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Design and Construction of Combined Drip and Sprinkler Irrigation Prototype for Instructional Delivery in Agricultural Education in College of Education, Zing, Taraba State, Nigeria

Dr. Jifin Danbeki Tsojon
Agricultural Education Department, College of Education, Zing, Taraba State, College of Education, Zing, Taraba State

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ABSTRACT: *The purpose of the study was to design and construct a drip and sprinkler combined prototype irrigation for instructional delivery in College of Education, Zing, Taraba State, Nigeria. The need for a facility such as this cannot be over-emphasized as it will enhance academic achievement of students of agriculture. The design was based on combined drip and sprinkler irrigation methods for teaching and learning. The study presents a novel combined irrigation system that is suitable for instructional delivery in institutions of learning. The result shows that the discharge of individual emitters/drippers and sprinklers delivered water adequately, wetting and sprinkling water, by the combined methods to the desired areas. The study recommends, among others, that such a novel irrigation facility should be established in institutions of learning, in Nigeria, to enhance instructional delivery in agricultural education.*

KEYWORDS: design, construction, drip, sprinkler, prototype irrigation

INTRODUCTION

Agricultural Education is one of the programmes mounted by Universities and Colleges of Education in Nigeria. Ukonze and Olaitan (2010) defined Agricultural Education as a programme designed for equipping students with knowledge, skills and attitude in teaching and technical aspects of agriculture to enable them to deliver same to students in Universities and Colleges. Akpomedaye (2011) maintained that Agricultural Education is an occupational education designed to develop knowledge and skills in various farming methods. In the opinion of Tsojon (2018, 2020), Agricultural Education is a programme in Colleges of Education and other tertiary institutions designed with series of activities for equipping students with knowledge, skills and attitudes in pedagogy in agriculture required for instructional delivery to students.

Agricultural Education is one of the courses offered in postsecondary schools in Nigeria. Postsecondary schools include Universities, Polytechnics, Colleges of Education, Monotechnics that provide education after secondary education. Agricultural Education is one of the courses

taught in Colleges of Education in Nigeria. A College of Education is a tertiary institution that offers a minimum of three years of training to students to obtain Nigeria Certificate of Education (NCE) to be qualified as professional teachers. (Federal Republic of Nigeria (FRN), 2004). The National Commission for Colleges of Education (NCCE) 2019 minimum standard gave the following as the objectives of Agricultural Education:

1. Prepare graduate with right attitude and knowledge/professional competence in vocational Agriculture.
2. Produce teachers who will be capable of motivating students to acquire interest in and aptitude for agriculture.
3. Develop in the student−teachers the appropriate communication skills for effective transmission of agriculture information and skills to the students in the context of their environment.
4. Equip the student−teachers with adequate knowledge and ability to establish and manage a model school farm effectively and
5. Provide a second background to enhance further academic and professional progression of the students.

To achieve the objectives stated above, the NCCE (2012) listed courses to be offered by students in Agricultural Education to include: Introduction to agriculture, arable crop production, Introduction to animal science, farm power and machinery, crop improvement, fish production, principles of farm management, land survey and farmstead planning, basic agricultural water engineering, entrepreneurship in Agricultural Education, among others. This study is focused on design and construction of combined drip and sprinkler irrigation prototype for instructional delivery of agricultural education in College of Education, Zing, Taraba State, which is a novel system.

Irrigation is an important component in crop production. It is therefore, the artificial application of water to the soil to enhance crop production, to supplement the rainfall which is inadequate (Eisenhaner, Martin & Hoffman, 2022). (Conserve Energy Future (2021) maintained that irrigation enables the crops to grow vigorously during it different growth stages for optimum yield. It assist in the growing of crops, watering livestock maintenance of landscape, regulation of disturbed soils and dust suppression (Ighrakpata et al., 2019). The water application complements the inadequate rainfall, at the right amount and time. The objectives of irrigation include: increase in crop production through higher yield to attain food security for the nation, sustain soil biological and chemical activity and mineralization during dry season, promote soil solution and nutrient uptake by plants, provides carbohydrate building block, $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$, provide plant structure and support and promotes the maintenance of optimum temperature within the plant.

