

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

University of Southern Queensland

Faculty of Engineering and Surveying

**Analysing the Effect of Speed Variation on Irrigation
Efficiency in Travelling Irrigators**

A dissertation submitted by

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Unit 4112

Towards the degree of

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Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

Abstract

Tests were carried out to analyse the affects speed variation has on irrigation efficiency in travelling irrigators. These trials required the data collection of a number of different parameters, these being longitudinal and lateral depth; applied velocity variation; water flow and pressure. From these results, distribution uniformity and velocity variations can be deduced.

It was found that velocity variation reduced distribution uniformity, and the velocity variation characteristics are dependent on the drive mechanism. The auxiliary engine offered consistent average velocity with small oscillating velocity values, while the turbine's velocity tended to vary slightly more across the run. As well, oscillations were greater, while the piston drive mechanism tended to change rapidly with no particular trend. It was decided this was due to a characteristic of the drive mechanism itself, as the test data offered no other reasons for the extreme variations. It was also concluded that the cable drum radius changes significantly across the run, causing variation in speed over the whole run as possibly causing oscillations throughout.

It was concluded that irrigation efficiency is influenced by the drive mechanism in use, and improvements in the performance of these drive mechanisms could be achieved if the cable could be applied evenly onto the cable drum.

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ENG4111 & ENG4112 <i>Research Project</i>
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CERTIFICATION

I certify that the ideas, experimental works, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

Nicholas Alexander Campbell

Student Number: Q12211431

Signature

Date

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Chapter One

Introduction

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

1. Introduction

Australia is the driest continent in the world, so irrigation plays an integral part in Australia's agricultural industry, with "77% of water used in Australia going to irrigation purposes" (Hoffman and Marin, 1993). The availability of water is becoming ever increasingly limited, stressing the importance of efficient irrigation systems. "An efficient irrigation system is able to supply the desired amount of water when required and at the same time provides leaching requirements, agronomic operations and environmental considerations." (Hoffman and Martin, 1993)

Soft hose travelling booms and guns play a vital part in irrigating Australia, with over 50% of irrigation in the dairy industry comprising travelling guns alone. However, from the little in-field testing that has been carried out on these irrigators, the results that have been attained illustrate that a low level of efficiency is present. "Distribution uniformities of less than 20% are common under travelling irrigators."(Newell) A major reason for this low efficiency is suspected to be that current soft hose travelling irrigator speeds vary along the field due to pressure, elevation and drive mechanism inefficiencies. A common cause is due to the system progressively dragging more and more hose the further it travels along its run. This variation in travel speed is significant, as the output of water normally remains the same, causing a variation in water being applied per unit area across the paddock.

This project will evaluate and report on the magnitude and nature of variations in speed, pressure and volume of water applied by travelling irrigators. It is envisaged that six tests on different irrigators will be evaluated, and data gained from past researchers are to be attained. On completion of this evaluation, I will ascertain a more comprehensive understanding of the varying irrigation efficiencies obtained by the three main drive mechanisms:

- Auxiliary Engine
- Water Turbine
- and, Piston Ratchet action

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and determine what drive mechanisms are more suitable to different areas. Following this, I will then recommend a solution to the problem.

There are two parameters when measuring uniformity in travelling irrigators: firstly, the lateral uniformity. This is how uniform water application is between lane spacings, and is affected by:

- Change in water hydraulics
- and, Sprinkler configuration

The second parameter is longitudinal uniformity: this is the evenness of water application along the length of the run. Low irrigation efficiencies in the longitudinal direction are a consequence of variation in drive mechanism performance. There are four main factors which influence the performance of a travelling irrigator:

- The load due to increased hose drag
- Variation in radius of cable drum intake
- Change in water supply hydraulics
- and, Topography

1.2 Dissertation Overview

The dissertation begins with chapter two, giving detailed background information and a review of literature written on papers relating to performance of travelling irrigators. The third chapter introduces materials and methods to be used so that results can be collected for analysis. This is followed by chapter four, giving a comprehensive account of the data collected in the field in a way that can be analysed. Chapter five is a discussion of the results found; this chapter makes sense of the data, so conclusion can be drawn from the results in chapter six. Chapter six also contains a segment of recommendations followed by recommended areas for future work.

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Chapter Two

Literature Background

2 Literature Background

2.1 Travelling Irrigators and their Performance

2.1.1 Types of Travelling Irrigators

There are numerous types of travelling irrigators available to farmers; the choice made depends on the size and shape of area to be irrigated, pressure available, water available, type of crop required and budget.

2.1.2 Travelling Gun

This system consists of a high-pressure gun positioned on top of a trolley propelled forward by the water pressure using several different drive mechanisms, which will be addressed later in the chapter.



Figure 2.1 Travelling Gun Operating in Field

“Travelling gun irrigators (travellers) are by far the most popular method for irrigating pasture in Queensland, accounting for over 51% of systems in use.” (**Wiggington and Raine, 2001**) They are the cheapest travelling system available; however require high overheads to keep the required pressure. It is common for farmers in the Lockyer Valley to spend two to three hundred dollars a mega litre to maintain desired the desired pressure.

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The travelling irrigator has the advantage of being very versatile as it may be used in paddocks with trees and other obstruction in the desired irrigating area and maybe used in undulating country however more easily than other systems. However, travelling irrigators are affected by wind severely, more so than any other travelling irrigator. It is advisable to use guns in non-windy conditions, however if this cannot be avoided, then the traveller should be positioned so it travels perpendicular to the direction of the wind.

2.1.3 Travelling Boom

The travelling boom is made up of a boom varying in width between 30 and 100m, fixed onto a self-propelling trolley. Either an auxiliary motor moves this trolley or water propelled mechanism by reeling in a wire cable that is connected to a fixed object (generally a tractor). They are either of the hard hose or soft hose variety; this too will be described in more detail later in the chapter.



Figure 2.2 Travelling Boom Operating in Field

Cost of a travelling boom varies between \$60 000 to \$100 000, depending on the quality and size of the systems according (Wallace, S 2005, pers. comm. April 6). The more advanced system is self-levelling to increase uniformity on undulating surfaces; some also possess a velocity correction mechanism. The boom requires much less pressure than a gun, therefore the overhead costs are reduced significantly.

Travelling booms have become very popular for intensive farming operations in the past decade, with the average age in the Lockyer valley is between 5-10 years.

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2.1.4 Centre Pivot

Centre pivot irrigation systems consist of a typical lateral system pivoted at one end, as shown in the figure (below right). They vary in size from 15 to 80 hectares, and are becoming increasingly popular due to their ease of operation, automation, efficiency and uniformity of application and low capital cost (\$2000/ha)(*Evaluating the Performance of Travelling Irrigators* 2004, Growcom, Viewed 26th March 2005,

<www.growcom.com.au>)

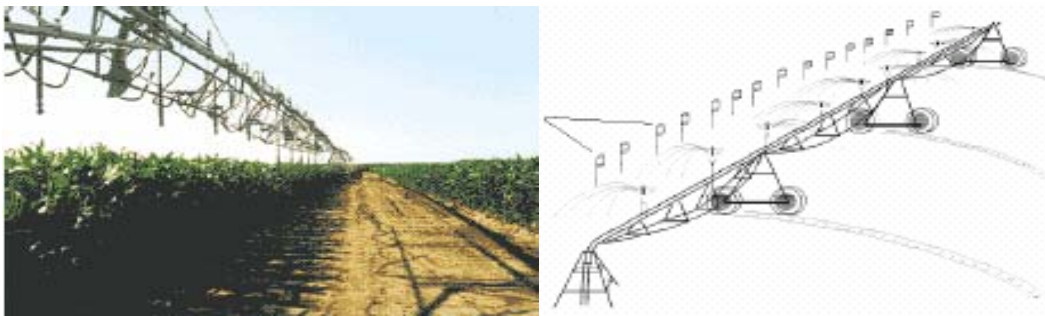


Figure 2.3 and 2.4 Centre Pivot not in use and Sketch of Centre Pivot and Catch Cans in Place

These systems are usually driven by individual hydraulic motors positioned on each wheel, where the inside motors are geared slower than the outer wheels. The drive mechanism is very inefficient and can operate at efficiencies as low as 5%. Unfortunately the centre pivot is restricted to irrigating a circular paddock, which is an inefficient use of a paddock and cannot be moved about to different blocks.

2.1.5 Lateral Move

Lateral move systems are similar in design to centre pivots, with moving towers and spans of pipe connecting the towers. The main differences being the towers move at the same direction and speed. Water is fed into the system either at one end or in the middle by either a supply ditch, trailing hose connected to a main line or disconnecting and connecting to hydrants positioned along the run. Due to there being no stationary point on the system, a diesel generator provides electricity.

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Figure 2.5 and 2.6 Linear System before being used and during use

The major advantage of this system over other options is the ability to irrigate large rectangular paddocks quickly, uniformly and efficiently. The system typically uses 20% less energy than travelling gun irrigators of similar capacity... Long lateral systems can apply water at a rate which allows all the irrigation water to be applied at night, taking advantage of night rate power. (*Dexcel Farm Fact 2001, Small Kiwi Farms, New Zealand, viewed 16 May 2005, <<http://www.dexcel.co.nz/farmfacts/>>*) However, these systems involve a high initial cost, and are generally only used for high value crops such as potatoes, vegetables and turf. A system configuration with the length of run 2-4 times longer than the system width is needed to make it competitive cost wise with a pivot.

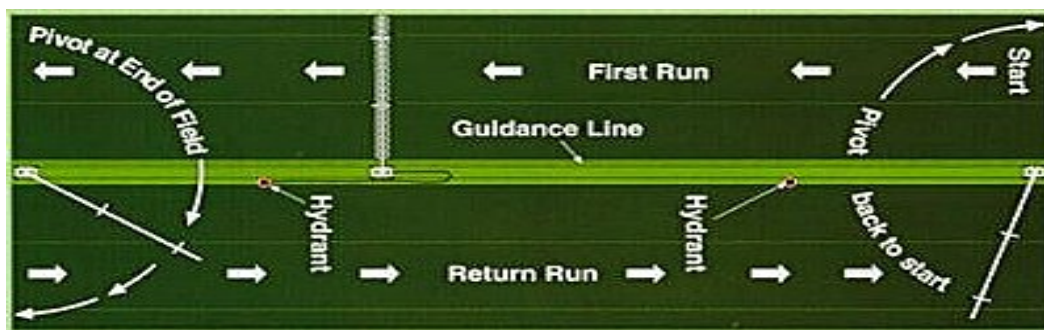


Figure 2.7 Typical Linear System Irrigation Run

2.1.5 Wheel move

The wheel move system (or side roll) consists of a lateral sprinkler system with 3m diameter wheels linked by the pipe, which acts as the axles. The standard length is a quarter mile, but variations in length can be purchased. (Thomas, J(Agricultural Engineer) 2004, *Irrigation System Selection, viewed 16th May 2005, <<http://msucare.com/pubs/publications/p1508.htm>>*) The system is placed in the desired stage and irrigates a section 20 to 30m wide. When the desired amount has been

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applied, a gasoline engine is used to shift the system to the next stage. The sprinklers are attached with a swivel connection in a way so that they are always facing upright.



Figure 2.8 and 2.9 Two Wheel Move Systems in use

This system is not appropriate for ground with more than a 5% slope, and is susceptible to damage in windy conditions. It is also restricted to low crops and requires high labour with comparison to other travelling systems. “Each lateral is capable of irrigating a maximum of 40 acres.” (Scherer, T (Agricultural Engineer)1998, *Selecting a Sprinkler Irrigation System*, Viewed 16th May 2005, <www.ext.nodak.edu/extpubs/ageng/irrigate/ae91w.htm>)

2.2 Different Drive System and their Performance

The way in which a drive mechanism for travelling guns and booms acquires forward motion depends on whether the system is a soft or hard hose traveller. A soft hose traveller derives its movement by reeling in a cable, which is fixed at a point at the other end of the field. A hard hose system propels itself forward by either pulling itself forward by reeling in the hose fixed at the end of the paddock. Or by a winch set up at the end of the paddock that reels the irrigator towards itself. There is a range of drive mechanisms that power the winches; they include axial and radial water turbines, water piston and auxiliary motor.

The water-powered mechanisms gain their power by diverting a portion of the water from the mainline through the piston or turbine. This water then either re-enters the main flow again or gets discharge by an individual nozzle. The fact that the drive mechanism is

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powered by the water flow means the traveller will stop moving when the water stops. This stops the problem encountered of the irrigator cart continuing to move after the desired run has finished.

An auxiliary motor is generally a internal combustion engine, it does not rely on the water pressure for its energy. This is a positive for travel speed uniformity as rise and drops in pressure do not affect the velocity of the traveller, and “no hydraulic energy losses occur due to the drive mechanism.” (Sutton, R, 2001)



Figure 2.10 A Travelling Gun with a Piston Action Drive Mechanism

2.2.1 Ratchet water piston action

The main driving component of a water piston is a completely enclosed piston encased in another slightly larger cylinder, which it slides within. The larger cylinder has two inlet valves placed at each end of the cylinder and two outlet valves also placed at each end of the cylinder. When water is diverted into one of the inlet valves, it forces the piston to the opposite end of the cylinder, this movement forces one of the driving arms to apply torque to the cable drum. The pressure is then released from the cylinder through the corresponding outlet valve, at the same time water is pushed through the opposite inlet valve. Hence, pushing the piston to the other end of the cylinder, this applies force to the second driving arm, which in turn applies torque to the cable drum. The cycle is repeated constantly, until the cable is completely reeled in or water flow ceases.

The outlet valves control the speed of the drive mechanism. If the degree of closure of the valve is increased, the resistance to the piston moving is increased, therefore slow the

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drive mechanism. On the other hand, the more the valve is opened, the greater speed the drive mechanism will operate at.

2.2.2 Radial Turbine

The heart of the drive system, this extremely efficient motor delivers quiet, smooth, continuous power. All the water you pump goes through the sprinkler. None of the water is wasted as in bellows or piston drives. The radial turbine involves 24 blades mounted on an axis perpendicular to the flow of the water. The radial turbine can deal with as high a pressure as 300m head and no less than 30m. The power produced by the turbine is transferred to a gearbox, which in turn drives the cable drum.

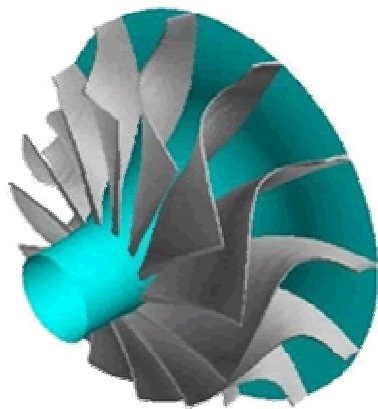


Figure 2.12 Blade shape of a radial inflow turbine

2.2.3 Axial Turbine

The axial turbine has only three to eight blades, with the axis of the turbine running parallel with the flow of the water. The operating pressure for these turbines is far less than that of the radial variety, with head requirement less than 30m. “A hydraulic motor or pump acts as a secondary mechanism, using the power generated by the axial turbine” (Newell, G., Foley, J. & Smith, R. 2002) This drive system does not require exhaust nozzles as all the water used to power the turbine is redirected back into the main flow.

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Figure 2.13 and 2.14 Picture of Auxiliary Engine and Turbine Drive Mechanism Attached to Travelling Irrigators

2.2.4 Auxiliary Motor

The auxiliary motor option generally is comprised of a diesel engine and hydraulic motor or pump combination. The hydraulic pump or motor then drives a gearbox or ratchet mechanism, which applies torque to the cable drum. This system creates uniform speed across the paddock, as it is not affected by pressure variations, however offers no response to varying water applications as a water powered mechanism may.

The auxiliary motor is generally preferred over the water powered turbine in three circumstances. When travel speeds are high, as auxiliary motors are capable of speeds twice that of turbines. When pressure is marginal, as turbines extract 6 to 10 Psi to power the turbine depending on the travel speed. Finally high amounts of solids present in the water, limits the use of turbines as limited size particles can pass through the turbine. If these factors are not an issue then turbines are preferred due there ease of use, low maintenance and repairs required (*Engine vs Turbine 2002, Kifco Products, Havana, viewed 7th April 2005, <www.kifco.com/a-series.html>*).

2.2.5 Bellows Drive System

The bellows system works by the expansion of a diaphragm and the use of a ratchet, the diaphragm expands, the pressure pushes the traveller forward. When the water is released the ratchet goes to the next cog. The Bellows drive system "...does not have any seals or sliding parts to wear out which insures outstanding reliability..."(*Turbine or Bellows*

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Drive Water Motors, Kifco Products, Havana, viewed 7th April 2005,

<<http://www.kifco.com/b-series.html>> It also "...does not take pressure from the water to operate the drive thus optimizing the water pressure at the sprinkler". (***Turbine or Bellows Drive Water Motors, Kifco Products, Havana, viewed 7th April 2005,*** **<<http://www.kifco.com/b-series.html>>**) The bellows system is more suited to smaller, slower machines as it cannot produce the same power generated by the turbines and auxiliary motors.

2.3 Irrigation Performance

The performance of an irrigation system is defined by two parameters, the efficiency of the system and the uniformity of the system. These two factors due to water becoming more and more valued resource are becoming ever increasingly important issues to be addressed when dealing with any irrigation system.

2.3.1 Uniformity

The uniformity of irrigation application is essentially the evenness of water applied over the area of ground designated for irrigation. Irrigation uniformity affects crop yield significantly, over irrigation causes water logging and nutrient leaching, reducing productivity and irrigation efficiency. While, under irrigating results in stress on the plant proportional to the magnitude of dehydration. Under irrigating is often visually evident in paddocks irrigated by travelling irrigators due to insufficient overlap (**Wigginton and Raine, 2001**)

There are two common methods of measuring irrigation uniformity.

- Distribution uniformity (DU)
- Christiansen's coefficient of uniformity (CU)

The choice technique depends on the type of irrigation being assessed.

The distribution uniformity method is the most widely used and recognised method of measuring uniformity (**Sutton, 2001**). This method divides the lowest 25% of application depth by the average application depth and multiplying by 100 to give the value as a

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percentage. The Christiansen's coefficient of uniformity is most used when determining uniformity of centre pivot (**Wallace, S, pers. comm. April 6**). Distribution uniformities of 80% and above are considered to be acceptable, anything below this value should result in steps toward greater uniformity should be taken.

2.3.2 Lane Spacing

The width of a lane spacing should be set to achieve uniform application occurs across from one run to the next. It is a general practice that the traveller overlaps the last run by a small amount, as it is better for the plant to be over irrigated then to miss out on it completely.

