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DEVELOPMENT OF 0.126 HECTARE SPRINKLER IRRIGATION SYSTEMS

M. O. Lasisi*, F. S. Omotayo and I. O. Oni

Department of Agricultural and Bio- Environmental Engineering the Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

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***Corresponding Author**
M. O. Lasisi
Department of Agricultural and Bio- Environmental Engineering the Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

ABSTRACT

The development of sprinkler irrigation system in places and periods of insufficient rainfall has made the production of food crops, citrus and vegetables possible throughout the year on small, medium and large scale basis at an affordable cost. Therefore, the system makes provision for all season farming. The system was not only developed to improve the standard of education and exhibition but also for the production and availability of food crops, citrus and vegetables in order to reduce high cost or scarcity of these farm produce during their known off- season. The field area of 1260 m^2 was properly cleared, stumped, ploughed and harrowed. The topography of the land used was flat with a suitable soil structure, texture, water retention capacity and loam clay soil. The major components are pump, suction line, main line, sub main line, lateral, risers and sprinkler heads. A most suitable pump was designed and selected to be 4.12Kw. The sprinkler irrigation system was installed and the static tests carried out showed the coverage diameter and performance efficiency of 26.00 m and 98.59% respectively. The total cost of development was estimated to be N41, 760.00.

KEYWORD: Development, Sprinkler, Irrigation, System

INTRODUCTION

The sprinkler irrigation system was developed to apply water to the land in form of a spray. It resembles a light rainfall in the form of a drizzle. The pump lifts water from a water source

(well) and supplied it to the lateral pipe lines through a main pipe and a sub main pipe. The water from the lateral passes through the risers and enters the sprinkler head which sprays the water over the line.

The polyvinyl chloride pipes and fittings were selected because of their low cost, high effectiveness, long life expectancy when protected from surge pressures, smooth walls relatively low friction loss characteristics and resistance to corrosion for most water conditions. In the development of a sprinkler irrigation system, the parameters and factors usually considered are: climatic factors, soil type, crops type, costs and benefits, water quality and quantity, water application rate and topography.

Garg (1978) define sprinkler irrigation as the application of water to farmland using mechanical appliances like pump, pipes, sprinklers to raise the water, break it into droplets of effective sizes and distribute them uniformly over the surface or space to be covered like rain drops which depends on the pressure applied by the pump and size of the sprinkler heads. The attempt by man to quantify crop water requirement and develop a means of supplementing rainwater at various stages of crop development for optimum performance is known as irrigation (Walker, 2002). According to (Anderson, 2002) irrigation is a system used for watering crops and plants that required proper design and operation along with experience, science and even some art. Irrigation is the artificial application of water to the soil for the purpose of supplying the essential moisture for plant growth to eliminate moisture deficiency at various stages of plant growth (Michael, 2000). Irrigation eliminates moisture at every stage of crop growth, since plant absorbs its nutrient from the soil with the help of moisture and so, it makes moisture available throughout the year (Alam, 2000). In other place like Egypt or the Arabian Peninsula it hardly rain at all, farmers cannot rely justly on the rainfall to water their crops, they have to find some ways of getting water from the river to their fields that is called wet farming and the way they got water from the river is called irrigation (Rolland, 2003). Irrigation is necessary to provide enough water to fill the deficit arising from the depletion of soil moisture through the combined action of two separate phenomena of evaporation and transpiration (Vickers, 2000). With sprinkler irrigation system, farmers can schedule agricultural operations in a planned manner. The availability assures a greater and better use of implements and machinery for tillage operations (Michael, 2003). An assurance of sprinkler irrigation enables farmers to grow cereals and high value crops such as vegetables, potato, tobacco and sugar cane. Those crops require large quantity

of water, large quantity of manure and fertilizers, good seeds, better cultural management, greater care against pests and diseases and high capital intensive. The development of irrigation system started long time ago and the need arose because of unpredictable nature of rainfall for agricultural production in Nigeria (Anderson, 2002). The problem of water availability for agricultural production in Nigeria had led to reduction in agricultural produce which in turn reduce the food production (FAO, 2002). The problem of not getting the required quantity of water at the right time brought about the use of irrigation system (FAO, 2002). It is regretted that our society has tremendously lost focus on her major occupation which is widely known as farming. The reason is not far from the tediousness involved in the practice, insufficient rainfall, unstable rainfall and its high capital requirement .Most of the growths in crop production needed to meet population increase over the past decades have come from irrigated agriculture (FAO, 2000). It is more pronounced that most of our agricultural products are suffering from natural rainfall for growth and development (Hargon, 1967). Unfortunately, many of our people have adjusted to living on the few and expensive products of such crops in our markets, particularly during the dry or off- season.