Irrigation can be classified into surface, subsurface, sprinkler and drip irrigation (Ighrakpata et al., 2019). This study was designed and constructed combined prototype of sprinkler and drip methods

of water application to the soil. Sprinkler irrigation simulates natural rainfall by spreading water, under pressure, into the air and falls on the soil in the form of rain, uniformly when needed at required quantity. It is suitable for sandy or shallow soils (Zakari et al., 2012 and (Ighrakpata et al., 2019). Drip irrigation, on the other hand, is the application of water to the farmland in the form of drops directly near the base of the plant (Zakari et al, 2013and (Ighrakpata et al., 2019). This method of water application is also known as trickle irrigation. This method delivers water to the farmland through a system of flexible pipes, operating at how pressure and is applied to the plant through drip nozzles, drippers or emitters. Drip irrigation delivers water at the base of each plant which is sufficient the meet the transpiration needs.

College of Education, Zing, Taraba State is in North East zone of Nigeria. College of Education, Zing runs educational programmes, among which is Agricultural Education. This programme is run both at the NCE and at the undergraduate studies of the College of Education, Zing. Both departments teach irrigation as a course. The College does not have irrigation facility hence the need to design and construct a prototype of sprinkler and drip irrigation systems for instructional delivery and research activities. Sprinkler and drip irrigation systems are very essential for conducting field practical demonstration with the students which will enhance the understanding of the leaners, therefore improving the academic achievement by the students. These systems of water application to the soil for crop use will serves as instructional facility in agricultural education for the departments. Umar and Ma'aji (2011) and Anyakoya (2013) posited that instructional facilities for instructional delivery in vocational and technical education are unavailable, poor, inadequate and obsolete in our tertiary institutions in Nigeria. Based on the foregoing this study intends to design and construct a prototype of combined sprinkler and drip irrigation facility in College of Education, Zing Taraba State for instructional delivery to students and research by lecturers of Agricultural Education in the Northeast and Nigeria as whole.

The purpose of this study was to design and construct a prototype of combined sprinkler and drip irrigation facility for instructional delivery in College of Education, Zing, Taraba State. Specifically, the study intends to:

i. Design a combined sprinkler and drip irrigation prototype facility in College of Education, Zing.
ii. Construct a combined sprinkler and drip irrigation prototype facilities in College of Education, Zing.
iii. Determine the functionality of the combined sprinkler and drip irrigation prototype facility in College of Education, Zing.

This study would benefit lecturers of Agricultural Education in College of Education, Zing, researchers, administrators of Colleges of Education and students of Agricultural Education.

This study would provide an avenue for lecturers of Agricultural Education to deliver practical instruction in Agricultural Education to students in the aspect of irrigation. Students of Agricultural

Education stand to benefit as practical activities would be conducted there and would gain practical experience thereby improving their academic achievement, rural urban drift for white collar jobs will be reduce as the younger agriculturalist adopt this farming system with the establishment of the combined sprinkler and drip irrigation facility in College of Education, Zing, it would serve as one of the requirements to obtain accreditation for agricultural department any time the exercise will be done. Other institutions in the Northeast and Nigeria as a whole can benefit by bringing their students on field trip to the College for practical demonstration which would qualify them for graduation. Researchers in Agricultural Education can also carry out their researches there to come out with results that will improve the quality of education in Nigeria especially in Agricultural Education. This study was restricted to the design and construction of a combined prototype of sprinkler and drip Irrigation College of Education, Zing, Taraba State.