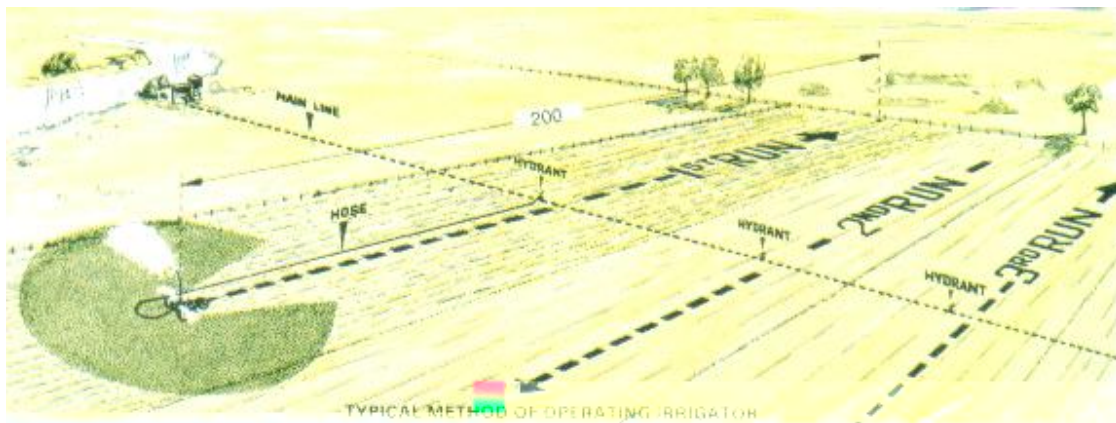


Figure 2.15 Typical Linear System Irrigation Run

Wind is the main obstacle encountered when allocating width of lane spacing, especially when dealing with travelling gun systems. Solomon (1990) recommended lane spacings be 60-65% of wetted diameter for wind speed below 7km/h, 50% for wind speed between 7 and 14km/h, and if irrigation must be undertaken above this range then 30-50% spacing should be used.

2.3.3 Machine Speed

Traveller speed variation affects the uniformity of water applied across the paddock.

When the machine increases in speed by for example going down a decline, the applied depth decreases as the same water output is the same but the traveller is moving faster. Of

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course the opposite occurs when the traveller slows down. Most top of the range travelling irrigators have uniform velocity mechanisms in place however; the majority of machines in use do not.

2.3.4 Efficiency

Efficiency of an irrigation system is effectively the water utilized for crop production divided by the total water applied to the crop. The efficiency of an irrigation system relies on matching soil infiltration rate with the application rate.

2.4 Review Past Work

2.4.1 Drive Mechanism for Travelling Irrigators and Their Effect on Machine Performance

In this paper Rohan found that significant variations in irrigation performance and traveller speed occur due to drive mechanisms in travelling irrigators. Out of the piston and turbine drive mechanisms analysed variations in performance were characterised by the type being studied.

It was found the water piston had no great trend in speed, but oscillated around a general value, these oscillations increased in magnitude as the traveller progressed along the run. This phenomena was explained by the machine being slowed down by the weight of the hose, however being sped up by the increase in cable drum diameter, with each layer of cable.

The turbine drive mechanism experienced an increasing speed trend as the traveller progressed. This was described to be due to the turbine had ample power to deal with the load increase experienced by the hose, however as the cable diameter increased so did the speed of the machine.

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Sutton firstly concluded that significant speed variations could be eradicated if the diameter of the cable drum reel remained constant throughout the run. Secondly, longitudinal uniformity is dependent on the speed of the irrigator. Finally, the effect of extra load from the hose drag on speed variations depends on the potential power of the drive mechanism. Piston powered mechanisms will slow down while turbine powered mechanisms will be unaffected.

Below are the results ascertained from the analysis of a piston drive mechanism and a turbine drive mechanism. These two trials were undertaken by Sutton in 2001. After developing the odometer wheel that was used in recording the change in velocity, Sutton conducted two trials to analyse the variation in performance of travelling irrigators below are the results of these findings.

Trial 1

This trial was carried out on a Southern Cross travelling gun featuring water piston drive mechanism. In this trial the depth applied, velocity, pipe pressure, motor pressure were logged. The initial and final force on the cable was also recorded,

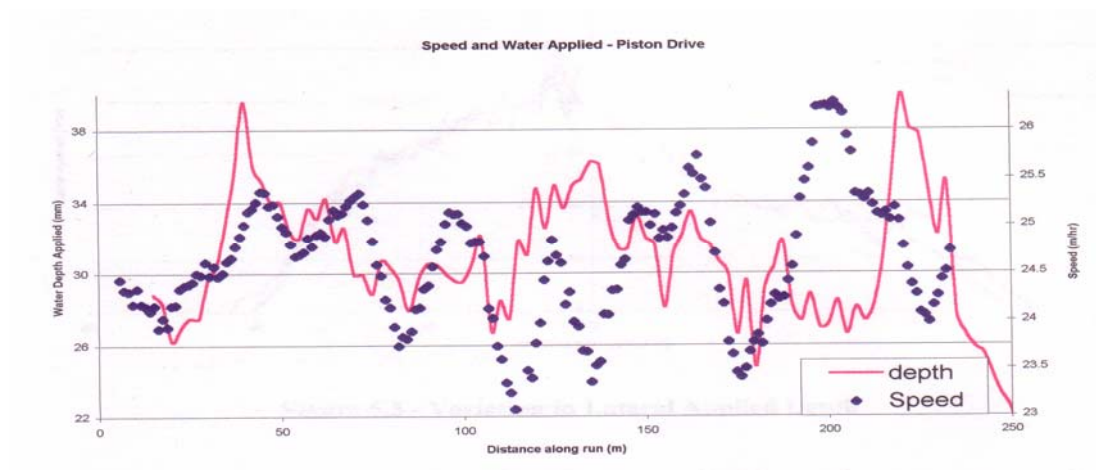


Figure 2.16

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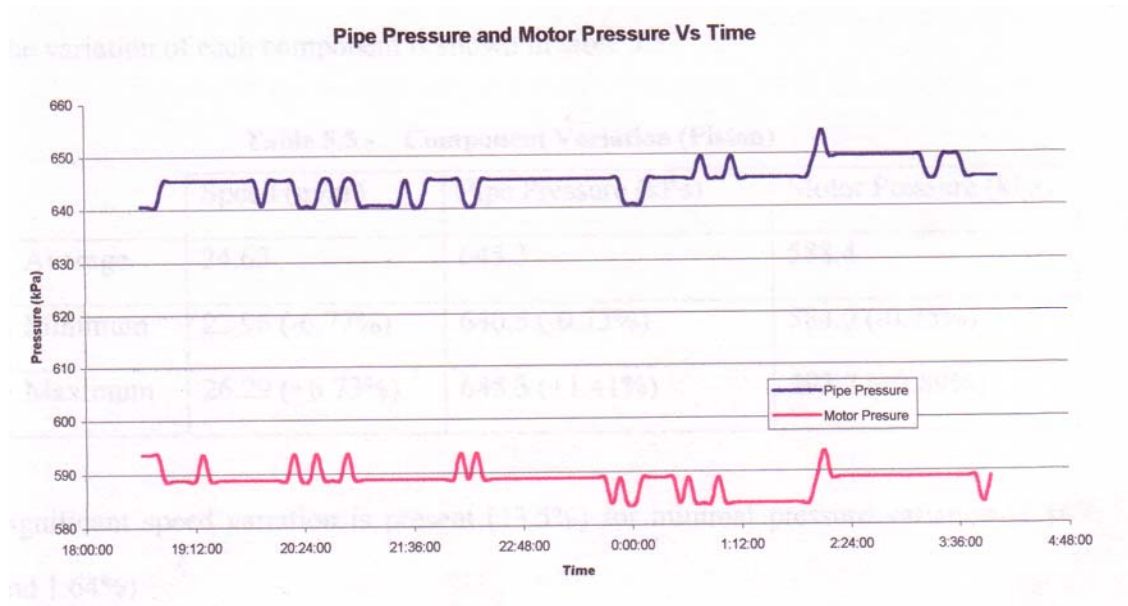


Figure 2.17

Trial 2

This trial was undertaken on an Upton travelling boom possessing an axial turbine drive mechanism, with a hydraulic changeover. This hydraulic system powers a piston ratchet action. The applied depth, velocity, motor pressure and flow rate were logged with this test as well as initial and final cable forces.

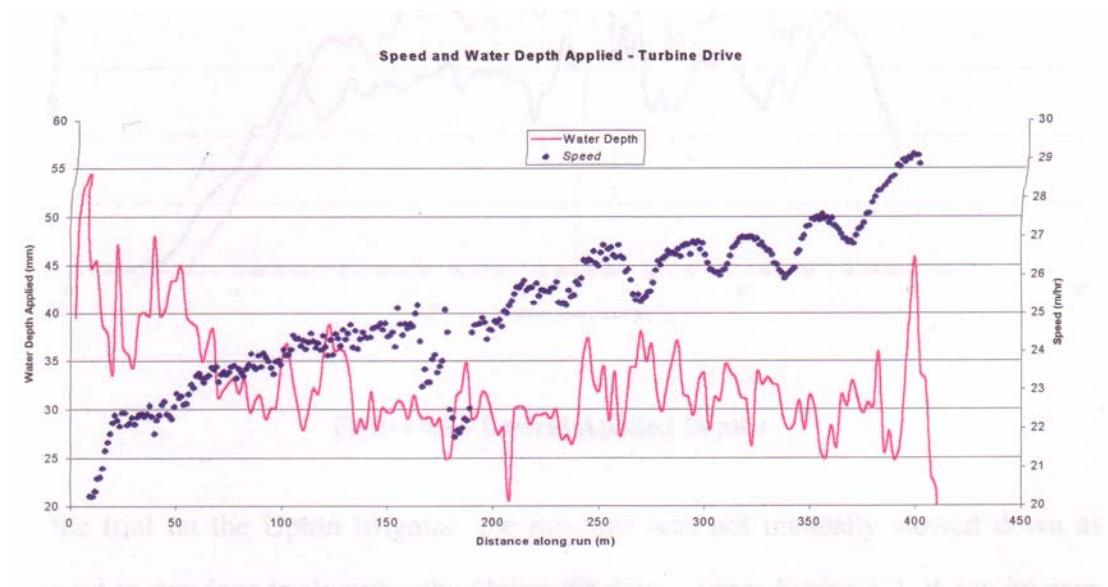


Figure 2.18

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

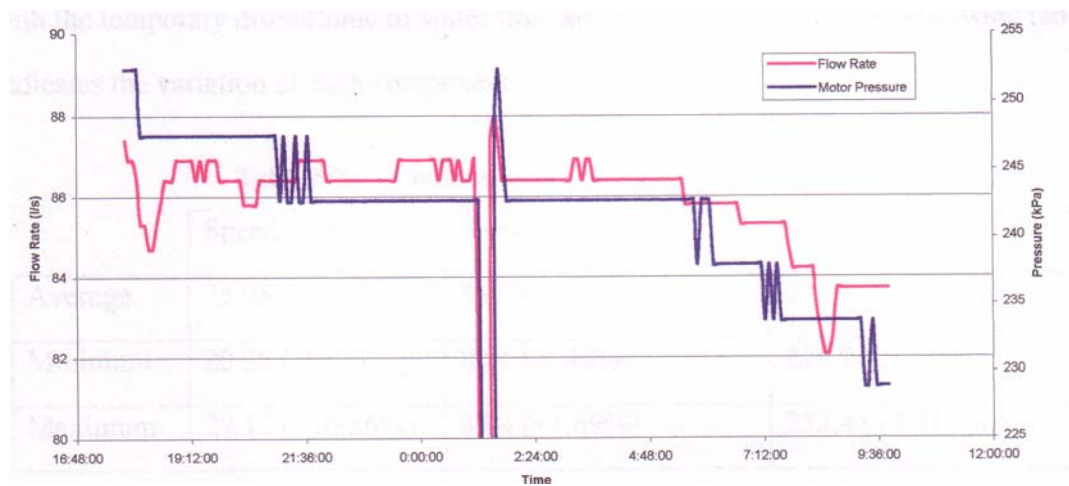


Figure 2.19

2.4.2 Travelling Gun and Boom Irrigation Machines

In this paper it was found that significant improvements could be made to the performance of traveling irrigation machines. It was established that these uniformity problems could be significantly improved by firstly, growers irrigating in periods of little to no wind. Selection of appropriate lane spacing, so even distribution is achieved and more educated selection of equipment and gun settings. To simplify the selection process, extension officers should be provided with a computer package that simulates the distribution pattern of their irrigator in varying conditions.

In this paper it was suggested that not enough work has been done in the area of speed variation in traveling irrigators, and the affect that has on uniformity of the applied depth. Also suggested that work must continue in matching soil infiltration rates to application rates. This paper also highlighted poor pump, pipeline and machine matching is resulting in growers paying higher running costs then are necessary.

2.5 Project Objectives

Wiggington and Raine conclude from their findings that further work is required to reduce the speed variation in the drive systems of traveling irrigators. Although Sutton has analyzed the effects that drive mechanisms on machine performance, there were only

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four tests carried out. This project's objective is to carry out at least six of its own tests as well as results from other work already undergone. This will help gain a more comprehensive understanding of the varying irrigation efficiencies obtained by drive mechanisms, and what drive mechanisms are more suitable to different areas.

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Chapter Three

Materials and Methodologies

3 Methodology

3.1 Introduction

The aim of this research project is to assess the performance of travelling irrigators with respect to their drive mechanisms. There are a number of performance measures that are to be carried out to explain the performance characteristics of these travelling irrigators.

3.1 Site Selection

Selection of the site depends on a number of parameters, the factor being the type of traveller being analysed. It is important in this research to analyse a number of different types of drive mechanisms, to ascertain the characteristic variation in performances of each mechanism. A variation in topography of the field is also important; to find the effect altitude has on the traveller's performance. Another issue is how advanced the crop is: the crop canopy must be lower than the top of the catch cans. Also, some crops such as potatoes cannot be disturbed once they reach certain maturity.

In all, there were six different sites used in the project. The first site was at a beetroot farm in the vicinity of Lowood in the Lockyer Valley. The first test was carried out on a 100m Herman boom irrigator possessing an auxiliary engine, coupled with a computer aided velocity compensator. This run had a total length of 408m, consisting of a substantial rise, peaking approximately 100m into the run. This was about 2.5m higher than the initial starting altitude. Following this, was a descent that reached its lowest point approximately 140m on, this drop in height was no less than 1.5m. The paddock then increased in height again at a gentle rise to the end. On the next page is a picture of the boom irrigator before it had commenced its run.

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Figure 3.1 Topography Variations in Test 1

The second site was also on a beetroot farm close to the town of Forest Hill. Unlike the previous test site, this site was completely flat. This test was also carried out on a Herman boom irrigator possessing the same drive mechanism attributes, however, this machine was slightly older. This field was 348m long, and the plant height was on the verge of being too tall, with the catch cans just reaching above the plant canopy. No test of pressure was carried out on the pipe main of either of these first two machines; this was not necessary as drive speed is independent of pressure with this drive mechanism.

The third test was carried out on a Upton traveling boom irrigator, however possessing a water turbine drive mechanism. This paddock was just across the road from the previous site, and again possessed no change in topography. The length of this run was 352m: the plants were not as advanced as in the previous paddock, leaving no difficulty in the catch cans clearing the plant canopy.

The last three tests were all carried out on the same turf farm located adjacent to Lake Cominya. All three of these irrigators were Southern Cross soft hose traveling guns. All three guns possessed a piston ratchet action drive mechanism, and test 4 and 6 were on irrigators of the same make and model. The first test was carried out on a paddock of length 344m with lane spacings of 65m; this paddock had a steady incline, peaking 300m into the run. This peak was approximately 2.5m higher than the starting position, the paddock then tapered off for the rest of the paddock, dropping about 0.5m.

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The second paddock run was approximately 450m, however the measured length of depth applied was only 408m, due to insufficient numbers of catch cans. The last paddock was only a short run of 280m in length, with a lane width of 65m

3.2 Instrumentation

3.2.1 Catch Cans

Catch can trials are used to measure uniformity of the irrigation water from sprinkler systems. These measurements will show up any change in performance of the traveller. The catch cans used are actually plastic cups with a small piece of 10mm plastic pipe vertically orientated and duct taped to the side of the can. A metal stake is then placed inside the pipe when assembling for use. This setup was adopted for ease of packing and to save space. It is important that the can is slightly higher than the canopy of the crop to ensure that the canopy in no way alters the catchments of the can.



Figure 3.2 Catch Can Layout

The catch cans are to be positioned both perpendicular and parallel to the direction of the irrigating run. The cans are to be spaced no more than 3m apart for the perpendicular run and 3 to 4m apart for the longitudinal run (depending on the size of the paddock). It is important that the perpendicular run is at least 50m in from the run so full irrigation occurs over the row of cans.

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3.2.2 Traveler Speed

The speed of the irrigator is recorded and logged using a speed sensor device designed and developed by a previous student. The odometer wheel is basically a bicycle wheel mounted to a steel frame, with an electronic device attached, which logs the time elapsed after the wheel rotates $1/8^{\text{th}}$ of a revolution. The wheel is attached to the traveller using two plates bolted together: this can be difficult to find on some machines, as there is not always an ideal position to mount the wheel. With the circumference and the time elapsed recorded, the velocity can be calculated using an excel data sheet.

3.2.3 Pressure Loggers

The pressure logger is an instrument that screws into the position where the pressure gauge is positioned on the irrigator. The logger records the pressure of the water in time increments: from this, data vs. time can be imported into excel. Using the time values and aligning them with the time values on the odometer wheel, the distance versus pressure change can be shown.

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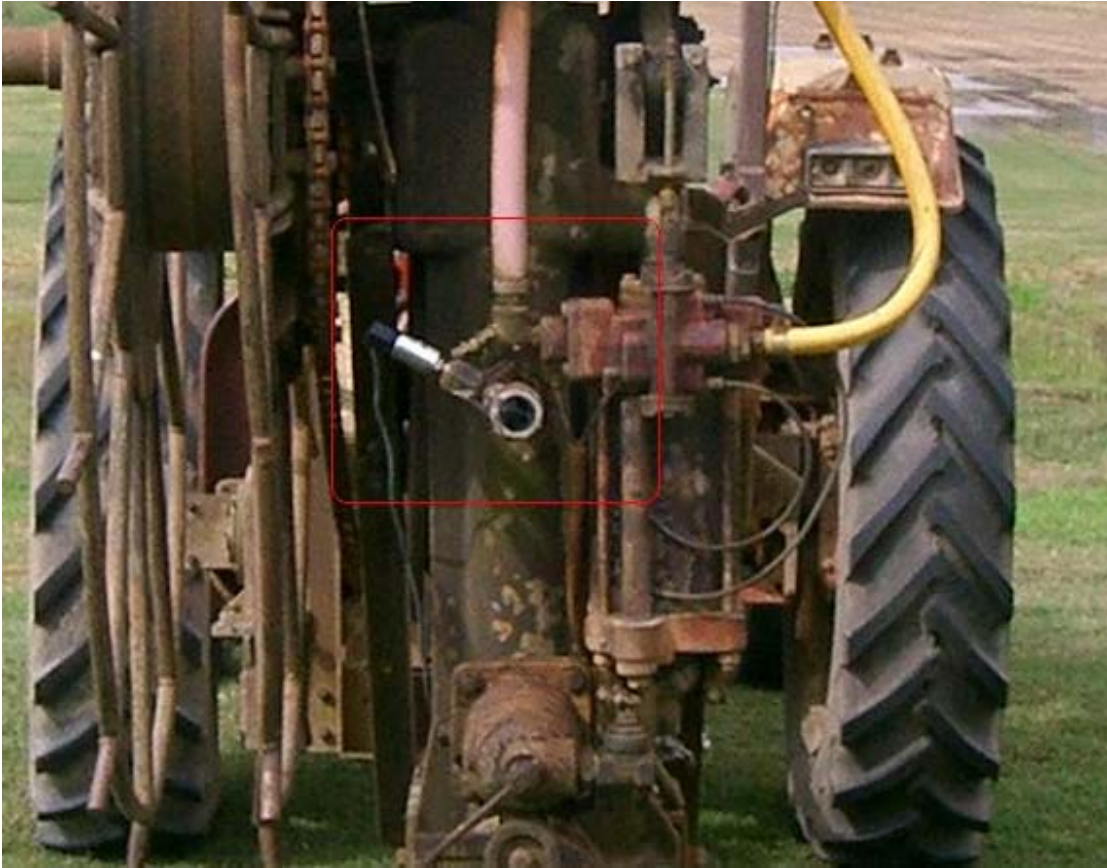


Figure 3.3 Pressure Logger in Place

3.2.4 Flow Meter

The flowmeter is attached to the hydrant; this measuring device records the amount of water in litres, which is utilised by the irrigator. It requires a reading to be taken before commencement of irrigation and then a reading after the run is finished. The amount of water utilised is calculated by subtracting the first reading from the second.