MATERIALS AND METHOD

The field area of 1260m^2 (0.126ha) was mapped out and a comprehensive irrigation layout of the system was designed. A most suitable pump of 4.12Kw was selected based on pump design and selection. The installation procedures were analyzed as follow: Pump was properly positioned and installed, stakes were inserted in the ground and extended twine between them to mark the locations of trenches for the pipes, ranging poles were inserted in the ground to determine spots for sprinkler heads, the trenches were dug to the predetermined depth with shovel and digger, pipes were cut to their required lengths using pipe cutter and laid near the trenches to know their locations, riser pipes were cut to the required heights (1m), application of PVC primer and glue to the inner and outer edges of the pipes and fittings and pushed a fitting onto a corner of the pipe and turned lightly for the glue to take hold, riser pipes were attached to the connectors in the PVC pipes at their predetermined locations and this was achieved by supporting a riser firmly with one hand and twisting the sprinkler head to join the two together and backfilling soil into the trenches to cover the pipes.

Description of Components

Pump: The pump lifts water from the source and pushes it through the distribution system to the sprinkler. It also boosts the water in an existing water distribution line to force it through the sprinkler head at the desired pressures. The pump was designed and selected to lift the required amount of water from the source of supply to the highest point in the field and maintain adequate operating pressure. The pump capacity is 4.12Kw.

Suction pipe: The suction pipe connects the sump with the pump inlet. The lower end of the pipe is fitted with a non-return valve and strainer. The foot valve does not permit the liquid to drain out of the suction pipe when the pump is not working. This also helps in priming. A strainer also allows only relatively clean water to enter the suction pipe. The diameter of the suction pipe is 40mm.

Main line: It delivers water from the pump to the sub main line. The main lines are temporarily buried below the ground. The diameter of the pipe is 40mm.

Sub main lines: These are pipes which deliver water from main lines to the laterals. They are temporarily buried below the ground. The diameter of the pipe is 40mm.

Laterals: These are pipes which deliver water from sub main lines to the sprinkler heads. The diameter of the pipes is 25mm.

Risers: These are pipes and fittings used to attach the sprinkler heads to the lateral pipes. It is also a short vertical pipe connected to the lateral pipe and carried the sprinkler head. The diameter of the pipes is 15mm.

Sprinkler head: It is connected to the risers and distributes water uniformly over the land without run-off or excessive drainage from the root zone. The sprinkler is the most important component of a sprinkler irrigation system. It operates under optimum water pressure and climatic condition; mainly the wind velocity will determine its suitability and the efficient of the system.

Testing Procedure

The delivery valve was closed and the priming of the centrifugal (surface) pump was carried out by opening the air-vent valve provided in the pump casing to displace the air inside the pump. While delivery valve was still closed, the external energy was supplied to the pump

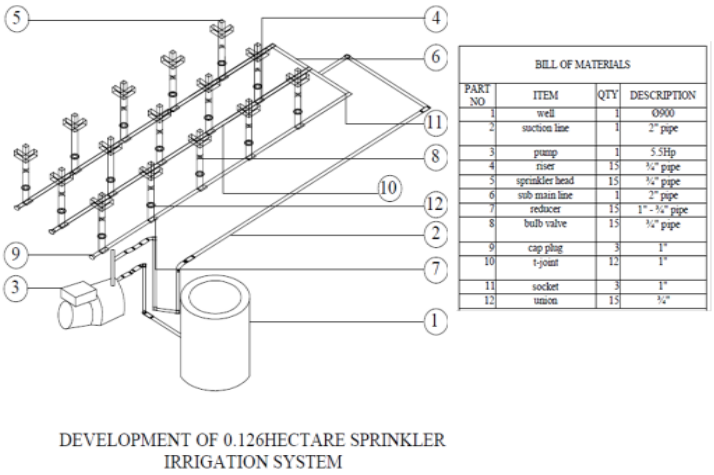
shaft by putting on the pump. The delivery valve was gradually opened and the water started flowing into the delivery pipe. The water moved from the sump to the pump due to the pressure differences at the two ends of the suction pipe. The pump lifted water from the well and supplied it to the lateral pipe lines through a main line and sub main pipe. The water from the lateral passed through the risers and entered the sprinkler heads which sprayed the water over the line. The coverage diameter of the sprinkler heads were uniform and measured to be 26.00m.