Research Design

The establishment irrigation facility in tertiary institutions in Nigeria is not widely known. Designing and constructing a combined sprinkler and drip irrigation prototype is novel and will demonstrate efficient performance for instructional delivery to students of agricultural education, adding to the body of knowledge (Michael, 2005). Designing is, therefore, creating something new or changing something that exists into a better situation (Elseier, 2003; Umar, Yusuf & Mustapha, 2019). Irrigation design deals with hydraulics, the study of water as it moves through a network of pipes to plants (Irrigation Design Rules of Thumb, 2020). The Rule explained further that the system involves having; a water source that provides appropriate flow and pressure for distribution needs, a mainline network connected to individual valves, pipes sized to allow water flow velocity within acceptable limits to reduce ware and extend service life and appropriate sprinkler head and drip emitter selection to provide even spread of water and in an amount that is adequate within the time of watering. The combined sprinkler and drip irrigation prototype design considered selection, spacing, capacity application rate and nozzle discharge. The study adopted the experimental research design since the study was an experimental one (Agbulu & Aboiyar, 2007; Emaikwu, 2011) as it involved construction of the facilities.

The area of the study will be Agricultural Education farm (30m x 40m) hectares in the College of Education, Zing, Taraba State. Zing has an area of 1.030km^2 with a population of 127,000 (NPC, 006) census, lat 8.8834, long 11.7452 the topography of Zing is undulating Zing is located in northeast Nigeria which is between latitude 8^{0}N and 14^{0}N and longitude 7^{0}E and 14^{0}E (Abaye, Ati & Iguisi, 2012).

MATERIALS AND METHODS

The materials that used for the study include; pegs, rope, digger, measuring tape, water pump, pipes, sprinklers, risers, elbow-joint, t-joint, end-plug, gum, mallet, emitters, 9” blocks, cement sharp sand, PVC pipes, union connector. Aluminium pipes used for the sprinkler and flexible polyethylene pipes for drip systems. The diameters of the pipes were selected dependent on the availability of the water source and the size of the land to be irrigated (Ighrakpata et al., 2019).

The area to be irrigated was measured to cover the portion for sprinkler and drippers to be installed in the field. The pressure needed to deliver water to both sprinklers and drippers were considered for efficiency. The combine system is as shown in the figure below and the mains, laterals, risers, emitters and sprinkler nozzles were mounted as required to deliver water to the farm for crop use. Drip irrigation system is made up of a 'head' and a distribution network. The head consists of water source, pump, filter and pressure regulators while the distribution network is made up of mainline and dripper lines along the plant rows. A well designed and maintained drip irrigation system is capable of an application efficiency of 90% (Taghvaeian, 2017)