Chapter Four

Results

4 Results

The data collected was from the field on in use travelling irrigator, the irrigators drive mechanisms differed between three types. The three types tested were water turbine, water piston and diesel auxiliary motors. This data was collected from six tests conducted this year and two other tests already conducted before this project was undergone.

4.1 Initial Testing

Initial testing was conducted on the depth applied, flow meter and velocity variation, no pressure variation was recorded as the pressure loggers were not ready. However this was not a problem as the first two tests carried out were on auxiliary engines, these engines are independent of water flow therefore the pressure results were not required.

4.1.1 Test 1

This test was conducted on a Herman boom, possessing auxiliary engine featuring a computer speed compensator. The applied depth and velocity were both recorded with this test as well as the total flow. The graph below illustrates the variation in velocity with respect to time. While speed oscillations occur throughout the run, the average velocity stays constant throughout the run.

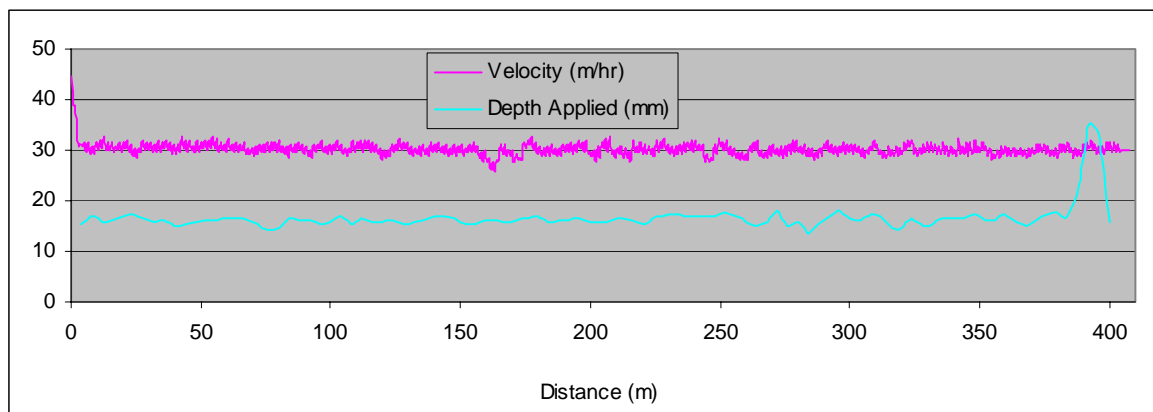


Figure 4.1

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

4.1.2 Test 2

This test was also carried out on a Herman boom; this also possessed an auxiliary engine featuring a computer speed compensator. However this irrigator differed, as it did not have pressure regulators on the nozzles, hence decreasing the cross-sectional uniformity. He applied depth and velocities were both logged during this test as well as total flow applied.

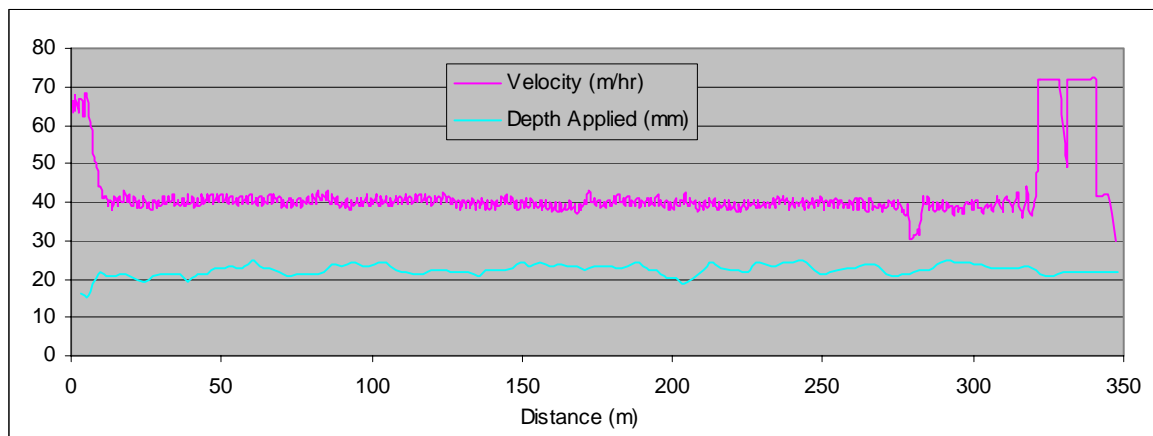


Figure 4.2

	Test 1 (m/hr)	Test 2 (m/hr)
Maximum	32.77	30.15
Minimum	25.93	43.99
Average	30.13	41.36
Variation	6.84 (22.7%)	13.84 (33.46%)

Table 4.1

4.2 Testing of Water Propelled Mechanisms

The testing of the turbine and piston mechanisms involved the recording of depth applied, velocity variation, total water applied and a pressure logger attached to the travelling irrigator. This gave an insight into any performance variations experienced due to a change in the hydraulics characteristics.

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4.2.1 Test 3

This test was carried out on an Upton travelling boom possessing an axial turbine mechanism very similar to the trial one carried out by Rohan Sutton. The depth applied and velocity tests were also carried out on this irrigator however due to technical difficulties no velocity variations were logged. The flow was also recorded on this test. The run was approximately 330m, a considerably shorter run than most due to paddock width limitations. The owner of the irrigator said that the pressure throughout the run drops considerably as the run progresses. However, the increase in cable drum diameter increases the speed hence compensating for the speed decreasing along the run. The velocity variation in this test is 11.86%.

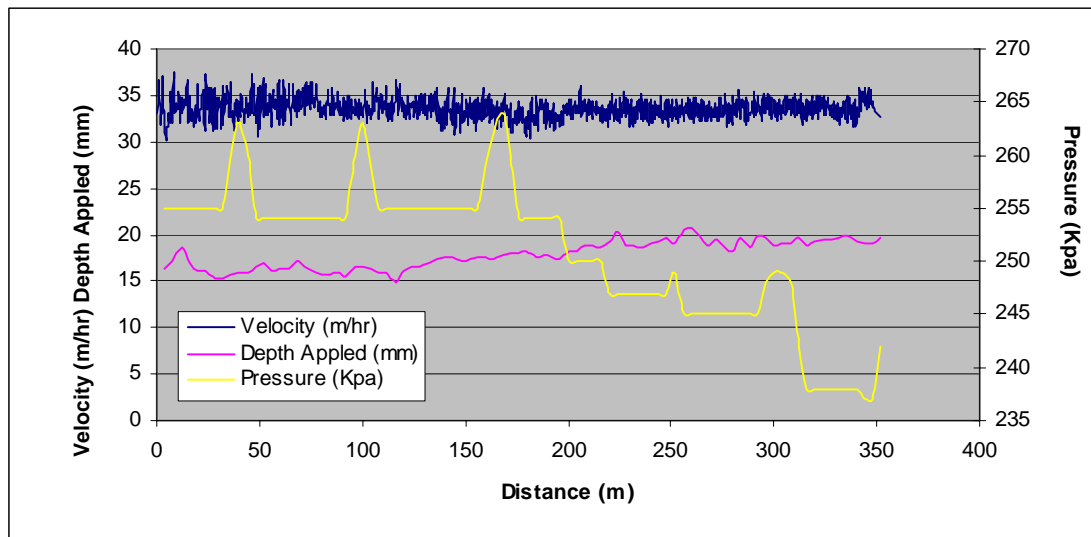


Figure 4.3

4.2.2 Test 4

The next three results were all recorded on turf farms, these sites were chosen as difficulties were experienced with mud building up on the odometer wheel giving inaccurate readings. These three tests were all done on Southern Cross travelling guns, which is driven by a ratchet piston action drive mechanism. The 4th and 6th tests were on identical make and model travellers, on the exact same paddocks. The velocity results of

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this test in figures 4.4 and 4.5 were averaged out over 200 data points to give a more readable graph. Figure 4.6 is averaged out over ten data points.

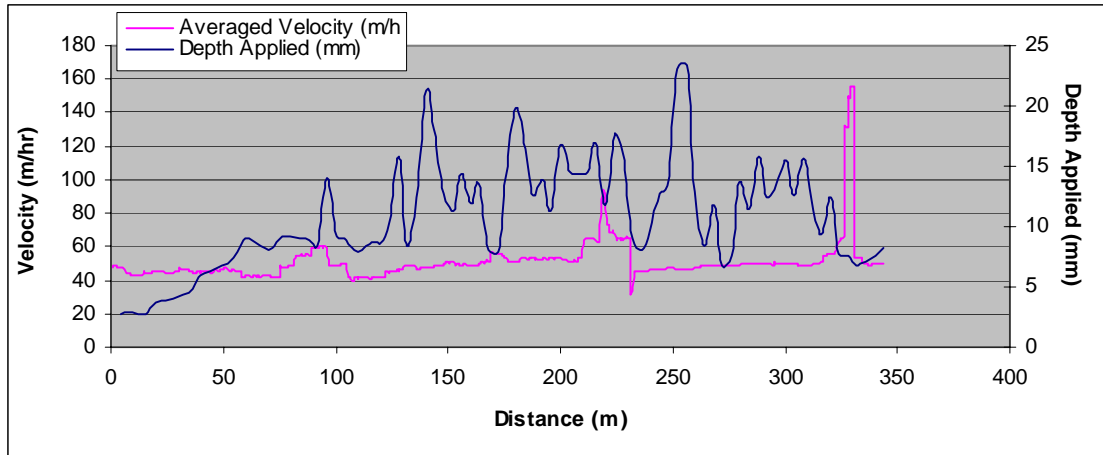


Figure 4.4

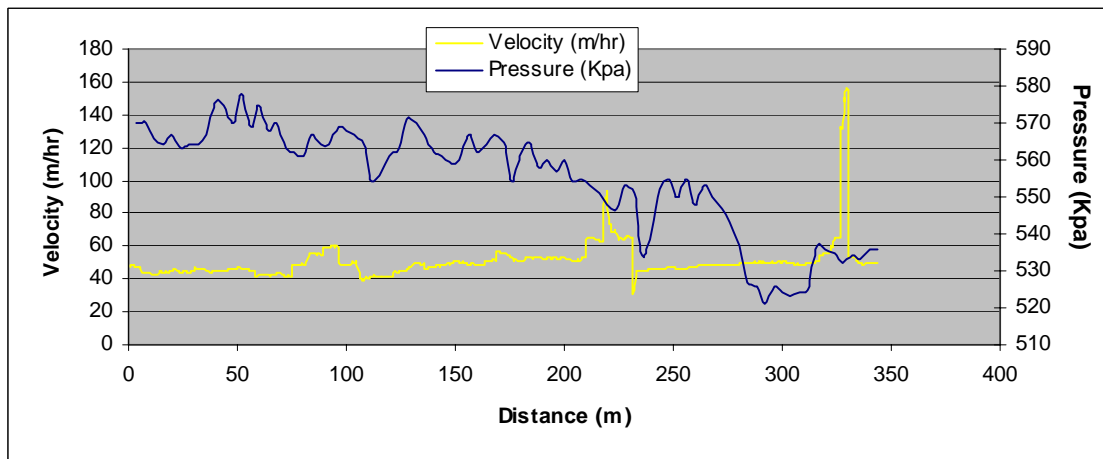


Figure 4.5.

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

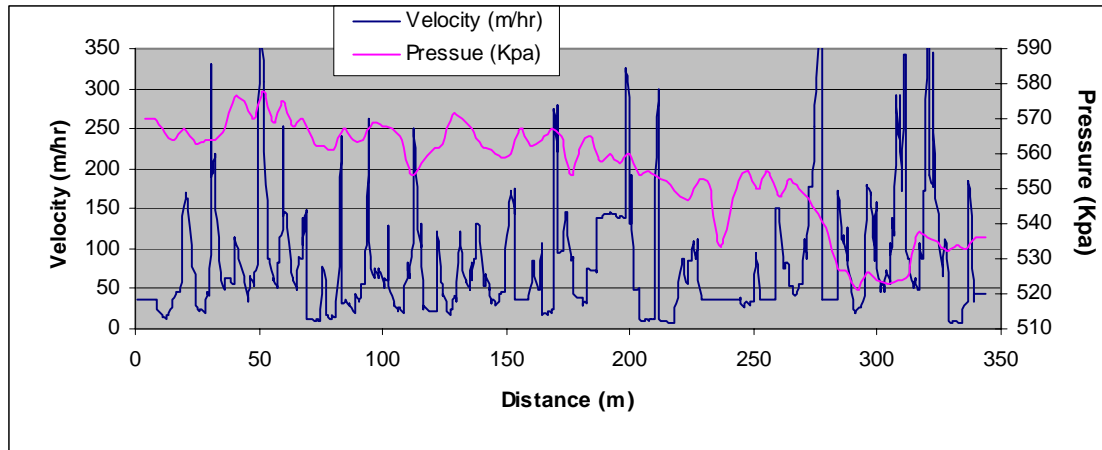


Figure 4.6

	1 st Third of Run (m/hr)	Last Third of Run (m/hr)	% Increase
Test 1	47.69	65.22	36.76%

Table 4.2

4.2.3 Test 5

This test was done on another paddock, which experienced negligible change in topography along the run, unfortunately the battery of the odometer wheel failed on this run early in the test. The data however still depicts the significant change in speed occurring compared with the other drive systems. This run had a total length of 450m, unfortunately the catch cans ran out at 408m, it would be expected that the depth applied would drop off at the end of the run as experienced in the other travelling gun machines.

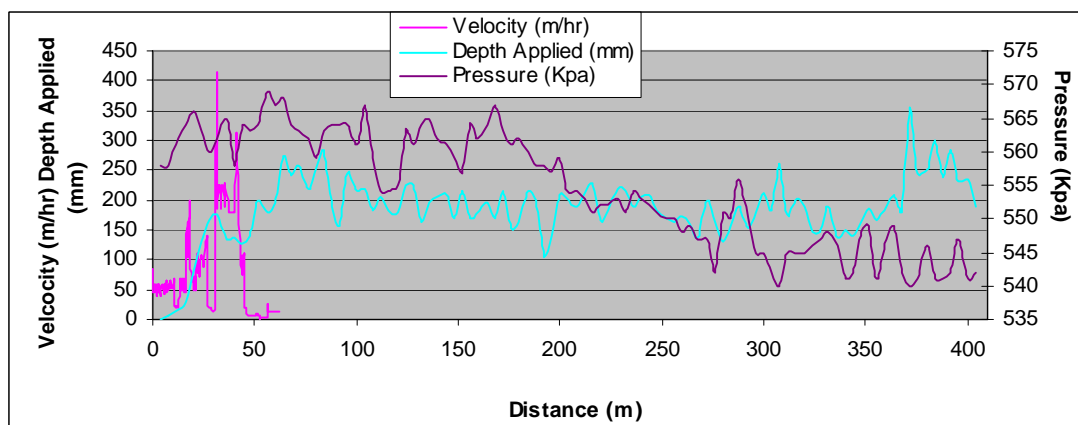


Figure 4.7

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

4.2.4 Test 6

This test was also carried out on a Southern Cross travelling gun, which is driven by a ratchet piston action drive mechanism. The weather the day this test was recorded threatened to rain, however since all the gear was already down at the site, it was considered there was little to lose going through with it. In the end it did not rain and hence the test was unaffected.

This test shows relatively consistent speed across the paddock, with the exception of some significant drops in speed along the run. It can be seen that a slight decrease in speed is encountered throughout the middle of the run, and then an increase is encountered towards the end of the run.

At the end of the run the traveller sat at the end of the run for a considerable amount of time causing a large amount of applied depth at the end of the run. These values were factored out of the DU calculations, as these values had no indication of drive mechanism performance.

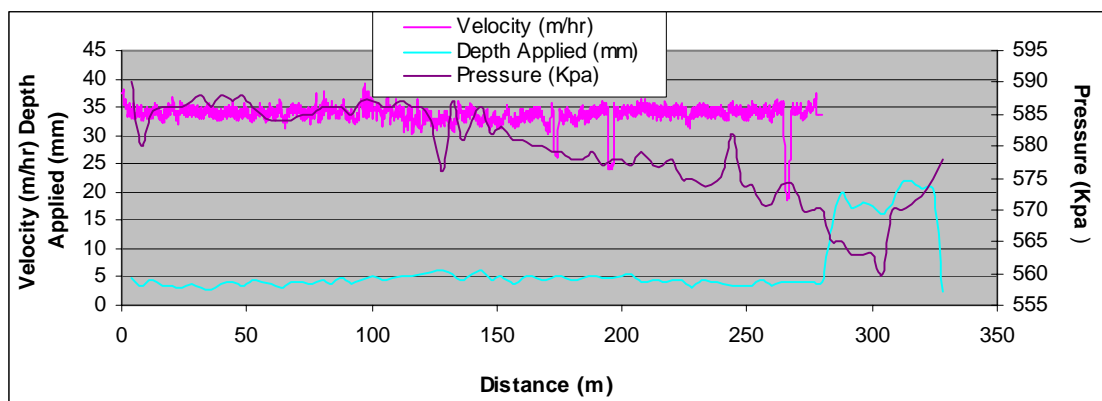


Figure 4.8

4.3 Tabulation of Results

This table tabulates the average, minimum and maximum velocities experienced along the run for the eight irrigators under analysis. It also shows the percentage of variation each extreme experience with respect to its average velocity.