RESULTS AND DISCUSSION

The results obtained from the static tests of the developed sprinkler irrigation system are shown in the table and graph below.

Table 1: Results of the static tests carried out on the system.

Lateral	Riser	Radius of Curvature(m)	Coverage Diameter(m)	Coverage Area(m^2)
	R/SH A_1	13.00	26.00	531.00
	R/SH A_2	13.00	26.00	531.00
	R/SH A_3	12.90	25.80	522.86
A	R/SH A_4	12.80	25.60	514.79
	R/SH A_5	12.45	24.90	487.02
	Total Average	**12.83**	**25.66**	**517.33**
	R/SH B_1	13.00	26.00	531.00
	R/SH B_2	13.00	26.00	531.00
B	R/SH B_3	12.88	25.76	521.24
	R/SH B_4	12.85	25.70	518.81
	R/SH B_5	12.43	24.86	485.45
	Total Average	**12.83**	**25.66**	**517.50**
	R/SH C_1	13.00	26.00	531.00
	R/SH C_2	13.00	26.00	531.00
C	R/SH C_3	12.85	25.70	518.81
	R/SH C_4	12.70	25.40	506.77
	R/SH C_5	12.39	24.78	482.34
	Total Average	**12.79**	**25.58**	**513.98**



BILL OF MATERIALS

PART NO	ITEM	QTY	DESCRIPTION
1	well	1	Ø900
2	suction line	1	2" pipe
3	pump	1	5.5Hp
4	riser	15	¾" pipe
5	sprinkler head	15	¾" pipe
6	sub main line	1	2" pipe
7	reducer	15	1" - ¾" pipe
8	bulb valve	15	¾" pipe
9	cap plug	3	1"
10	t-joint	12	1"
11	socket	3	1"
12	union	15	¾"

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Figure-1.

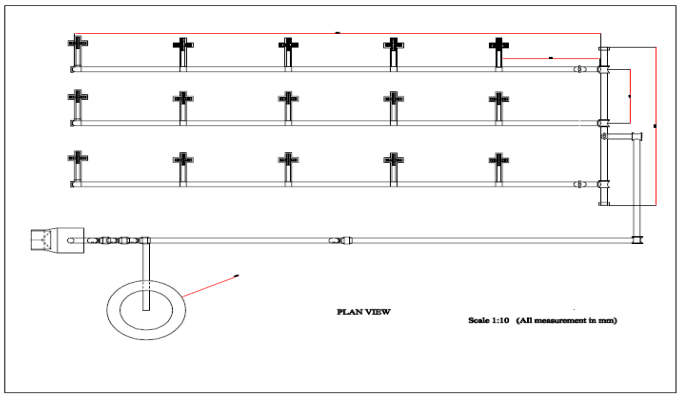

Figure 2: Sprinkler Irrigation Layout.

DISCUSSION

The wetting pattern of the sprinkler system was uniform and the wetted area was circular while testing. The coverage diameter of the sprinkler head was measured to be 26.00m and the degree of coverage was 360^0 because the sprinkler heads completed the full rotation while carried out testing. The maximum spacing between the sprinklers was 26.00m.

Functional Efficiency

The functional efficiency of the system was estimated by determining the total coverage diameter and the expected coverage diameter of sprinkler head.

$$Functional\ Efficiency = \frac{Total\ coverage\ diameter}{Expected\ coverage\ diameter}\ x\ 100$$

$$= \frac{384.50}{390}\ x\ 100$$

$$= 98.59\ \%$$

CONCLUSION

A sprinkler irrigation system was not only developed to improve the standard of education and exhibition but could also be used for the production of food crops, citrus and vegetables in places and periods of insufficient rainfall throughout the year in order to reduce high cost or scarcity of these farm produce during their known off- season period. The system makes provision for all season farming. The static test carried out showed that the 4.12Kw pump was suitable for the system because the coverage diameter of 26.00m by the sprinkler heads were uniform. The results also showed a uniform distribution of water and an unobstructed flow of water to avoid flooding during irrigation. The cost of development of the system was N41, 760 which is affordable to the farmers and the performance efficiency was 98.59%.

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