***

- High initial purchase cost
- High intensity of precipitation resulting into runoff and water paddling
- Not recommended for heavy soils of fine texture with low permeability
- Transportation from one field to another is made by a tractor (Figure 9.8).

**FIGURE 9.7 - Spray Boom machine.**



## **EXAMPLE DESIGN – Spray Boom in alfalfa**

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### **Area and crop**

The field is a rectangular area with dimensions 100 m along the road x 280 m, more or less plain and uniform slope, total area 2.8 ha. It is planted with alfalfa, perennial, deep-rooted forage crop tolerant to salinity.

### **Soil, water and climate**

The soil is of medium texture, with high infiltration rate of > 15 mm/h and Sa 120 mm/m. The source of the irrigation water is a deep tube-well of 30 m<sup>3</sup>/h capacity at 3.2 Bars pressure output. The water is slightly saline with TDS 1 400 mg/l with no sodium hazard and any other problem. The climate is semi-arid with warm summer and highest evaporation 9 mm/day in July August.

### **Crop Irrigation requirements and irrigation program**

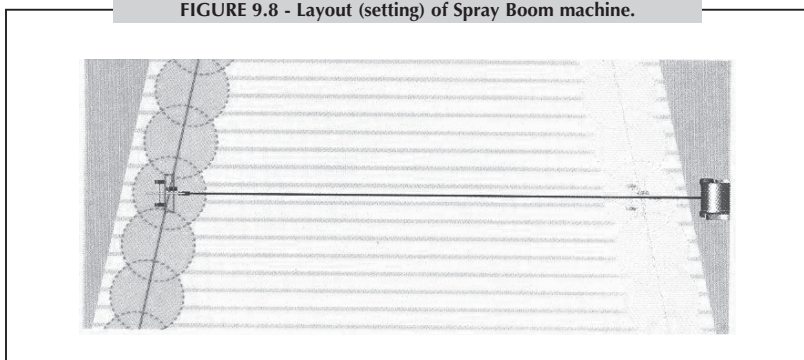
Alfalfa is a perennial crop and grows for 3 to 4 years in climates with mild winters. Crop water requirements are high ranging from 900 to 1 500 mm per season. There is a variation in the water consumption (kc values) during the irrigation season that depends mainly on the timing of the cuttings and the dormancy period, which is practiced by the farmers during the high temperature months. With average kc 0.95 and 80 percent irrigation application efficiency the gross irrigation requirements in this example case amount to 1 350 mm. This total depth (amount) of water is applied in steady irrigation dosages of 50 mm, with a total number of 27 irrigations per season.

### **System characteristics layout and performance**

The selected Spray boom machine is of low connecting pressure around 3 Bars and flow 30 m<sup>3</sup>/h to match with the available source. The length of the boom is around 32 m with 50meters effective irrigation strip width. The flexible HDPE hose is 75 mm and 300 m long. The Spray boom is towed and placed at one end of the field 280 m apart and the Reel cart on the other, near the hydrant, with the PE reel pipe laid unwinds on ground. When operated the pipe is re-winded and the spray boom on the trolley is dragged backwards irrigating a 50 m strip. With two spray boom settings (50 m x 280 m) the whole area is covered.

The application of 50 mm depth per irrigation is achieved with the 30 m<sup>3</sup>/h system flow at a travel speed of 12 meters/hour (see table or make use of formula). The time required per setting is  $280 \text{ m} \div 12 \text{ m/h} = 23.3$  hours. With 8 operating hours per day three days are needed per setting and six days to fulfil irrigation. In summer time the daily operating hours can increase to 10 or 12, so the time to fulfil irrigation can be two four days, i.e. two days per setting. According to the irrigation program the total number of 27 irrigations will be given, 2 in April, 3 in May, 5 in June, 5 in July, 5 in August, 4 in September and 3 in October. During the peak demand the machine will operate for 20 days per month to meet the requirements (Figure 9.9).

FIGURE 9.8 - Layout (setting) of Spray Boom machine.



## TECHNICAL SPECIFICATIONS (MINIMUM REQUIREMENTS)

### *Description and General Requirements*

One Traveller Spray Boom Irrigation Reel type machine, integrated unit to be used as a single whole irrigation system as follows:

- Area cover per position: 1.2 to 1.8 ha.
- System flow and connecting pressure: 30 m<sup>3</sup>/h at 3.0 to 3.5 Bars.
- Type of Systems: Travelling mechanised.
- System's Component parts: a) Reel machine on hydraulic travel wheeled cart, b) HDPE reel Pipe 75 mm c) Boom with sprayers mounted on trolley.
- System layout: The Spray boom is placed at one end of the field and the Reel cart on the other with the PE reel pipe laid unwinds on ground. When operated the pipe is re-winded and the spray boom on the trolley is dragged backwards.
- Total Length of reel pipe: 300 m.

**Reel (assembly)**

- Travel cart assembled from best quality steel and aluminium, with adjustable track width. Easily moved.
- Frame mounted on 2–4 wheelbase with large size tyres.
- Hydraulic or mechanical swivel aid for turning in any desired position on level and unlevelled ground.
- Machine supports with mechanical winch.
- Completely hot-dip galvanised travel cart and turntable.
- Revolving pipe Reel with integrated supports, swivel reel around 2 m
- Adjustable retraction speed with tachometer for digital speed indication.
- Equipped with drive mechanism powered by water pressure (full-flow turbine, pressure gauge, 4 speed gearbox, feeler bar, safety guards.)
- System for asymmetric and symmetric pipe guidance.
- Blow out system for residual water in the pipe.
- Hydraulic automatic lifting device for boom assembly and supporting legs
- Built-in automatic shut-off
- Arrangement for easy coupled to hydrant through connecting hoses 10 m.

**Boom and Trolley**

- Swivelling boom arms.
- Hot zinc plated or aluminium.
- Mounted on Trolley with wheels.
- Rotator Sprayers full-circle with fine drops and large radius coverage suitably placed at even frequent spaces; half-circle pattern near the trolley; end sprinklers.
- Effective irrigation strip width 50 to 55 m (Figure 9.10).
- Boom easily folded and unfolded.
- Adjustable boom height above ground 1.2 to 2.5 m.

**FIGURE 9.9 - Variable irrigation strip widths with different sprayers arrangements.**