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Drive Mechanism	Average (m/hr)	Min (m/hr)	Maximum (m/hr)
Piston	24.63	22.96 (-6.77%)	26.29(+6.73%)
Turbine	25.05	20.28 (-19.17%)	29.12 (+16.26%)
Auxiliary	30.19	26.64 (-11.76%)	32.29 (+6.95%)
Auxiliary	40.32	30.38 (-24.65%)	42.05 (+4.29%)
Turbine	33.55	30.24 (-9.87%)	37.53 (+11.86%)
Piston	78.84	6.12 (-92.24%)	470.16 (+496.35%)
Piston	72.72	1.54 (-97.88%)	411.95 (+466.49%)
Piston	33.7	18.68 (-44.57%)	38.88 (+15.37%)

Table 4.3

Below is a table of each traveller's velocity variations along with their respective distribution uniformities.

Drive Mechanism	Speed Variation	Distribution Uniformity
Piston	13.5%	78.9%
Turbine	35.43%	85.6%
Auxiliary	18.71%	85.89%
Auxiliary	28.94%	86.59%
Turbine	21.73%	78.9 %
Piston	588.6%	65.34%
Piston	564.37%	71.63%
Piston	59.94%	80.47%

Table 4.4

Chapter Five

Discussion

5.0 Discussion

5.1 Performance Evaluation

There are significant performance variations occurring with travelling irrigators, with each drive mechanism featuring distinct performance characteristics. From the results found the piston drive mechanism is clearly the least uniform with speed variations up to 588.6%, and the level of speed variation has a direct affect on the achieved distribution uniformity (as can be seen in the table 5.4). This extreme variation may be somewhat due to inaccuracies in the odometer; however the same odometer wheel was used for all tests hence giving a sound comparison between the different drive mechanisms.

5.2 Auxiliary Engine Drive Irrigators

5.2.1 Velocity

The oscillating variations do occur with this drive mechanism, these oscillating variations may have been due to radii variations on the cable drum. With the cable drum a number of different radii develop due to the cable winding unevenly on the drum. With comparison to the other drive mechanisms used these two irrigators with auxiliary motors and computer speed sensors are acceptably uniform.

A slight problem with the beginning of the run the machine takes off quicker each time then what it should, before the speed sensor is able to correct it. This is probably a slight design fault that may not have been addressed. The second machine took longer to adjust then the first; this may have been due to wear, as the second machine was an earlier model. There is also the increase in speed at the end of the run with the second test. This is puzzling, there is no obvious reason why this occurred, and may have been some malfunctioning in the speed sensor calculations.

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5.2.2 Topography

This test was carried in a field, which was 400m long and with quite a significant change in topography throughout the run. Despite the significant deceleration forces encountered throughout the run, the traveller handled it with ease. There were no distinct changes in velocity across the whole run apart from the spike at the beginning where forces were at their minimum. This is a strong indicator that the auxiliary engine has ample torque to deal with the resistances encountered.

5.2.3 Depth Applied

A direct correlation can be recognised between depth applied and speed variation in the spikes in velocity at the start of both test and the spike at the end of test 2. A noticeable drop in depth applied is evident in these cases. The distribution uniformity of this travelling irrigator is deemed acceptable for both the lateral and longitudinal directions. The DU being 85.89% in the longitudinal direction A spike in depth applied occurred at the end of the run, this was due to the irrigator sitting at the end of the run, but still applying water.

5.3 Turbine Drive Irrigator

5.3.1 Velocity

When these results are analysed closely, the magnitude of oscillating variations reduce the further along the run the irrigator advances. Considering this reduction in variations, it could be said that the drive mechanisms performs better the second half of the run then it did the first due to far less speed variations. Below in table 5.1, the max and min values experienced in the first and last quarter of the run, as well as a total difference value are recorded.

Distance Along Run	Min (m/hr)	Max (m/hr)	Difference (m/hr)	Variation Percentage %
1 st Quarter	30.24354	37.52596	7.28242	21.5%

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4 th Quarter	31.57819	35.84637	4.26818	12.66%
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Table 5.1

As shown in the table, velocity variation decreases markedly (nearly 50% from the first quarter to the last). This is a substantial change in behaviour by the irrigator; this behaviour could be explained by considering the increase in drag and decrease in pressure along the run as dampeners of the speed oscillations. However, due to the turbine drive system possessing ample power, the velocity decrease is minimal.

The average velocity of the traveller also drops slightly however noticeably along the run. This drop in velocity is most likely due to the drop in supply pressure to the irrigator due to poor water supply from a bore; this low supply pressure is very common in the Lockyer valley in recent years. These findings differ to the results found by Sutton, “The turbine drive machine indicates a significant trend of speed increase”(Sutton 2001), despite pressure dropping over 20 Kpa over the duration of the run.

5.3.2 Cable Drum

	Radius
Initial	0.205
Final – Min	0.265
Final - Max	0.290

Table 5.2

The initial radius as well as the final maximum and minimum radius of the cable drum was recorded. Knowing that the velocity of the traveller is proportional to the radius of the cable drum, it was possible to deduce the maximum expected velocity variations due to inconsistent cable drum radius.

$$V = w2\pi r$$

...Eqn(0.1)

From this formula, it can be deduced that a maximum 14.1% of the speed variation may be accounted to the cable slipping from radius to radius. It can also be construed that the variation in speed from the initial velocity and the final (neglecting increased drag from

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the hose) could be up to 41.46% due to the increase in cable drum diameter. Increasing in speed however is not the major area of variation with this irrigator over the run however; the uneven application of cable could be the major reason for the velocity oscillations of 21.5% in the first quarter of the run and 12.66% in the last quarter. If the cable drum application was uniform, then this could reduce the variations to under an acceptable 10% variation.

5.3.3 Pressure

In both tests carried out, the pressure tends to drop off as the traveller progresses along the run. Although the velocity speed does tend to decrease a fraction, this slight reduction cannot be linked to the reduction in pressure.

5.3.4 Depth Applied

There is a direct relationship between depth applied and velocity variation in the two samples of data obtained from this drive mechanism. In the test obtained in 2001, Sutton found “A strong relationship is evident between the two parameters. The increase in irrigator speed along the run produces a decrease in depth of water applied.” (Sutton 2001) These findings were not as strongly recognised in the results as they were with Sutton’s finding, however there is still a relationship there. The depth applied showed consistent application with a slight increase in depth applied the further along the run. The table below illustrates this, displaying average velocity in the first and last quarter, and average depth applied in the first and last quarter. It also displays the variation percentage of both these parameters.

Section of Run	Average Velocity (m/hr)	Average Depth Applied (mm)
1 st Quarter	33.87	16.28
Last Quarter	33.57	19.27
Variation Percentage	1.48%	18.37%

Table 5.3

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A reduction in average velocity of 0.5m per hour resulted in an increased application of nearly 3mm. Although 0.5m per hour is significant, this does not come close to explaining the large variation in depth applied. This is shown by the average velocity varying by just 1.48%, while the depth changes by 18.37%. This large variation can only be accounted for some change in hydrology occurring in the irrigator.

This may be due to the drop in water pressure that occurs along the run, as the irrigator progresses along the run the pressure drops considerably. This drop in pressure may change the lateral portfolio of the irrigator causing longitudinal profile, which incorrectly illustrates the longitudinal uniformity of the irrigator.



Figure 5.1

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

5.4 Piston Drive Irrigators

5.4.1 Velocity

Significant speed variations occur with this drive mechanism, these findings back up the findings in Sutton findings. The piston ratchet action has very significant speed variations and no apparent trend can be correlated. These massive variations in speed may be placed down two main factors.

Firstly, the cable is winding onto the cable drum in an uneven fashion causing a concentration of cable towards one side of the drum. This causes variation in travel speed when the cable slips to an area on the run with different sized radii. This can be attributed to the guider not functioning properly or the cable drum being out of line with the direction of the traveller.

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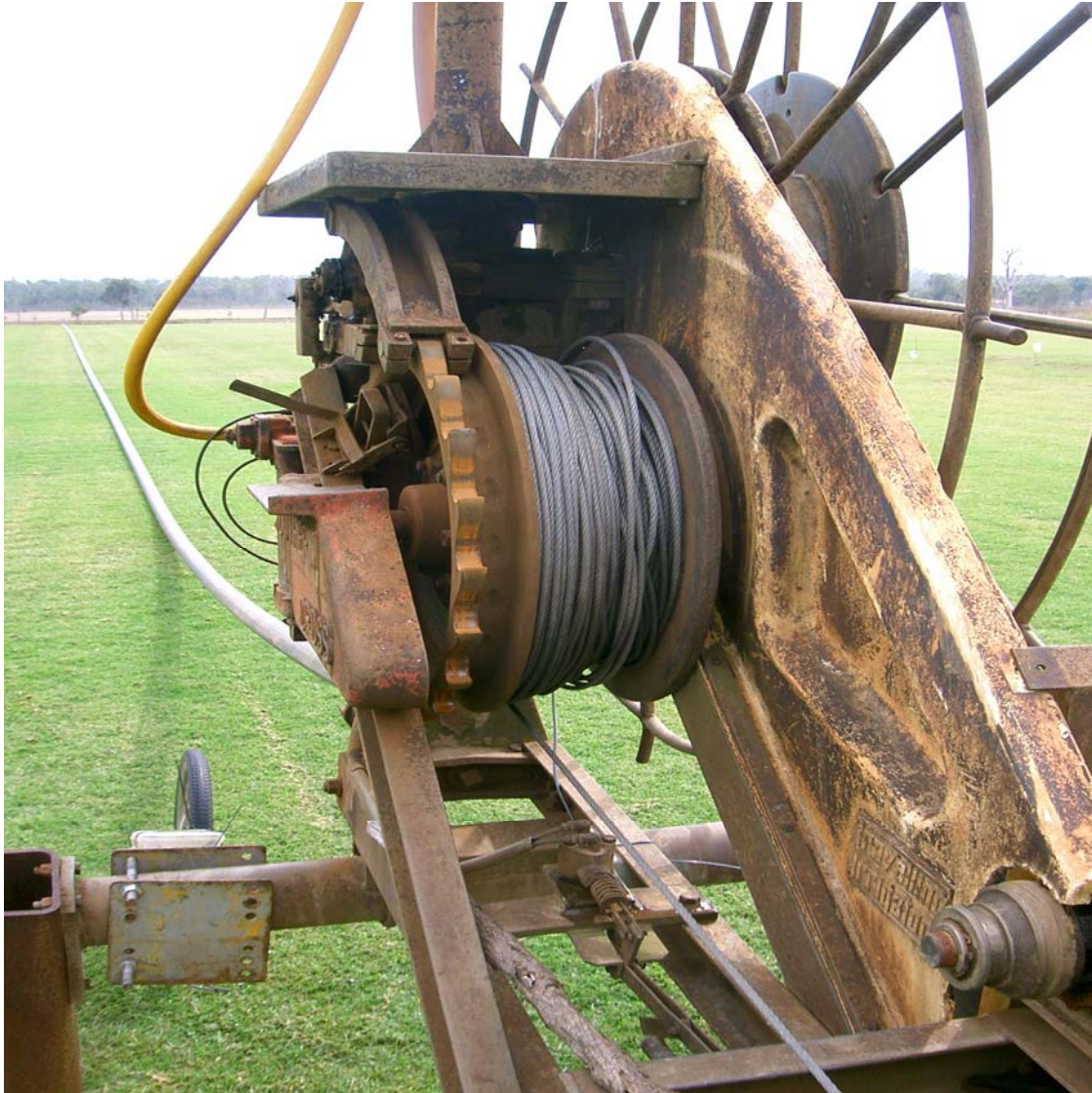


Figure 5.2

Secondly, the piston drive mechanism works on a piston ratchet action, resulting in a jerking forward movement when an arm is applied to a tooth of the sprocket, then a stop in torque between the periods of time when the other arm comes in contact with the cog. This causes highs and lows in velocity as the traveller progresses along the run, giving the large velocity variations shown in the table above. “This is a negative characteristic involved with the use of a ratchet mechanism as a power conversion technique.” (Selvan Pather 18-10-2005) With comparison to a turbine drive or auxiliary motor, the power from this motor is converted to winding in a cable through a hydraulic motor to a gear box rather than a ratchet, this torque is therefore applied constantly via at least two teeth in contact at all times. This results in a slower but continual application of torque on to

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the cable, rather than the stopping and starting involved in the ratchet action. Below is a diagram of the piston ratchet action and a simple gear system. However, the affect of this theory is minimal as the velocity results are an average taken of ten recorded results.

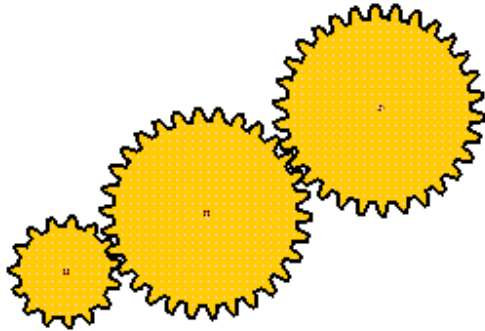


Figure 5.3

“The amplitude of the speed oscillations tends to increase as time progresses” (Sutton 2001) this trend was also seen with the tests on piston drive mechanisms undergone in 2005. This could be explained by the increased drag by the soft hose, causing increased decelerations, while the increase in cable drum radius causes the increase in acceleration spikes.

5.4.2 Cable Drum

As with the turbine drive mechanism the initial and final maximum and minimum radius of the cable drum were recorded, and by using equation 5.1, the expected speed variations due to variation in cable radius can be evaluated.

	#4Radius (m)	#5Radius (m)	#6Radius (m)
Initial	0.2	0.21	0.205
Final – Min	0.25	0.245	0.245
Final - Max	0.28	0.275	0.28

Table 5.4

From these values the expected change in velocity accounted to the cable slipping from radius to radius is shown in the table below.

	Speed Variation %
Test 1	12%

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Test 2	12.2%
Test 3	14.3%

Table 5.5

These expected variations are significant however, they are trivial with respect to the variations encountered with these drive mechanisms and would not likely to make a considerable difference in DU.

5.4.3 Pressure

The pressure results logged for these three irrigators indicate that the pressure available is minimal, as the pressure drops considerably in every run as the irrigator progresses along the run. This however, does not noticeably affect the velocity of the irrigator, this may be due to the increased cable drum radius compensating for the increased drag and decreased pressure.

This change in pressure experienced may have contributed to the unexplained increase in application. As when the pressure of water changes the lateral application profile immediately changes. The three lateral profiles of the travelling gun irrigators are shown in appendix A. A large variation in application occurs across a lane width, and when the pressure reduces this would change the position of high and low application areas in relation to the traveller. However, the distance the cups are from the irrigator remains constant resulting in a variation in results.

5.4.4 Topography

The topography of test 3 consisted of a constant incline along the run until 40m to the end of the run. This incline would have been approximately 2.5m, this should equate to approximately a change of 25 Kpa in water pressure. This change in pressure would be expected to result in a loss in torque applied by the drive mechanism.

5.4.5 Depth Applied

No direct correlation can be accurately ascertained between the traveller speed and depth applied. This is likely to be due to the type of irrigator used in the test, as a travelling gun irrigator involves irrigating a large area at a time, making it less sensitive than a travelling boom irrigator (which irrigates a small area at a time) would be to these speed variations. It is assumed that if these velocity variations were to be encountered with a travelling boom that significant drop in DU would be recorded. Unfortunately, no irrigator of this kind could be located; however it is known that Upton did manufacture travelling booms with this drive mechanism in place.

Chapter Six

Conclusion

6 Conclusion

6.1 Project Findings

Considerable variation in irrigation performance due to the drive mechanisms of travelling irrigators occurs. From the three different types of drive mechanisms analysed, each mechanism has its own specific traits. Significant deviation in velocity were recorded, the magnitude and cause of these variations, varied with each mechanism being analysed. Below is a summary of each drive mechanisms performance.

6.1.1 Auxiliary Engine Drive Mechanism

The Auxiliary engine with computer speed compensator performed very well in the two tests carried out. Small oscillations in variation occurred throughout the run; however these did not affect the depth applied so were obviously insignificant or measuring error. The average velocity stayed constant throughout the run, and this was reflected by the longitudinal uniformity profile and the calculated DU. The first test was also confronted with significant change in topography, but the auxiliary drive mechanism handled it with ease.

6.1.2 Turbine Drive Mechanism

Velocity of this travelling irrigator slightly decreases along the run due increased drag of the hose and pressure dropping throughout the run. The cable drum radius increasing as the irrigator advances lessens the decrease in irrigator speed. Depth applied increases along the run by a substantial amount; this amount is partially due to the decrease in irrigator speed. Pressure drop throughout the run results in a change in the lateral distribution profile, this makes the findings of the depth applied inaccurate, which may result in larger variations in depth applied than is actually occurring.

Oscillations occur throughout the run, varying by a greater amount to start with then becoming smaller as time progresses. This variation is due to the cable winding onto the cable drum in an uneven fashion, cable was wound on evenly, and velocity variation

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could decrease by over 14%. The reason for the velocity variations varying in amplitude could have been due to either the nature at which the cable wound as time progressed, or the increased force from the drive mechanism and drag acted as dampeners to the oscillations, or possibly a mixture of both.

6.1.3 Piston Ratchet Drive Mechanism

The nature of velocity variation by the piston drive mechanism varied considerably by comparison to the other two systems analysed. Oscillating variations exceeded 500% in some cases, although these variations can be partially attributed to cable drum radius, the majority must be attributed to be a characteristic of this drive mechanism. Whether these drive mechanisms have behaved like this for the complete duration of their life or deteriorated to this over time is unsure.

Significant increase in average velocity also occurred along the run despite drag and pressure reduction. This resulted in a slight reduction in application, however again pressure was not constant in any of the tests deeming depth applied results inaccurate.

6.2 Project Overview

A number of conclusions can be construed from this project, the first is the significance of the cable drum intake radius and the cable drum and irrigator direction is to be aligned. Currently, the cable drum winds on in a concentrated area of the drum, resulting in a greater increase in radius as well as variations of radius along the duration of the run. Substantial reductions in speed variations could be made if the cable was wound onto the drum evenly.

Secondly, velocity variations in drive mechanisms result in a decrease in a decrease in distribution uniformity. Although it was difficult to see a link between velocity change and depth applied, as a whole the irrigators which varied in velocity the most had the lowest distribution uniformities.

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Thirdly piston drive mechanisms are adequate for travelling gun irrigation systems; the large variations in speed are not significant when irrigating the large arc that travelling guns cover. However, a boom irrigator would be far more sensitive to these variations, and it would be expected that the distribution uniformity would suffer substantially if a piston ratchet action were placed on a boom irrigator.

Finally the auxiliary engine and turbine drive mechanisms offer similar velocity uniformity, and are suitable for both boom and travelling gun systems. The auxiliary engine handles change in topography and pressure well, while the turbine is more influenced by pressure and topography. The auxiliary engine would be the preferred mechanism of choice in areas where pressure is marginal, and/or topography is an issue. However, if neither of these is a problem then the turbine offers adequate uniform velocity across a run.