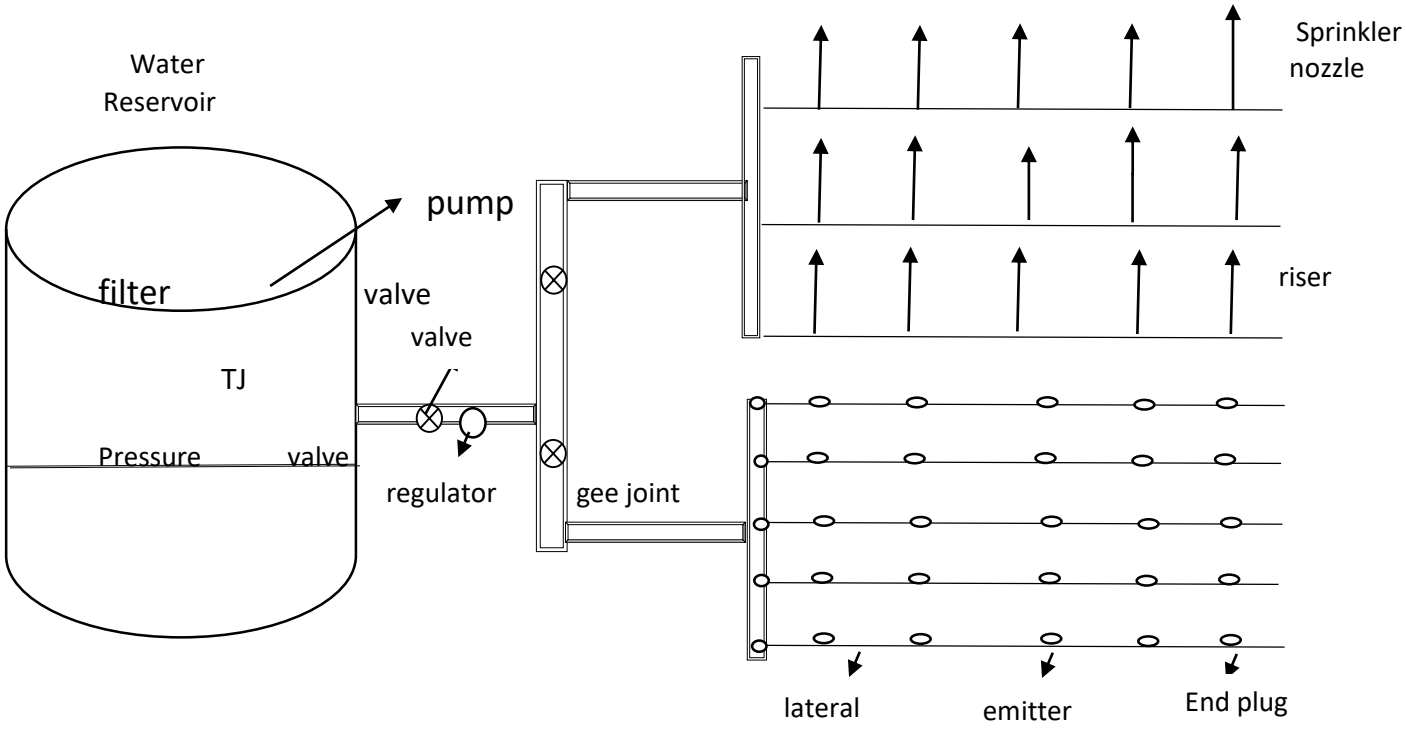

Figure 1. Design of combine sprinkler and Drip irrigation prototype

Figure 2. Risers and Sprinklers connected Lateral. (Ighrakpata et al., 2019)

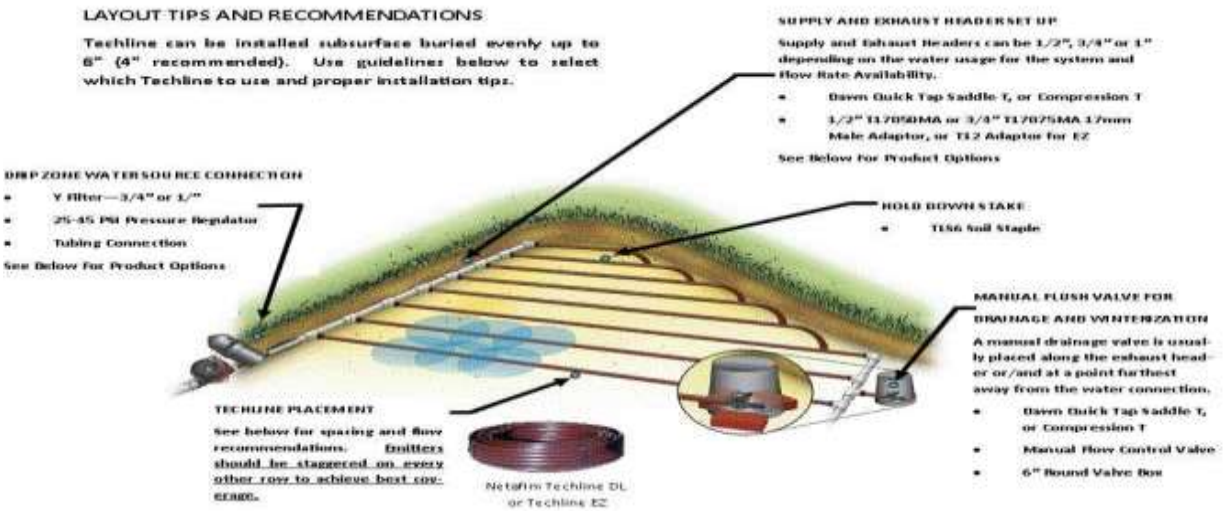

Figure 3. Drip Line System. (Ighrakpata et al., 2019)