6.3 Recommendations

- The piston ratchet action should not be used in the driving of travelling boom irrigators due to its large variations in velocity across the field. Although the piston ratchet action is adequate for the driving of travelling gun irrigators, this is due to the large irrigating of area at a time, The area of application is much smaller for a travelling boom making this system much more sensitive to velocity change,
- So long as topography is minimal and pressure abundant, the water turbine is a good choice in drive mechanism for its simplicity and lack of maintenance required. The turbine-powered irrigator offers uniform power so long as the conditions are adequate, however this system will take 8 –9 Kpa from the water pressure. So if pressure is marginal or topography is an issue then uniformity can suffer.
- The auxiliary engine is the drive mechanism of choice for areas of marginal pressure, change in topography and high velocity requirements. These engines when coupled with a velocity speed compensator are very uniform, and are

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becoming more and more popular for low-pressure booms. It is unsure how they would perform if the velocity compensators were not available.

6.4 Future Work

Future work in soft hose travelling irrigators would be on reducing piston ratchet drive mechanisms speed variations.

Firstly, a test on a travelling boom irrigator with a piston ratchet action would give a better understanding of the affect speed variation has on distribution uniformity. It is known that Upton produced irrigators of this kind.

Secondly, develop a speed-sensing device based on cable intake rate that adjusts the water intake rate of the water-powered mechanism. This system would need to mount on existing irrigators in the field. A speed sensing mechanism of this kind could increase the value of old travelling irrigator that are ever increasingly loss of popularity for their more uniform counterparts.

Finally, develop a mechanism that guides the cable onto the cable drum evenly, layer by layer. This would eradicate the problem of a cable concentrating in one particular area. Resulting in greater uniformity across the run as well as decreasing substantially the oscillating variations encountered.

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Chapter Seven

References

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Appendix A

Specification

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_____ (supervisor)

___ / ___ / ___

Appendix B

Test 1

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)
1296.269	44.53274052	10674.47	29.75721291	20354.81	30.88175031
1311.359	41.6739522	10707.21	30.40355953	20374.22	30.00671215
1321.091	38.91375122	10729.77	29.68030878	20398.46	28.64019864
1354.711	38.83868751	10753.7	28.95438828	20423.33	29.31307212
1368.474	37.95963599	10782.61	29.92319532	20460.19	30.64660431
1383.17	36.340089	10818.58	31.53502497	20483.15	29.9399521
1392.804	33.62998852	10837.07	30.88753655	20507.62	28.91291559
1403.863	30.88765712	10860.81	29.63118299	20536.08	30.10214369
1424.212	30.71667585	10885.43	30.1133704	20568.42	31.34452517
1449.034	31.16269361	10919.89	31.22910738	20591.08	31.3264078
1473.954	31.33856646	10940.38	30.3231666	20611.04	29.42009749
1501.233	30.74018391	10967.47	29.75721291	20637.93	30.23776587
1524.433	30.79305903	10996.37	30.64660431	20674.74	31.86584835
1558.446	31.69024238	11026.99	31.70268516	20693.27	30.70487573
1576.927	30.3346751	11047.04	31.18074492	20718.39	29.73507196
1600.913	29.65850441	11069.51	29.71318709	20747.44	30.61162908
1628.094	30.27756733	11093.25	30.11921619	20781.3	32.10086897
1660.043	31.39352197	11127.85	30.84611636	20798.95	31.33248595
1681.818	31.19291371	11148.2	29.92319532	20820.87	29.5441138
1702.953	29.15366392	11173.27	29.20649919	20843.68	30.00671215
1726.448	29.6148808	11201.33	30.07411349	20880	30.91722508
1758.642	30.59990951	11233.38	31.24119061	20899.61	30.13034091
1781.4	30.0853193	11254.56	30.58252427	20923.06	29.11140462
1808.138	29.15355651	11276.58	28.98567713	20950.97	29.79026192
1837.777	30.15295974	11300.81	29.46314872	20984.5	31.09656173
1867.71	31.11441413	11335.81	30.27768318	21005.93	30.76947007
1889.436	31.67159651	11355.96	29.39310417	21027.8	28.87114017
1912.095	29.81787761	11384.37	29.24892712	21051.49	29.00140008
1935.491	30.29472346	11412.64	30.07399919	21088.7	30.28915718
1974.37	31.97969543	11444.19	31.15668116	21107.38	29.09053477
1993.638	31.00663409	11464.44	30.57082697	21135.93	28.85061327
2017.231	30.50141853	11486.66	28.88673907	21162.23	29.23304271
2044.412	30.84034563	11513.3	29.58752903	21194.87	30.34630872
2079.556	32.57516189	11549.57	30.77545369	21216.59	29.90634425
2100.199	32.24239658	11569.38	30.04020394	21238.96	28.08058512
2122.023	30.69915772	11597.15	29.63118299	21263.09	28.33762485
2139.275	29.89527134	11625.17	30.26621787	21301.87	29.70794397
2177.466	31.59067227	11654.91	31.03058824	21324.33	29.29679256
2196.685	30.48990066	11675.75	30.55937466	21349.94	28.61979167
2221.802	29.99567851	11698.16	28.90235484	21379.38	29.62574693
2248.835	30.28336114	11723.28	29.23833559	21410.2	30.4609095
2276.655	31.19279075	11760.58	30.55937466	21432.91	30.43794357

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2300.985	31.47944813	11780.74	29.81237284	21455.62	28.87640818
2322.465	29.68042011	11806.69	29.45240151	21481.18	29.38786425
2345.615	30.16985988	11832.79	30.13607852	21520.74	31.23514783
2379.776	30.82845032	11864.2	31.15668116	21542.32	30.48402755
2403.959	30.65824089	11886.61	30.92314546	21568.22	30.22067417
2427.945	30.05161276	11909.91	29.64217214	21594.42	30.66418133
2456.207	30.70499488	11934.68	30.1133704	21626.42	31.8281646
2485.6	31.59685341	11971.94	31.42419164	21646.47	30.92302462
2510.127	31.57214335	11993.91	30.79305903	21669.97	29.60413338
2530.329	29.75173052	12019.52	29.77916272	21692.88	29.97340849
2552.349	30.05161276	12046.16	30.28324525	21729.64	31.09033044
2589.065	31.60303697	12075.35	30.80480712	21750.43	30.54769506
2607.89	30.68154059	12095.36	30.26633364	21774.07	29.31839402
2636.448	30.25487692	12118.16	28.41771834	21801.89	29.98999424
2662.056	30.95290252	12142.49	28.65554892	21830.06	30.68737105
2691.252	31.77780277	12176.85	29.55492806	21852.47	30.26621787
2713.911	31.38742012	12197.45	28.4931349	21875.03	28.82465439
2736.03	29.54963029	12223.74	27.85236081	21902.36	29.54433442
2760.753	30.05720624	12250.87	28.6861949	21937.26	30.74006449
2796.29	31.07238364	12285.23	29.82338442	21956.87	29.96217242
2815.656	29.53881991	12307.45	29.56055902	21984.15	29.49554741
2839.446	28.8248644	12332.22	27.87158949	22009.46	30.06828519
2865.791	29.29158692	12356.8	27.71315997	22043.97	31.3995016
2897.986	30.24932527	12396.61	28.42272007	22065.74	30.76970937
2917.696	29.75173052	12418.63	27.29973193	22087.91	29.28638313
2940.256	28.40262174	12444.58	26.33518047	22113.91	29.88409377
2966.012	29.07471505	12475.15	26.84452647	22149.55	31.27168681
3003.81	30.4782741	12507.84	27.52843192	22170.19	30.57673358
3024.011	29.79564633	12526.71	27.1020643	22194.67	29.54422411
3050.947	29.45240151	12550.55	25.92787981	22220.96	30.34037446
3083.534	30.96477291	12575.13	26.68420254	22252.42	31.21100006
3113.959	31.75892628	12616.12	28.01229131	22272.62	30.72872371
3135.93	31.41807786	12642.32	27.77541815	22295.97	29.25433391
3159.572	30.1133704	12675.01	28.17396877	22322.9	30.05149863
3183.657	30.58831716	12708.48	29.4199881	22358.1	31.33248595
3218.85	31.65905144	12745.05	31.03643039	22378.69	30.24366006
3238.166	30.71667585	12769.92	30.96489409	22402.58	29.52801743
3263.431	29.89538429	12795.28	29.32882622	22428.97	30.09653347
3289.58	30.4783915	12818.68	29.75161865	22462.5	30.84022543
3319.611	31.56584595	12855.74	31.06043061	22481.76	30.3231666
3339.076	31.04848677	12871.66	29.62585785	22505.95	28.87661895
3363.111	29.7077209	12898.6	28.89718288	22530.13	29.22753582
3387.785	30.22644623	12927.21	29.53881991	22566.45	30.26066206
3422.339	31.0425183	12955.86	30.02356262	22586.21	29.34503258
3442.344	30.3346751	12977.44	30.01786778	22610.64	28.28282828
3468.788	29.77927479	13000	28.91798749	22640.33	29.20660699
3495.772	30.41489533	13025.46	28.89201278	22670.56	30.01228893
3528.114	31.80910037	13065.08	30.04602136	22691.89	29.83980451

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3549.2	31.56597188	13084.64	28.20862001	22719.07	29.06948123
3570.287	29.68042011	13110.49	27.50498808	22742.71	29.44166214
3593.929	30.06839945	13138.76	28.22341036	22779.97	30.6231206
3629.466	31.43043264	13172.42	29.01692727	22800.86	30.15859101
3649.569	30.61162908	13195.08	29.19593837	22827.94	29.90634425
3677.241	30.26054633	13219.41	28.14941302	22855.86	30.78120016
3703.194	30.91734588	13241.04	28.11011286	22890.41	32.06912483
3734.503	32.10086897	13273.63	28.49816322	22911.25	31.68377092
3755.934	31.86584835	13299.33	28.27787566	22934.21	30.27189153
3776.873	30.00125119	13328.43	28.11990263	22957.06	30.38044668
3799.875	30.40916794	13365.15	30.43209046	22991.27	31.11453647
3836.887	31.65905144	13398.18	31.67768254	23011.47	29.88962506
3857.089	31.12053268	13419.12	31.4857111	23038.36	29.12190436
3881.222	29.11140462	13445.12	30.44953938	23063.23	29.42009749
3908.059	29.89527134	13466.11	30.4494222	23092.53	30.05720624
3938.73	31.12053268	13500.51	31.91648986	23112.93	29.6913344
3959.128	30.9886624	13522.53	31.08446798	23137.16	28.56895282
3981.001	29.3236092	13551.29	30.97677368	23161	28.7785274
4004.25	29.75721291	13579.16	31.64031573	23195.6	29.75173052
4040.622	31.25945649	13609.83	32.76738832	23217.52	28.74256717
4060.086	30.42647359	13625.16	31.69658952	23245.59	28.50309064
4086.825	29.75721291	13647.97	29.96773265	23276.21	29.39310417
4111.352	30.27200735	13670.43	30.28336114	23310.07	30.63497656
4153.033	32.51599541	13704.99	31.36291211	23332.19	30.15272993
4172.743	31.91018305	13725.97	30.34619234	23355.79	28.76816916
4192.993	30.26054633	13748.44	29.15355651	23379.43	29.08508144
4214.473	30.9827169	13777.09	30.04590727	23414.13	30.0853193
4250.845	31.83431096	13806.73	30.76958972	23435.95	29.34492375
4270.162	30.84034563	13829.24	30.52459813	23461.56	28.6861949
4293.755	29.71318709	13851.31	28.80419351	23492.82	29.7077209
4320.149	30.34607596	13874.81	28.94919768	23523.2	30.62916599
4352.737	31.91005436	13912.01	30.39188198	23545.41	30.40916794
4372.742	31.37522353	13931.72	29.58221956	23568.37	28.86608469
4396.384	29.81226052	13957.28	28.88684453	23594.62	29.35570156
4420.714	30.3231666	13986.73	29.82327201	23630.84	30.38044668
4454.482	30.82256613	14019.85	30.86994347	23651.48	29.56044859
4469.867	29.72982112	14040.45	30.39783641	23677.14	29.10615758
4499.407	29.71329866	14063.89	29.00650308	23705.6	30.14147386
4526.735	30.62323911	14088.47	29.53330746	23737.4	31.52271342
4560.061	31.84071594	14126.02	30.9886624	23759.18	31.14454061
4580.901	31.13853516	14148.14	30.26054633	23781.54	30.07960101
4600.709	29.66395249	14172.37	29.1589281	23805.63	30.75201119
4624.941	30.15859101	14199.21	29.72959772	23842.49	32.04354112
4661.805	31.35073456	14231.21	30.57673358	23864.16	31.49185123
4681.663	30.44953938	14252.05	30.14158867	23891.3	30.82845032
4711.203	30.31758986	14276.18	28.95438828	23919.17	31.39377108
4736.024	31.06043061	14300.76	29.45229189	23949	31.97982468
4765.712	31.84686715	14336.69	30.36342636	23968.12	31.25353008

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4785.127	31.69024238	14356.4	29.62031287	23988.42	29.13230443
4808.573	29.92308216	14381.37	28.84545981	24013.24	29.6420611
4835.017	30.92326631	14409.63	29.82327201	24044.6	30.26066206
4867.457	32.05626294	14443.74	31.3264078	24062.94	29.40938166
4887.314	31.15655848	14465.37	31.12653119	24089.43	28.92834816
4914.201	30.50718072	14489.99	29.76818377	24115.43	29.64761423
4941.529	31.46104942	14514.57	30.22078959	24147.97	30.52459813
4972.2	32.50277264	14549.47	31.024505	24171.22	30.37473225
4990.779	31.83431096	14569.42	30.29472346	24196.43	29.2436304
5014.176	30.61162908	14597.29	29.79014976	24221.3	29.64195006
5034.819	30.4436818	14623.54	30.49565851	24260.04	31.18086779
5073.011	32.2230955	14655.68	31.3997508	24280.19	30.27189153
5090.902	30.71083426	14674.95	31.1446632	24306.09	29.75721291
5114.298	29.45229189	14696.33	29.3663783	24331.99	30.4494222
5141.283	30.15859101	14719.58	29.82889325	24362.96	31.4917259
5173.576	31.54747191	14755.81	30.9827169	24382.32	30.79305903
5193.04	31.03655212	14776.4	30.31189905	24407.2	29.63662105
5215.65	29.90645728	14804.52	29.80114492	24431.72	30.27756733
5239.341	30.38056332	14830.62	30.4436818	24467.01	31.40585744
5272.666	31.06640597	14862.91	31.83443903	24488.25	30.30644253
5294.735	30.3346751	14883.01	31.3997508	24513.81	29.58221956
5318.574	29.46852527	14907.69	30.47252282	24541.58	30.46114403
5348.557	30.62323911	14929.02	30.42074183	24572	31.34452517
5382.963	32.17147713	14965.78	31.52886799	24591.86	30.57673358
5403.656	31.84071594	14984.86	30.27768318	24614.22	29.27024148
5424.398	29.856468	15011.2	29.68042011	24639.29	30.01809553
5447.991	30.55347476	15037.45	31.01271032	24674.19	30.91734588
5480.235	31.30199494	15070.04	31.89114901	24693.06	29.74625014
5499.797	30.4609095	15090.53	31.0904526	24718.97	29.21178247
5527.372	29.63673205	15111.47	29.19583064	24749.34	30.26621787
5555.585	30.34037446	15135.01	29.48466669	24781.29	31.38742012
5587.091	31.66525938	15167.36	29.6420611	24801.35	30.92326631
5606.949	31.14454061	15189.13	29.25422576	24824.45	29.38786425
5628.92	29.79575853	15216.75	28.67579909	24850.64	30.00671215
5652.168	29.87856452	15246.2	29.35025723	24884.56	30.65835968
5689.426	31.18074492	15277.8	30.04031799	24902.89	29.51160839
5706.973	30.17549747	15292.6	28.54864722	24930.12	28.7218056
5733.024	29.97885931	15318.16	27.73715464	24959.07	29.53870964
5759.566	30.07411349	15345.04	28.71680228	24989.84	30.58819891
5794.365	31.41807786	15382.5	30.58831716	25010.78	30.41489533
5816.386	31.102551	15403.38	29.60391187	25033.39	29.10626464
5836.98	29.19593837	15434.3	28.5842268	25057.23	29.46314872
5861.016	29.65861557	15459.61	29.24892712	25093.7	30.07399919
5894.488	30.57094508	15492.69	31.0425183	25114.35	29.3342626
5917	29.80675783	15515.8	31.35694641	25142.66	29.01160787
5943.198	29.18538518	15541.21	30.44953938	25171.02	30.36330985
5969.199	29.79564633	15569.76	31.17484832	25205.62	32.32656663
5996.97	30.18113717	15603.43	32.22296428	25226.95	30.60582736

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6022.676	30.41489533	15620.59	30.78718835	25248.53	29.04323378
6046.22	28.99608636	15641.18	29.65850441	25270.94	29.76818377
6070.796	29.50621611	15670.67	30.42062488	25305.25	30.91734588
6108.004	30.94697073	15711.13	32.7408143	25325.8	30.41489533
6127.812	29.5441138	15730.15	31.81549522	25356.81	29.33959221
6153.322	29.23304271	15747.6	29.55503845	25384.09	29.76258538
6182.47	30.20383235	15768.14	29.37695375	25415.4	31.61566399
6214.32	31.15655848	15801.07	29.92874109	25431.62	31.15668116
6234.768	30.87584576	15823.58	29.52790725	25450.4	28.99109325
6259.147	29.50093579	15849	28.60458307	25485.49	30.60002784
6282.838	29.82889325	15877.6	29.34503258	25520.98	31.62185492
6319.112	31.25945649	15907.98	30.40928481	25536.76	30.16974485
6338.97	30.17561255	15930.79	30.22090501	25561.19	29.31806814
6363.693	29.6148808	15952.81	29.19583064	25585.96	29.71329866
6395.642	30.72848505	15978.86	30.22656169	25626.51	31.70891022
6424.002	31.55351033	16015.33	30.8226862	25649.96	31.74032684
6444.45	31.19291371	16037.5	29.86773765	25665.68	29.45777414
6468.289	29.71329866	16065.46	28.8815727	25685.59	29.60391187
6491.046	30.16985988	16091.56	28.47806058	25723.34	30.82232601
6527.369	31.42419164	16125.62	30.05720624	25744.08	30.2889253
6548.111	30.38616325	16147.25	30.4494222	25771.21	29.53870964
6572.245	30.14158867	16168.19	28.63512007	25799.03	30.43794357
6601.195	31.510286	16192.62	29.07984388	25831.08	31.61566399
6630.883	31.37522353	16223.83	29.52261916	25852.26	31.45479625
6653.149	31.30199494	16240.64	27.67042236	25876.05	29.84554455
6674.776	29.69679456	16272.05	28.01715133	25899.25	30.00113744
6698.123	30.13034091	16302.42	29.04312718	25934.3	30.81056456
6734.594	31.97349281	16339.44	30.91734588	25952.88	29.64217214
6753.321	30.25487692	16369.42	31.83418288	25980.06	29.00140008
6779.175	29.44155259	16388.88	29.65850441	26005.32	29.47401357
6808.519	30.38056332	16407.12	29.46852527	26039.09	30.42647359
6834.766	30.68165956	16444.52	30.91130696	26059	29.8401421
6852.313	30.25487692	16464.72	30.14733056	26081.36	28.1198027
6883.082	29.35559265	16491.86	29.6420611	26103.82	28.34269995
6905.938	29.75173052	16526.61	30.98259559	26141.18	29.3236092
6941.229	30.79905183	16554.47	31.57201738	26163	28.83526351
6960.742	29.856468	16574.87	31.32020804	26191.12	28.4278257
6982.074	28.42772357	16595.37	29.18000384	26219.82	29.31285494
7014.859	29.86210176	16617.98	29.71329866	26252.9	30.14733056
7047.938	31.00056024	16655.68	31.04239652	26273.79	29.77916272
7068.975	30.95290252	16675.63	30.07948666	26299.15	28.37756419
7092.666	29.56044859	16700.51	29.30742649	26324.17	29.01692727
7113.851	29.44692126	16727.2	29.40927235	26362.76	30.63497656
7152.632	31.03058824	16758.8	30.76360837	26383.01	29.58221956
7171.899	29.98442574	16782	30.74030333	26411.02	29.12715708
7198.146	29.65294719	16805.1	29.43082113	26437.42	29.51160839
7225.77	30.51871165	16827.52	29.34503258	26469.47	30.64648562
7260.422	31.52886799	16866.54	30.57673358	26489.77	30.3346751

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7279.837	31.25340664	16884.29	29.32893493	26515.37	28.93353127
7303.185	29.81787761	16910.58	28.75792289	26539.51	29.28074778
7324.615	29.95094477	16938.7	29.84002957	26577.99	30.22656169
7360.348	31.24131396	16970.5	31.26550868	26596.87	29.63662105
7382.565	30.18689414	16996.25	31.77155063	26621.05	28.72701926
7407.632	29.34492375	17016.01	29.69701746	26650.49	29.48994119
7435.796	30.13022618	17039.41	30.07399919	26682.69	30.48978318
7464.993	30.67583127	17073.96	31.43655123	26705.54	30.1924229
7485.047	30.26633364	17097.16	30.92314546	26727.66	28.80943712
7511.392	29.36093002	17125.33	30.48978318	26750.62	28.92834816
7533.019	28.97527537	17154.08	31.41196646	26788.86	30.15859101
7568.556	30.09653347	17185.73	32.40467347	26809.75	29.64772531
7588.807	29.25963451	17203.87	31.98615906	26839.78	29.14829427
7613.628	28.52847331	17223.58	29.87337567	26863.86	29.32893493
7644.692	30.13022618	17245.31	29.90634425	26896.5	30.24920963
7677.28	31.12653119	17282.46	30.98259559	26918.81	29.8013694
7698.416	30.83445691	17302.52	30.21501968	26942.21	28.67600693
7722.942	29.7735602	17325.67	29.25941812	26967.62	29.06403579
7746.486	30.26621787	17353.05	29.63673205	27002.32	29.86762491
7780.893	31.12653119	17384.85	30.69320373	27024.15	29.40916305
7806.107	30.65230276	17405.98	30.20383235	27051.23	28.62476124
7831.47	30.20948265	17429.92	29.01171424	27076.64	28.79895181
7859.241	30.91130696	17451.25	29.25433391	27111.24	30.37473225
7890.993	32.09448908	17488.46	30.59399395	27133.66	30.00113744
7907.312	30.89947751	17509.89	29.72423715	27158.09	28.70648842
7931.494	29.45229189	17537.86	29.3236092	27184.33	29.53881991
7955.038	29.97885931	17564.4	29.84002957	27218.15	30.4782741
7988.708	30.90551181	17596.11	31.02462664	27239.88	29.68598762
8007.926	30.07971535	17620.04	30.89947751	27267.25	29.31274635
8035.107	29.30232558	17642.65	29.31839402	27293.21	29.76840775
8064.254	30.26066206	17667.96	30.11910154	27327.66	31.24748253
8093.401	31.0904526	17702.67	31.49799376	27351.4	31.33856646
8115.225	30.81680421	17721.74	30.45516477	27371.75	29.56597118
8137.54	29.35581047	17747.1	29.5441138	27397.41	30.14158867
8163.394	29.86210176	17776.1	30.42085879	27433.73	31.25945649
8200.159	31.18688959	17807.7	31.60922295	27452.21	30.20936732
8218.984	30.57082697	17829.58	31.61541135	27477.77	29.70760936
8244.74	30.05720624	17851.15	29.84531941	27506.43	30.46102676
8270.987	30.59411223	17876.12	30.3174737	27537.2	31.33248595
8305.147	31.80910037	17912.54	31.82163669	27559.02	30.72251968
8325.742	31.35085877	17930.68	30.72251968	27580.89	29.15882065
8347.91	29.91199685	17953.88	29.74625014	27603.89	29.62574693
8371.994	29.99567851	17981.55	30.34607596	27639.38	30.60002784
8407.088	30.97665242	18014.93	31.74019952	27659.93	29.56586071
8428.372	29.87326289	18036.21	31.51643572	27686.86	28.75792289
8453.881	29.35025723	18058.04	29.81237284	27714.14	29.32893493
8477.819	29.6913344	18079.86	29.92319532	27744.13	30.04031799
8507.998	30.42074183	18116.28	31.17484832	27766.19	29.7351837

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8529.625	30.31201517	18137.12	30.53048689	27789.74	28.65554892
8553.906	28.79895181	18161.21	29.9176516	27816.57	29.20111006
8578.137	29.38229888	18188.24	30.20948265	27852.26	30.3346751
8612.446	30.30052385	18219.89	30.99473159	27870.99	29.15903555
8635.792	29.90634425	18242.31	30.18125229	27897.97	28.5842268
8662.532	29.43618588	18264.23	27.60872978	27927.56	29.70225672
8693.251	30.61151065	18287.28	28.16414133	27962.02	31.28380302
8723.48	31.85956153	18323.46	29.25952632	27983.94	31.06055253
8744.321	31.21112316	18344.3	28.85061327	28007.53	29.72423715
8768.11	29.71318709	18370.1	27.99772135	28032.3	30.18689414
8790.67	30.05149863	18396.3	27.71801384	28065.87	31.22319248
8828.666	31.62804827	18425.69	28.1198027	28087.55	30.58264247
8847.442	30.68165956	18450.17	28.4426424	28113.11	29.69679456
8873.59	30.23210499	18475.19	27.99752322	28142.35	30.59979118
8900.378	31.07238364	18504.48	29.14829427	28174.79	31.67768254
8931.344	32.05626294	18550.83	31.3264078	28193.96	31.2170335
8951.742	31.63424405	18568.23	30.09653347	28214.95	29.47917443
8971.845	29.75173052	18593.89	29.13777549	28238.69	29.72970942
8997.846	30.57673358	18618.56	29.61499164	28273.74	30.40344271
9034.416	31.8848522	18652.72	31.66525938	28294.43	29.54951994
9053.978	30.85200954	18681.77	32.28765424	28319.3	28.6451753
9078.849	30.42635659	18707.09	30.89356618	28346.29	29.04845815
9105.342	30.96489409	18728.37	31.12077747	28379.56	30.26066206
9135.325	31.74019952	18757.81	31.46117451	28400.94	30.01251659
9155.035	31.43655123	18775.95	30.45516477	28424.59	28.66063473
9178.185	29.76807178	18803.43	29.81787761	28447.44	29.09053477
9201.876	30.34037446	18831.15	30.4436818	28483.37	29.93428892
9237.806	31.66513266	18865.46	31.73408944	28504.85	29.29668409
9256.631	30.41489533	18885.75	31.53489929	28534	29.02224863
9282.584	29.58221956	18902.61	29.19583064	28562.21	29.78476734
9310.454	30.38627994	18926.85	29.68587625	28595.54	31.08446798
9338.913	31.0425183	18963.22	30.70511403	28618.69	31.20484588
9360.883	30.71083426	18982.63	29.74054822	28641.05	29.88420663
9384.624	29.18538518	19009.32	29.02746545	28664.59	30.18102205
9406.742	29.04845815	19035.77	29.10101946	28700.67	31.53489929
9444	30.31201517	19068.8	30.23210499	28719.45	30.54769506
9462.677	29.26493703	19091.06	30.20383235	28747.71	30.21525044
9487.696	28.21847852	19114.8	28.6096508	28774.94	30.93511398
9516.793	29.01692727	19136.68	28.77831806	28806.64	32.0117807
9550.069	30.0628018	19173.64	29.7187669	28827.88	31.56584595
9570.861	29.71329866	19193.4	28.92834816	28850.09	30.04579318
9593.815	28.31774798	19220.92	28.22824323	28872.26	30.34037446
9618.538	28.83001049	19248.69	28.50843061	28905.83	31.27762011
9655.746	30.0628018	19281.92	29.66395249	28926.77	30.21525044
9679.142	29.40916305	19307.68	29.31828539	28951.59	29.35570156
9705.045	28.75771386	19330.53	27.99752322	28978.48	29.72970942
9733.062	29.4199881	19353.04	27.91032352	29009.59	30.69320373
9768.108	31.01854574	19391.38	29.38229888	29030.73	30.47850889

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9789.489	30.6524215	19411.63	28.5640026	29053.83	29.19055313
9813.278	29.59848581	19439.89	28.25313852	29078.55	29.70214523
9837.166	29.97318141	19466.93	29.19055313	29113.45	30.8226862
9873.244	31.1446632	19501.24	30.31770602	29133.06	30.03473079
9893.002	30.4609095	19526.25	30.6055906	29158.82	29.36103896
9918.955	29.81776525	19548.67	29.44681168	29188.65	30.42635659
9948.201	30.97689495	19577.57	30.2322205	29221.14	31.61566399
9980.199	32.18443166	19613.16	31.43655123	29244.64	31.51643572
10002.02	32.10738168	19636.55	31.18049918	29267.39	30.0853193
10023.21	30.14733056	19660.69	30.14147386	29290.35	30.50118338
10047.64	30.43794357	19688.65	30.97083275	29324.9	31.41807786
10080.62	31.49799376	19719.96	31.74019952	29344.96	30.57673358
10101.16	30.63485795	19738	30.39771963	29370.17	29.76829576
10127.31	30.36319334	19762.23	28.9231669	29396.52	30.28347704
10152.77	30.72251968	19784.79	29.24903523	29428.32	31.41807786
10184.33	31.5660978	19817.38	30.00136494	29448.72	30.92918901
10203.64	30.85200954	19839.3	29.27554784	29471.42	29.52228872
10226.06	29.16946216	19864.86	28.42282217	29495.71	29.97874573
10248.47	29.51711275	19890.32	28.91798749	29530.41	31.04848677
10285.68	30.69915772	19923.21	29.73540719	29549.77	30.17008994
10307.6	29.98999424	19944.14	29.30221707	29576.76	29.50082581
10331.83	28.87124551	19969.26	28.52343429	29603.74	30.18928606
10359.46	29.60402263	19998.31	29.17473205	29635.98	30.17870178
10387.92	30.28336114	20035.81	30.85188925	29657.81	30.16346634
10410.33	29.95661425	20055.33	30.1472157	29680.17	30.15927857
10435	29.06926765	20081.13	28.91259866	29704.55	30.14009189
10460.12	29.34503258	20109.59	29.90080677	29739.45	30.11430209
10497.33	30.86392305	20143.26	31.00651259	29759.65	30.10715882
10516.55	29.74066	20163.95	30.50718072	29785.26	30.09309013
10543.43	28.75781838	20189.31	29.21178247	29812.05	30.07528831
10571.45	29.79026192	20214.19	29.41987872	29844.98	30.05293272
10605.9	31.04264008	20246.68	30.3232828		
10626.74	30.58831716	20269.53	29.68587625		
10649.21	29.23315071	20292.29	28.65565269		
		20317.8	28.95438828		

Analysing the Effect of Speed Variation on Irrigation Efficiency in Travelling Irrigators

Distance (m)	mm in Can	Distance (m)	mm in Can	Distance (m)	mm in Can
4	207	196	221	388	312
8	226	200	215	392	472
12	214	204	215	396	450
16	218	208	220	400	212
20	226	212	225		
24	232	216	220		
28	222	220	207		
32	215	224	222		
36	217	228	229		
40	204	232	234		
44	206	236	228		
48	214	240	227		
52	220	244	230		
56	218	248	226		
60	222	252	239		
64	221	256	227		
68	219	260	211		

Analysing the Effect of Speed Variation
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72	209	264	203
76	194	268	213
80	198	272	242
84	222	276	200
88	218	280	213
92	217	284	184
96	209	288	208
100	212	292	228
104	231	296	246
108	210	300	221
112	221	304	217
116	213	308	234
120	214	312	228
124	217	316	198
128	209	320	199
132	215	324	224
136	217	328	202
140	230	332	208
144	230	336	221
148	221	340	225
152	210	344	222
156	210	348	234
160	218	352	216
164	216	356	220
168	213	360	234
172	220	364	212
176	222	368	200
180	226	372	217
184	212	376	236
188	216	380	238
192	218	384	230

Appendix C

Test 2

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)
15211.61	63.45570899	20520.22	41.60908661	26102.51	40.43868884
15233.92	66.27635249	20535.85	40.36772133	26118.63	39.55430919
15241.45	63.65632919	20555.22	39.47675637	26138.44	39.15037627
15259.88	68.06943895	20574.98	40.24678674	26158.05	39.48640921
15266.22	65.25590064	20599.06	41.78199733	26182.68	40.65288759
15276.83	63.45520012	20615.77	41.74937082	26197.92	40.35763285
15290.3	66.91019787	20633.17	39.98645692	26215.76	38.36657907
15302.64	66.85423162	20651.51	40.48959207	26232.87	38.62446001
15312.62	65.49517858	20676.67	41.95635114	26262.16	40.3173293
15324.41	63.40587839	20691.96	41.48039421	26278.08	39.15018257
15336.31	62.44613855	20710.39	39.80882427	26298.19	38.32087095
15353.32	67.47160544	20731.87	40.71480393	26318.68	39.02698864
15365.75	68.47589048	20755.66	41.91257091	26340.56	40.06643307
15376.12	63.43078391	20771.59	41.46974199	26358.45	40.15610172
15387.48	63.37997709	20788.45	39.71053186	26377.32	38.55013154
15401.53	60.52132411	20805.3	40.15610172	26393.98	38.63370049
15408.56	55.9762309	20831.06	41.65223479	26422	40.236554
15421	53.69816161	20846.94	40.2666531	26437.73	38.96088549
15433.43	51.54851403	20865.27	39.17906568	26458.42	38.5871659
15449.21	51.36780878	20882.72	39.59329904	26480.2	39.60300896
15463.02	50.02686965	20909.16	41.43803514	26504.68	41.1730425
15470.59	45.33542647	20926.22	41.36351993	26521.44	40.76619509
15481.31	43.8773643	20944.45	39.89754346	26538.05	38.45832321
15500.87	44.2391985	20962.39	40.31712387	26555.5	39.26499705
15512.32	41.8038503	20987.71	41.77141017	26582.58	41.54529512
15532.28	40.7764889	21002.36	40.58179133	26598.8	40.33726538
15549.92	41.0676936	21021.03	39.71073115	26618.66	39.41854557
15568.36	41.2258125	21043.45	40.84890222	26640.83	40.45895202
15586.93	41.33154346	21067.23	42.37607643	26663.49	41.58831104
15603.25	38.93232306	21082.57	41.98907927	26680	41.50215042
15621.19	39.59329904	21100.12	39.76920912	26696.86	39.53513935
15645.13	40.30706066	21117.52	40.42856486	26715.54	39.88768859
15661.65	39.66156746	21142.78	41.66298098	26743.8	41.01553996
15679.73	38.06719778	21158.66	40.47964968	26757.02	39.19808587
15701.61	39.42856289	21177.14	39.2934645	26773.04	38.05804323
15726.33	41.27871794	21197.34	39.7300717	26794.97	39.53494182
15742.6	41.16233341	21220.29	40.78720838	26819.4	40.81813727
15760.29	39.17887169	21237.15	40.53065615	26836.4	40.33726538
15778.38	39.75941754	21253.96	38.55933649	26853.75	38.36639304
15806.5	41.50215042	21271.02	38.85737857	26870.66	38.72634907
15821.05	40.68382221	21299.09	40.44881789	26897.01	39.90720194
15841.44	39.77900552	21313.24	38.99852144	26913.91	38.82915818
15861.15	40.50990631	21332.71	38.09432109	26936.72	38.88544892

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15887.6	42.80405277	21354.13	39.20740862	26958.89	40.13614069
15902.29	42.1207282	21378.52	40.69428373	26980.96	41.09947644
15918.02	39.8382866	21396.5	40.67336606	26995.11	39.93681012
15934.83	40.33747101	21414.3	38.31177949	27013.25	38.04047882
15962.26	42.26471531	21432.38	38.88525782	27032.57	38.73601762
15977.4	40.81813727	21459.17	40.61220091	27059.99	40.57117953
15997.16	38.94209475	21474.66	39.33213705	27074.99	39.28429581
16015.54	39.564	21494.71	38.24807498	27095.29	38.36657907
16040.36	41.37411765	21516.14	39.55430919	27117.7	39.59349716
16056.48	41.09947644	21540.42	41.08859221	27140.21	41.16254753
16072.46	38.67070668	21555.95	40.35742702	27156.04	40.7561164
16090.15	38.9516796	21572.96	37.98660618	27173.49	38.42153564
16116.65	40.35763285	21591.05	38.63351187	27193.25	39.13140235
16131	39.22684526	21620.83	40.55080381	27221.26	40.49974665
16149.48	38.33015239	21635.88	39.43819217	27236.84	40.0362273
16171.25	39.36089777	21654.01	38.36657907	27255.03	38.96088549
16200.35	41.34190879	21675.84	39.41874194	27276.41	40.04635839
16215.54	40.45915889	21701.59	40.91162906	27301.53	41.45931247
16231.61	38.41220989	21716.19	39.94709262	27317.55	41.14135973
16249.01	38.67051769	21733	38.09468789	27332.44	38.05804323
16277.08	40.21651292	21752.02	38.48600695	27350.19	38.92313065
16293.3	39.1406934	21781.27	40.38791343	27379.43	40.46909123
16312.71	38.08515349	21795.87	39.29385475	27395.46	39.7300717
16332.72	38.6890472	21815.97	38.10312614	27416.64	39.30302789
16355.92	40.35763285	21836.51	38.87646963	27434.48	39.22684526
16372.29	40.29679726	21860.25	40.30706066	27458.13	40.67357513
16391.75	38.34854293	21876.57	39.87783859	27474	40.33726538
16411.12	39.26499705	21895	38.07617352	27492.38	38.67089566
16437.61	40.38832573	21914.27	38.81982397	27509.88	39.28390575
16453.63	39.72029938	21940.71	40.41803304	27540.36	41.25741041
16473.83	38.94209475	21957.62	39.70056996	27553.48	39.74963078
16495.46	40.0662302	21977.19	39.0171743	27574.96	38.70816253
16520.48	41.5771664	21997.24	39.81884058	27594.62	39.34191489
16537.24	41.63097806	22023.63	41.77118966	27617.97	40.57117953
16551.98	39.36070197	22040.05	41.17261403	27636.2	40.68403138
16568.65	39.3227549	22056.57	39.48660625	27652.67	38.26638682
16598.09	41.77118966	22075	40.3173293	27670.17	38.33015239
16612.64	40.32719211	22102.82	41.92345187	27697	39.61272365
16633.53	40.06602732	22118.11	40.50990631	27711.31	38.80116902
16652.85	40.71501343	22136.49	39.32255948	27732.15	38.24807498
16677.03	42.2536565	22156.94	40.08612174	27752.55	38.69888639
16692.95	42.24260349	22179.99	41.35314376	27779.38	40.29659204
16710.79	39.09312333	22195.96	40.7764889	27795.75	39.88748752
16727.31	39.4379956	22213.07	38.32996672	27813	38.08515349
16753.02	40.66354218	22232.24	39.24591188	27830.7	38.87608763
16769.88	39.74963078	22256.96	40.2666531	27859.45	40.93194562
16787.52	38.80116902	22271.26	38.70778382	27876.61	40.49974665
16808.85	39.9074032	22291.56	38.0134321	27896.76	38.17555506