Sprinkler Selection & Spacing

$$Qn = \frac{S_I \times S_m \times I_r}{360}$$

Where Q_n = discharge of individual sprinkler (lit/sec)
S_I = Spacing of sprinkler along lateral (m)
S_m = Spacing of lateral along the main (m)
I_r = Optimum application rate (cm/hr)

Total discharge is the discharge per sprinkler multiply by the number of sprinklers ie$Q_{nT} = Q_n$ X N where N is number of sprinkler.

The volume of water applied per irrigation by dripper was determined by multiplying the total area to be irrigated by the depth per irrigation (Zakari, Tadda, Maina, Abubakar & Lawan, 2013)

In this method of water application only part of the soil was wetted, therefore, the depth or volume of irrigation interval and spacing were different depending on the crop cultivated (Zakari, Tadda, Abubakar, & Lawal, 2013)

Material selection is very important which will ensure the desired performance of the irrigation prototype method. Selecting appropriate pump will ensure the head with which the pump will be performing. The materials to be used for this method of water application would be selected after a careful study of the proposed materials. The proposed irrigation facility is expected to have the following components: reservoir, water pump, pipes for mains, laterals and risers; sprinklers, filters, values pressure regulators, elbow and tee joint, end plugs, emitters and wash bore.

The discharge per sprinkler and emitter or dripper was calculated per given time to determine the volume of water applied and also the irrigation requirement of the soil under study. This determined the efficiency of irrigation prototype in instructional delivery in College of Education, Zing.

RESULTS AND DISCUSSION

The study designed and constructed a combined prototype of sprinkler and drip irrigation facility for instructional delivery to students of agriculture. The irrigation was recommended for instructional delivery by experts in irrigation. The sprinkler section of the facility delivered the required water simulating rainfall to the farmland at 30psi while the drip section delivered water to the expected base of the crop at 20psi.

The water reservoir was constructed in the College farm to preserve the water for irrigating the farmland. A water pump was connected to the water reservoir to deliver water to both the sprinkler and drip sections of the irrigation facility. The pump was linked to two valves regulating water

flow to each of the main lines of the sections. The mains have the lateral lines connected to it upon which the risers and sprinklers were mounted while emitters or drippers were attached to the drip section. Water delivery was done via endpoints of the irrigation pipelines, sprinklers and drippers/emitters. This was based on the consideration of the size and coverage and type of watering mechanism.

CONCLUSION

The design and construction of a combined drip and sprinkler irrigation prototype was carried out to provide facility for practical demonstration in instructional delivery and research in agriculture in College of Education, Zing. This prototype facility works simultaneously as the sprinkler segment sprinkle water to the plots simulating rainfall while the drip segment delivers water through the emitters/drippers placed at the base of the crops planted at a predetermined rate. The combined irrigation facility also applied water interdependently as both segments have valves regulating the flow of water to each. The desire by lecturers/researchers and learners to make use of facility such as this for instructional delivery in agriculture cannot be over-emphasized as it will contribute immensely to students' academic achievements (Tsojon, 2020).

Recommendations

Based on the design and construction of combined drip and sprinkler irrigation prototype facility, the following recommendations were made:

- ✓ That similar irrigation should be established in institution of learning to enhance instructional delivery in agriculture.
- ✓ Lecturers should be given regular orientation/workshop on how to make use of the novel facility to demonstrate to the learners during practical sessions to bring about the desired instructional delivery.
- ✓ Varied crops should be studied using this facility to test its performance and suitability.
- ✓ Performance evaluation should be carried out on the delivery rate of water by the facility to the soil.

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