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16831.02	41.18354282	22313.44	39.15037627	27915.24	38.15769804
16847.19	40.83857183	22337.72	40.42856486	27939.03	40.39801706
16864.3	38.97028767	22354.33	40.50990631	27957.02	40.99429081
16880.27	39.20760289	22371.34	38.38463218	27975.75	39.29385475
16913.2	41.86888195	22390.01	39.16917472	27994.13	38.6799693
16927.95	40.20649987	22419.51	40.78720838	28020.77	39.79921335
16947.61	39.35150189	22433.86	39.6224431	28034.24	38.87608763
16968.94	40.90084409	22453.47	38.64275668	28052.77	37.70172337
16991.45	41.74981137	22475.69	39.52506781	28071.98	37.88784188
17007.13	41.02596009	22499.72	40.90084409	28104.03	40.82845732
17023.16	38.70778382	22515.55	40.35763285	28122.61	41.14135973
17040.95	39.20760289	22533.44	38.28453097	28134.9	38.23901803
17067.34	40.7764889	22549.66	38.62446001	28150.04	38.0223825
17082.09	39.6224431	22577.48	40.08612174	28177.12	38.83887815
17102.19	38.92351358	22592.03	38.85737857	28198.7	39.08385484
17124.75	40.35763285	22613.51	38.52254305	28219.59	38.56873382
17148.69	41.83589847	22633.56	39.17906568	28237.78	38.69850787
17162.4	40.80782243	22658.24	40.61220091	28262.65	39.6518288
17180.98	39.25545215	22675.88	40.57117953	28280.83	39.41893831
17200.01	40.00667385	22693.18	38.07617352	28297.84	37.69256419
17227.58	41.93478295	22711.62	38.93251461	28314.94	37.95963599
17242.77	40.78720838	22740.12	40.52007108	28341.83	39.43819217
17261.4	40.00667385	22754.53	39.01755909	28358.15	38.62446001
17281.79	40.78720838	22774.88	38.0134321	28380.86	38.28416051
17305.48	42	22795.67	38.77341017	28401.16	39.02698864
17320.82	41.45931247	22818.91	39.9074032	28424.75	40.48938489
17337.83	39.63256434	22835.53	39.59349716	28442.25	40.21692172
17356.31	40.59136751	22853.07	37.64880528	28462.2	39.05569019
17382.55	42.1207282	22870.92	37.88820471	28481.57	39.68105912
17397.79	41.06790675	22901	39.93741483	28507.77	40.69428373
17416.27	39.7792055	22914.86	38.41239636	28523.4	39.36070197
17436.77	40.70433186	22935.4	37.46466736	28542.47	37.98660618
17459.18	42.03301957	22957.33	38.22073236	28563.01	38.81982397
17475.8	41.69547256	22983.03	39.81884058	28587.54	40.25681987
17493.88	40.2363494	22999.74	39.44782615	28603.91	39.70096834
17511.68	40.6737842	23017.19	37.58746325	28620.18	37.47371612
17537.48	42.07660443	23035.38	37.96837888	28639	37.30833789
17551.25	40.5919922	23063.25	39.52506781	28664.81	38.13030069
17570.41	39.39931088	23079.76	38.48563258	28680.98	37.30868971
17590.47	40.12616761	23099.13	37.79879622	28702.21	36.56291587
17615.19	41.5983682	23120.86	38.9422864	28724.43	37.66672696
17631.17	41.29961638	23146.61	40.35783869	28750.77	39.36070197
17647.44	39.28390575	23164.36	40.0564946	28766.85	33.65802615
17665.57	39.798813	23181.75	38.08515349	28784.1	30.15295974
17690.54	40.79730245	23200.33	38.36639304	28803.22	30.41489533
17706.22	39.99636066	23227.71	39.72987222	28831.33	31.40573279
17725.54	38.91394259	23243.78	38.53192246	28851.09	31.49811914
17746.18	39.96666414	23263.45	37.08504984	28872.33	31.28974091

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17771.25	41.62024837	23285.37	38.33033807	28893.07	31.88459524
17787.67	41.36330371	23308.47	39.69101124	28918.63	33.08386363
17805.41	39.71073115	23324.05	39.41874194	28934.5	32.68091012
17822.76	40.36772133	23342.68	38.04907604	28951.81	31.57844327
17848.86	41.73902035	23361.9	38.97969438	29001.94	36.75499919
17864.39	40.61220091	23389.52	40.6015732	29046.52	41.49105191
17884.5	39.69121033	23406.58	40.14632241	29063.38	40.61220091
17904.06	40.49974665	23426.88	39.7300717	29083.29	39.70056996
17928.88	42.14316148	23449.14	40.7867879	29102.31	40.17608262
17944.17	41.53417352	23476.81	42.83834922	29125.21	41.27871794
17961.37	39.52506781	23491.8	42.05491247	29141.24	40.99492796
17978.97	40.0564946	23507.83	39.80862399	29157.8	37.98660618
18004.67	41.25741041	23524.79	39.74963078	29176.63	38.83868751
18018.78	40.06643307	23550.64	41.20455954	29202.38	39.87783859
18038.44	39.14088701	23564.89	39.798813	29217.23	38.69850787
18059.23	40.11599611	23584.41	39.09370276	29237.23	37.6579432
18083.86	41.67373272	23603.68	39.56439564	29258.22	38.45832321
18099.44	41.28884135	23626.04	40.50990631	29282.6	39.78900683
18116.64	39.15967634	23643.14	40.49974665	29299.26	39.32236407
18134.68	39.60300896	23661.53	38.55971229	29316.91	38.0853368
18161.57	41.22602729	23679.96	38.80116902	29334.26	38.28453097
18176.51	40.12616761	23706.6	40.16649746	29366.11	40.7248622
18196.46	39.65143141	23723.85	39.769409	29380.36	38.99852144
18216.27	40.55080381	23742.68	38.61522395	29400.81	37.65758477
18240.6	42.13171752	23763.71	39.94709262	29421.7	38.28471621
18256.48	41.63097806	23786.81	40.67336606	29447.36	39.99636066
18273.73	39.69081214	23803.67	40.74520345	29463.97	39.53454676
18291.08	40.2367586	23821.37	39.09331647	29481.47	38.35783779
18318.71	41.93478295	23838.52	39.21712453	29500.49	38.93289773
18334.48	40.92199645	23866.74	41.36308749	29524.67	39.16917472
18353.5	39.81823946	23883.89	40.62241708	29540.94	37.98624146
18373.71	40.29679726	23903.6	39.65143141	29560.41	36.66286731
18396.02	41.27893328	23922.82	40.57117953	29583.26	37.49964457
18411.4	40.32719211	23947.59	42.02208167	29610.93	38.9419031
18428.41	38.37569656	23961.8	41.39511282	29628.38	39.05511189
18446.55	38.99832923	23981.36	39.75003014	29645.19	37.62267022
18473.09	40.41844595	23997.88	39.99696717	29664.12	38.23920282
18487.74	39.15987014	24023.78	40.84932398	29687.76	38.64275668
18507.4	38.37569656	24040.29	40.02630381	29703.73	37.28267323
18527.85	39.09331647	24058.04	38.9422864	29726.69	36.72957843
18552.23	40.78720838	24078.68	40.15610172	29749.25	37.85249925
18570.07	40.60198987	24103.16	41.77141017	29776.23	39.8186402
18587.71	38.6799693	24117.85	41.02596009	29794.27	40.18648871
18607.62	39.01736669	24135.89	39.05511189	29814.13	39.53494182
18634.61	40.37781486	24152.95	39.0743978	29830.99	39.62283992
18649.45	39.39970324	24180.42	40.57117953	29855.51	40.39801706
18668.86	38.73601762	24195.71	39.8186402	29871.05	38.25713623
18689.8	39.72029938	24217.48	39.02698864	29892.53	37.92379583

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18713.59	40.95291822	24237.98	39.740248	29915.97	38.86673085
18730.25	40.43868884	24261.23	41.1518439	29942.12	40.50990631
18746.23	38.25713623	24275.73	40.59157574	29958.29	40.2363494
18764.96	38.98910564	24292.59	38.2936095	29974.95	38.62408294
18792.28	40.71480393	24310.73	38.97028767	29991.17	38.43049262
18810.42	40.1064396	24338.5	40.50990631	30014.28	38.72672814
18830.57	39.31298658	24355.46	40.01658761	30030.69	37.80764581
18850.28	40.07637647	24375.46	38.79146792	30051.38	37.00803974
18873.14	41.33154346	24394.43	39.1881853	30077.88	37.99554395
18889.02	40.92199645	24420.24	40.95291822	30101.18	39.04566875
18906.81	39.35150189	24437.1	40.80740152	30119.56	39.71013329
18925.93	40.22632647	24453.51	39.02698864	30137.45	38.46748436
18953.06	42.01114946	24470.67	39.5155934	30154.95	39.01755909
18967.9	40.82845732	24499.22	41.00512512	30179.82	39.6520275
18986.63	39.69061306	24513.77	39.73984883	30197.07	38.35746591
19007.72	41.0361727	24533.83	39.19808587	30218.6	37.33456637
19031.85	43.11377246	24553.19	39.80862399	30239.98	37.93288591
19047.73	42.70195302	24579.44	41.76060798	30265.2	39.70096834
19064.59	40.53003334	24596.35	41.81489584	30286.13	41.27828727
19082.38	40.76619509	24613.45	39.17887169	30303.83	40.49995394
19107.89	42.15371338	24631	39.66156746	30318.82	39.7792055
19122.63	41.38472079	24656.27	40.58137507	30343.15	40.5919922
19141.41	40.46909123	24670.91	39.2266508	30357.75	38.54149416
19161.71	41.63075903	24692.2	38.51354311	30379.38	37.65758477
19185.99	43.25281645	24712.89	39.38970057	30403.36	39.04624677
19200.54	42.17618182	24735.7	40.29720769	30430.54	41.0361727
19215.38	39.6713109	24751.96	39.56439564	30448.58	41.55533148
19233.03	40.18608053	24768.92	38.1123024	30464.51	40.89048741
19259.82	41.78199733	24785.58	38.18458198	30477.83	40.4388955
19276.48	40.84890222	24815.42	39.91746919	30499.21	40.54020821
19295.6	39.44802281	24830.51	38.40326142	30517.74	39.31298658
19313.84	39.996765	24851.25	37.92361407	30538.09	37.32576076
19336.94	41.5128193	24872.63	39.06494532	30563.06	38.06701465
19351.78	41.02596009	24897.65	40.99492796	30589.5	40.11619949
19368.94	38.45832321	24913.77	40.63263839	30606.02	41.66298098
19388.15	39.32255948	24932.06	38.75442016	30623.37	42.23155625
19414.84	40.21630852	24951.96	39.55430919	30639	42.29815258
19429.93	39.29385475	24976.54	40.35742702	30658.02	40.43868884
19449.2	38.42153564	24992.81	40.35742702	30673.5	38.12129942
19470.19	39.39009274	25013.65	39.47655942	30694.39	36.71304824
19496.19	41.01553996	25036.55	40.86978978	30719.02	36.13629202
19511.67	40.6015732	25059.9	42.38742648	30750.08	39.16936861
19527.55	38.06719778	25075.19	41.44867107	30770.92	42.04373977
19544.65	38.42153564	25090.67	39.19789169	30786.75	43.98541379
19574.69	40.44881789	25108.51	39.25545215	30795.94	41.81445391
19589.38	39.09350961	25136.23	41.02596009	30810.73	39.04586142
19611.6	38.88583111	25152.01	39.80842372	30826.07	36.78011323
19631.31	39.64209493	25172.61	39.30341834	30853.69	36.66286731

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19655.15	41.23633976	25188.88	39.48640921	30881.07	36.57948021
19671.07	40.89069872	25214.09	40.68403138	30909.92	39.06494532
19689.11	39.06494532	25230.16	40.14632241	30937.99	44.05766115
19706.56	39.16956251	25246.58	37.71933588	30952.1	47.50264144
19735.41	41.25741041	25266.09	38.32978105	30959.13	48.14222179
19750.6	39.96726975	25292.54	39.88728646	30966.64	76.428
19770.31	39.05511189	25310.09	38.85737857	30985.18	70.4304
19791.79	40.41823949	25329.11	37.96856106	31013.39	67.3632
19815.09	41.91257091	25350.78	39.21712453	31041.21	64.8
19830.91	41.66320035	25373.93	40.66354218	31069.52	64.08
19847.04	39.07459075	25389.27	40.15650929	31097.39	60.408
19864.58	39.45707134	25408.59	38.63351187	31112.48	189.9535487
19891.67	41.02596009	25427.26	39.32236407	31117.59	141.4641995
19908.57	40.35742702	25456.36	40.92199645	31118.67	114.8263702
19927.2	39.4669114	25472.53	40.12637109	31123.49	78.17324411
19948.58	40.59136751	25490.92	38.9516796	31123.54	76.03246491
19972.92	42.15438709	25513.72	39.88768859	31123.98	54
19987.56	41.29983194	25537.51	41.08880557	31124.03	52.308
20003.88	39.00813409	25552.55	40.50990631	31124.77	49.18662547
20020.84	39.45726809	25568.53	38.11211883	31124.82	56.2824
20049.54	41.39511282	25586.32	38.61484706	31125.5	59.1552
20065.13	40.35783869	25613.4	40.03642987	31171.51	64.314
20084.54	39.35111049	25628.49	38.88583111	31200.9	68.1948
20104.64	40.01658761	25649.72	38.35746591	31230.54	63.6624
20127.7	41.26795381	25669.73	38.9422864	31261.31	68.292
20143.52	40.7764889	25694.06	40.11640287	31275.37	48.42
20160.63	38.95148785	25712.1	40.38791343	31280.09	72.036
20179.16	39.53474429	25730.09	38.22091698	31280.87	76.428
20206.73	41.00512512	25747.88	38.63351187	31285.64	70.4304
20221.38	39.996765	25776.14	40.66354218	31285.69	67.3632
20240.7	38.88583111	25791.23	39.04624677	31285.79	64.8
20261.19	39.798813	25811.04	37.89709622	31287.21	64.08
20285.62	41.52392947	25831.98	38.59638854	31289.28	60.408
20302.38	41.26773859	25856.02	39.76900924	31289.33	41.79938106
20319.44	39.40931843	25872.92	39.38970057	31290.02	41.73962758
20337.57	39.9074032	25891.31	37.46466736	31335.38	41.72034328
20363.77	41.33154346	25908.02	37.56997365	31365.66	41.69087708
20379.3	40.43868884	25937.12	39.30341834	31399.53	41.64248871
20399.7	39.69081214	25952.7	38.53229773	31439	41.69789727
20419.21	40.25661506	25970.74	37.33456637	31446.61	41.7825109
20444.18	41.86888195	25993.89	38.7823419	31446.81	41.83411232
20460.01	41.32096754	26019.84	40.38791343	31448.68	42.19637616
20476.18	39.4669114	26036.99	40.39801706	31448.73	29.81226052
20494.12	39.99696717	26054.98	38.19361316		
		26073.81	38.73601762		

Analysing the Effect of Speed Variation
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Distance (m)	mm in Can	Distance (m)	mm in Can	Distance (m)	mm in Can
3	222	150	326	297	330
6	209	153	315	300	324
9	285	156	327	303	318
12	282	159	314	306	311
15	283.5	162	318	309	305
18	285	165	316	312	308
21	276	168	314	315	311
24	259	171	304	318	315
27	280	174	314	321	298
30	290	177	316	324	280
33	290	180	314	327	280
36	290	183	310	330	292
39	260	186	318	333	293
42	290	189	328	336	293
45	287	192	302	339	294
48	306	195	298	342	294
51	305	198	275	345	294
54	312	201	274	348	294
57	310	204	255		
60	335	207	275		
63	312	210	304		
66	310	213	327		
69	295	216	311		
72	281	219	300		
75	285	222	300		
78	287	225	294		
81	290	228	327		
84	296	231	320		
87	318	234	314		
90	317	237	326		
93	325	240	328		
96	324	243	333		
99	315	246	312		
102	325	249	285		
105	325	252	297		
108	299	255	304		
111	295	258	308		
114	290	261	306		
117	290	264	320		
120	300	267	320		
123	303	270	301.5		
126	295	273	283		

Analysing the Effect of Speed Variation
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129	292	276	290
132	293	279	290
135	282	282	304
138	300	285	302
141	300	288	324
144	304	291	335
147	305	294	325

Appendix D

Test 3

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)
286.228	33.05000856	8705.769	33.97057498	17251.83	32.43083733
330.564	34.10013532	8727.347	36.1928198	17270.36	33.02297435
352.977	35.08099912	8761.556	35.08084359	17292.77	35.25763274
375.833	36.67952236	8780.676	34.11454291	17326.88	33.64414455
398.344	32.80746634	8811.102	33.24105309	17344.33	32.35260446
419.135	31.9352964	8825.11	34.76274366	17365.12	33.26830581
429.162	32.65447612	8850.62	34.0496579	17389.26	34.63553635
461.947	33.13845381	8868.954	32.62135922	17419.63	34.30355053
483.623	36.96585489	8889.696	33.9562887	17437.67	32.43735165
527.614	34.22328522	8918.106	33.96343034	17460.58	32.6875253
551.649	33.3580655	8946.319	32.84096239	17481.42	34.61296193
569.983	32.64114051	8960.278	32.41117728	17514.35	33.10407149
585.023	32.15226083	8980.185	33.1656775	17532.39	31.8974483
601.391	30.24354447	9006.235	34.91351924	17551.31	33.21356615
614.072	31.52886799	9043.05	34.8153591	17579.52	34.62826084
660.324	31.58461962	9063.153	32.37868428	17609.7	34.19415059
676.938	33.02283654	9078.243	33.07031328	17627.1	31.9926253
704.266	32.84096239	9101.344	34.04233351	17648.09	32.06249772
722.403	32.08173691	9132.261	33.94900441	17668.34	33.90623594
741.671	35.35056603	9151.135	33.70734824	17704.52	33.90623594
782.86	34.66558019	9179.299	33.74270801	17723.49	32.54233942
807.191	33.78520894	9201.221	34.34002387	17742.96	33.82781706
827.441	32.09448908	9224.323	33.99932971	17771.41	34.33257403
847.495	33.27530089	9244.819	32.69427825	17799.38	33.83490475
875.708	37.52596485	9269.69	33.24105309	17817.76	32.86769929
911.294	35.83841733	9290.432	34.97401082	17838.21	33.33066558
927.465	33.12472005	9322.626	34.07106319	17858.51	33.89882788
943.882	33.42739823	9340.616	33.2548835	17895.42	33.48298727
963.346	34.13632442	9364.701	32.47649263	17915.13	32.60146758
988.316	33.57376827	9384.214	34.18691161	17937.89	32.76074077
1006.698	33.56678955	9414.049	35.02757833	17956.86	35.05023122
1035.452	33.56678955	9435.725	32.94186216	17986.11	33.70734824
1061.65	35.45955635	9454.748	33.74976008	18005.33	32.12015425
1094.042	34.83053086	9477.553	35.12678457	18029.86	32.6476049
1113.506	31.96070749	9511.714	34.03515865	18051.63	33.21356615
1122.156	32.79414142	9528.475	32.99584675	18078.96	32.54863085
1148.256	34.75526196	9548.874	33.26173312	18095.91	33.13179359
1182.761	34.12160414	9572.86	34.61326474	18128.85	33.61598722
1200.062	33.02283654	9602.645	35.11930124	18151.46	34.61341615
1220.116	33.67908507	9627.861	33.04324586	18180.6	33.67908507
1242.382	34.6429666	9645.506	32.78734715	18198.4	31.59079839

Analysing the Effect of Speed Variation
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1271.185	33.87749335	9661.627	33.90609065	18211.87	32.98236839
1297.383	34.56125792	9694.953	32.83428496	18240.08	34.62826084
1317.192	34.8153591	9712.008	32.52241033	18276.21	33.66518609
1340.686	36.60435489	9736.978	33.79213447	18294	32.60805064
1369.735	35.42827976	9760.964	34.838045	18317.2	32.87452689
1389.543	31.95438319	9788.686	34.89088881	18339.02	34.60554455
1410.433	32.33964639	9810.755	32.7141481	18367.68	34.57605789
1431.962	34.6728714	9831.251	33.84908905	18386.85	32.31996471
1459.732	35.00464499	9853.173	35.18817455	18409.21	33.19308519
1477.329	32.34612413	9884.974	33.37889142	18433.34	33.61584441
1499.595	33.43431911	9902.964	33.79935159	18462.34	33.35820612
1530.954	32.69427825	9928.327	34.53893094	18479.99	32.39803961
1546.142	32.84764253	9953	35.31963898	18504.71	32.99570916
1567.965	31.62804827	9980.281	35.0579958	18529.04	34.57620897
1585.906	32.07536462	9995.125	32.34599191	18559.86	33.78520894
1612.89	33.89897311	10015.82	33.00933613	18579.72	32.24239658
1658.061	33.15206006	10037.54	35.7826667	18596.33	31.97349281
1676.64	31.99883535	10073.13	33.13151614	18615.7	33.90594537
1687.945	32.92157785	10086.94	31.9670343	18654.04	32.6875253
1703.379	36.16040215	10109.85	33.7568151	18671.73	32.7141481
1744.224	34.85308303	10140.02	33.57376827	18697.73	33.03621007
1767.621	32.32009672	10162.44	33.38579222	18717.2	34.43566812
1788.166	32.56189097	10182.1	31.35085877	18748.95	34.50955764
1808.859	33.27530089	10204.32	31.11453647	18768.86	32.24870399
1836.089	33.54587078	10220.83	33.63699355	18788.71	33.07708707
1859.584	34.17982333	10260.45	32.48956062	18813.93	34.21618186
1891.484	35.65577095	10277.26	31.510286	18841.75	33.66504286
1915.322	35.69533914	10294.26	33.09078135	18863.18	33.11127477
1935.229	33.19990937	10325.77	34.3401729	18887.41	33.58074989
1943.732	31.24735913	10357.38	34.01350602	18913.8	34.73298861
1963.049	33.14525554	10374.43	31.87855787	18939.61	33.48993118
1994.654	37.28267323	10398.12	33.07031328	18956.71	32.39817226
2032.992	35.17300238	10419.11	35.81441031	18978.73	32.56189097
2051.867	33.53193942	10456.71	34.29626515	18998.15	34.55401357
2073.887	34.11439584	10475.14	33.58773442	19034.08	33.70031389
2095.464	35.76665431	10495.69	33.036348	19053.15	32.53578286
2122.989	34.19429836	10520.81	33.40651175	19073.01	33.88460188
2137.244	32.02447731	10545.38	33.34428965	19098.22	34.2886857
2156.905	34.02081802	10564.89	31.74019952	19126.39	34.8455624
2182.07	35.85433158	10587.8	32.28778599	19149.44	32.1072514
2216.28	33.57376827	10607.07	35.77473958	19167.43	33.30989977
2233.385	31.12640875	10646.34	33.07031328	19192.99	34.75526196
2245.23	32.21653577	10658.38	30.86392305	19222.97	33.71438554
2276.835	34.74015568	10677.65	32.00517726	19241.16	32.6875253
2309.865	35.69550017	10705.86	32.76074077	19263.08	33.20673636
2327.413	31.36303642	10731.27	34.05683887	19287.95	34.15769139
2344.223	32.31349744	10760.32	33.01608495	19316.21	33.83490475
2368.651	34.83789162	10782.25	33.50396951	19331.74	32.21037206

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2403.991	31.33248595	10802.2	34.20139264	19357.16	32.43083733
2414.657	31.44879555	10837.1	32.8208021	19376.52	34.65055176
2436.973	34.77022858	10852.14	31.00663409	19413.88	33.35117615
2469.069	33.66518609	10867.52	32.33951422	19430.54	32.15866371
2499.445	34.3840438	10897.65	35.0579958	19450.64	32.80746634
2522.448	32.1009992	10934.03	35.20367306	19475.86	34.28155516
2537.636	31.46717993	10953.1	32.13306748	19505.15	33.82073234
2549.088	36.0551161	10972.81	32.43070441	19526.24	32.2296579
2596.52	33.91335653	10992.66	33.36509837	19547.87	32.39817226
2613.527	31.75280899	11021.91	32.30703277	19565.61	33.89171339
2631.123	34.02067175	11038.38	32.60818501	19602.82	33.79920722
2667.2	35.13458311	11068.46	33.11792674	19620.51	32.20368644
2688.582	33.66518609	11093.23	34.55386268	19642.24	32.96217148
2696.643	34.39136652	11122.72	33.77814205	19667.8	34.25973632
2734.489	34.20878565	11142.33	31.92279918	19696.7	33.70031389
2752.578	35.92644722	11159.73	32.26185234	19717.05	32.27474813
2784.133	35.26533232	11177.87	34.77022858	19735.97	32.6609458
2800.55	32.68104509	11219.06	33.31677207	19760.2	33.71424189
2815.984	32.70089885	11236.66	32.53564908	19793.38	33.02297435
2846.851	34.92106924	11259.07	33.13831503	19809.85	32.93500656
2880.323	36.36463906	11283.3	34.20154047	19836.29	32.61490522
2899.788	32.74067883	11311.12	34.13617715	19854.62	34.06387623
2913.796	32.58830943	11332.16	32.09448908	19887.95	34.04218705
2931.687	33.1656775	11351.72	33.73551506	19907.85	32.7141481
2964.57	33.2822989	11376.59	34.64311827	19927.66	33.43446038
2983.887	31.28986464	11407.61	33.26844568	19951.85	33.72861271
3004.383	31.64044225	11423.14	31.27762011	19981.14	32.28791774
3024.929	33.33052518	11446.63	32.94172502	20002.47	32.33977857
3058.106	34.58346263	11474.16	34.80785473	20028.08	33.36495769
3088.826	33.74976008	11502.27	34.14354199	20049.46	34.53923246
3106.914	32.23596032	11522.08	32.52241033	20076.54	34.66542832
3117.384	34.34747694	11542.48	32.86769929	20097.24	32.74745376
3155.477	33.78506469	11563.96	34.2306877	20120.24	32.91473068
3174.498	32.68091012	11598.27	32.95530743	20140.29	33.89897311
3203.154	32.62135922	11611.14	32.2617208	20169.54	32.67429761
3221.635	35.23439726	11636.01	33.09078135	20188.51	33.19322443
3257.27	34.80785473	11660.98	35.7509793	20215.74	35.21103571
3275.014	34.02067175	11699.62	34.47978352	20247.54	35.02711317
3295.51	33.51092213	11714.36	32.53564908	20272.76	33.83490475
3317.629	33.036348	11729.6	34.03515865	20286.62	31.57819122
3341.369	33.43431911	11753.83	34.57620897	20305.64	32.14572991
3362.849	31.96083658	11785.78	32.77417431	20325.5	34.09293608
3385.852	34.2306877	11804.71	32.9281538	20361.87	33.09091974
3408.708	34.69537193	11829.43	34.20878565	20380.7	32.08811173
3445.277	34.09998836	11851.25	35.21902846	20402.96	33.01594719
3464.2	32.72077675	11881.28	33.97757672	20430.68	33.88460188
3481.846	33.70734824	11900.11	31.97349281	20454.13	33.08414028
3502.342	34.02081802	11920.95	32.78748301	20472.27	31.87239442

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3528.098	34.20139264	11943.85	34.57605789	20498.66	32.78748301
3553.755	32.80080253	11972.8	32.37219349	20520.48	35.00479984
3580.887	33.13845381	11986.32	32.57516189	20556.22	33.5387615
3599.516	37.256693	12014.63	33.91335653	20571.65	32.94844622
3633.43	34.03515865	12046.14	33.87053279	20593.97	33.20673636
3639.869	33.09078135	12069.73	33.40651175	20619.82	34.35478409
3673.342	36.21750275	12082.56	31.8848522	20649.56	34.50188363
3696.247	33.62298642	12105.96	32.53564908	20670.35	32.57502779
3723.674	32.81413287	12132.99	34.3988419	20687.65	33.6720625
3737.092	33.036348	12168.43	33.06354227	20711.44	35.7032311
3760.685	32.13946272	12185.19	31.41196646	20746.93	33.91306584
3785.114	35.75081778	12201.66	33.28901977	20761.82	32.47649263
3822.125	34.74030821	12230.75	33.63685056	20782.27	33.186403
3838.296	30.52448038	12257.54	33.17235134	20807.58	34.18691161
3845.816	32.84764253	12279.46	32.20368644	20834.12	34.6281093
3872.358	35.97463117	12303.35	31.53502497	20858.11	33.68625398
3912.466	31.4917259	12319.42	34.20863776	20879.88	33.66504286
3914.727	34.60584724	12354.13	34.17967569	20899.69	34.34747694
3959.013	34.96659243	12376.2	32.16506914	20930.56	33.02972876
3978.232	34.24520585	12398.46	33.35117615	20946.44	31.83443903
4000.203	36.92342151	12424.51	35.10387692	20968.55	33.20673636
4031.316	32.76087641	12453.56	34.27427913	20995.15	34.83789162
4043.457	33.89171339	12468.45	32.9013185	21025.91	34.18691161
4066.066	36.23375553	12492.78	33.9562887	21046.02	32.26816736
4105.044	33.44816946	12518	33.89185855	21065.58	32.60146758
4113.252	32.86101098	12549.06	33.34428965	21086.62	33.18612464
4132.421	34.17967569	12570.35	31.54131008	21114.78	32.89475325
4165.993	33.67908507	12585.44	32.0243477	21134.74	32.8812207
4187.668	32.8946165	12607.7	34.18691161	21160.94	33.34414914
4204.528	33.30975955	12644.47	33.15206006	21186	34.442713
4231.266	33.28915982	12661.77	30.96489409	21217.12	33.83519411
4245.619	35.10387692	12678.97	31.09643952	21233.44	32.74745376
4284.989	32.55546047	12699.32	32.54220559	21253.05	33.93459074
4299.539	31.64664288	12733.28	32.07549464	21277.47	35.30403823
4323.426	33.51092213	12751.03	32.13293699	21310.8	33.78520894
4349.821	35.49853076	12782.53	32.53564908	21329.33	32.94186216
4373.217	34.25988466	12807.65	33.35117615	21353.22	33.39255496
4397.499	33.44124285	12836.31	33.29616367	21375.29	34.24520585
4422.615	34.17982333	12854.79	31.80296374	21401.58	34.89842902
4445.078	34.45036071	12875.92	32.5685921	21423.31	33.39974336
4468.818	34.06402287	12900.45	33.77799786	21446.85	33.19280672
4483.318	32.43721868	12934.51	34.33287196	21467.3	33.80628292
4510.4	35.15753087	12953.78	32.11389703	21494.68	32.50290615
4542.595	36.62095681	12976.44	32.45691034	21510.65	32.26829895
4573.462	34.87566443	12997.72	33.82058778	21534.93	33.79227878
4585.947	31.82176466	13028.79	33.59486448	21563.54	35.24224366
4596.122	33.58074989	13050.86	32.08173691	21593.42	34.57620897
4628.463	34.96674695	13073.56	31.97969543	21612.25	33.10420998

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4659.233	33.95614299	13092.44	33.74976008	21632.65	33.18626382
4676.583	31.79657394	13124.73	31.73396217	21650.05	34.66542832
4698.505	31.85956153	13143.41	31.60934922	21683.77	34.17244283
4715.61	36.44704842	13168.77	30.67559343	21705.69	33.59500711
4754.342	34.92862251	13184.25	31.98602976	21728.74	34.55371179
4767.662	32.97549592	13222.84	32.59488717	21754.1	35.19615693
4789.535	32.16519989	13241.52	31.46117451	21780.15	34.91351924
4812.833	34.35478409	13262.75	31.73383491	21797.7	32.80080253
4844.782	34.14339466	13286.39	33.26858556	21817.95	33.69328246
4864.098	34.60569589	13320.21	32.24883542	21841.1	34.73283616
4885.528	33.67908507	13339.87	30.4436818	21871.67	33.70002683
4909.613	36.19298534	13359.19	33.06340412	21888.48	32.49636547
4947.362	35.59274003	13392.76	34.67302333	21912.03	33.37889142
4963.975	32.24239658	13419.1	34.3988419	21937.24	34.59828163
4971.446	31.89114901	13442.2	33.11113622	21964.28	34.40617092
4994.204	35.28089888	13470.22	31.74643932	21983.1	32.72077675
5029.495	36.16850112	13484.28	32.47649263	22004.97	32.65447612
5058.838	33.8776384	13514.26	32.86114745	22024.34	34.09278919
5075.108	33.51787764	13535.74	31.75268157	22059.19	33.26872543
5095.85	33.35820612	13558.05	33.3030303	22075.95	32.3136294
5114.184	34.97431999	13585.24	34.94389317	22099.49	33.30317047
5144.56	33.6440015	13619.1	33.60899094	22123.28	34.47227293
5165.99	32.67443253	13632.08	31.10842028	22155.53	34.04951138
5186.29	34.53154525	13647.31	31.44892054	22174.3	32.3590874
5216.862	35.69533914	13672.24	34.52431336	22192.98	32.66108061
5242.323	33.52483604	13709.2	33.89171339	22213.08	33.89882788
5253.775	33.2340724	13733.53	33.61598722	22246.8	33.18612464
5277.614	35.33493795	13757.91	33.51078022	22266.66	33.08386363
5308.678	35.30403823	13776.54	34.61326474	22291.28	33.51759369
5331.927	33.51787764	13807.26	33.63685056	22313.79	34.87566443
5351.391	33.95614299	13822.84	32.1009992	22344.37	34.46491572
5370.806	35.14207296	13845.54	32.76725262	22360.88	32.86783581
5401.182	35.79853147	13867.52	34.55386268	22385.07	33.35820612
5428.461	33.62998852	13901.68	33.53165523	22406.69	34.92877669
5446.009	32.88791724	13923.84	31.43642634	22437.51	33.82781706
5463.999	35.14987828	13938.39	32.37881677	22455.35	33.42033907
5489.803	36.53809746	13967	33.87749335	22480.22	34.32557413
5515.707	33.84199542	13993.3	34.15076262	22505.1	34.54647061
5532.615	34.89842902	14012.66	31.92911098	22530.46	34.48729739
5556.06	36.07138787	14035.86	31.66538609	22549.87	33.00919842
5587.468	34.89842902	14058.08	33.21342674	22571.25	32.80760237
5603.836	33.47618786	14092.04	32.5685921	22590.47	34.78536103
5626.348	33.83490475	14109	32.00517726	22625.81	33.83490475
5649.498	36.0792825	14130.68	32.45691034	22643.9	32.60805064
5681.299	36.37299698	14159.82	34.16506552	22664.05	33.8560408
5704.598	34.47242311	14190.1	34.20863776	22689.27	35.13473911
5714.919	34.04233351	14211.38	31.22910738	22716.99	33.94885876
5732.27	34.8003536	14226.87	31.32033201	22735.62	32.93486947

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5766.431	34.8228667	14244.36	33.17249041	22759.51	33.45524038
5782.798	33.78506469	14283.69	33.1451167	22779.31	34.56865632
5806.833	34.87581815	14307.97	32.19739664	22810.97	34.310839
5830.574	36.3317462	14330.28	32.87452689	22831.66	33.01594719
5862.719	36.08750975	14351.96	32.3136294	22853.29	33.68625398
5883.363	33.80657179	14377.91	32.85446181	22877.77	35.16518679
5900.616	33.337406	14403.62	31.53515065	22906.72	33.90623594
5922.144	33.44816946	14421.71	31.79031442	22922.99	31.93542529
5944.459	34.3767242	14442.69	33.3030303	22942.2	32.99584675
5964.71	33.69328246	14480.25	32.20368644	22968.7	34.09278919
5993.808	32.70752213	14497.01	31.87213766	22999.76	33.04987052
6010.028	33.81350609	14522.22	32.93500656	23015.83	32.522544
6041.043	33.03621007	14546.7	34.02784049	23039.87	32.74067883
6057.459	32.58173433	14576.04	33.30975955	23062.28	34.5390817
6080.512	33.27530089	14592.66	33.08400196	23092.95	34.11439584
6102.63	34.00634331	14622.79	33.76387307	23112.66	32.32656663
6134.677	33.80642736	14644.46	34.15061523	23131.73	33.09064297
6159.499	32.56202496	14672.63	33.48312895	23156.36	34.33257403
6181.028	32.98910619	14691.6	32.8543254	23189.98	33.83476008
6194.889	35.0579958	14717.85	33.85618566	23208.51	32.96217148
6228.656	35.56138798	14742.72	34.60584724	23231.86	33.30989977
6251.954	33.88474698	14770.49	33.98487328	23255.25	34.95917718
6275.056	34.06402287	14786.95	32.51599541	23283.17	34.42832653
6296.978	33.78520894	14808.58	32.84777889	23303.96	32.39803961
6323.372	33.02959089	14830.21	34.49451378	23322.05	33.10448698
6340.428	32.86783581	14861.96	33.00933613	23344.61	34.24520585
6367.363	34.25973632	14878.82	32.3590874	23376.51	33.5387615
6393.561	35.74290477	14904.33	32.7940055	23395.48	33.14539438
6424.035	34.25232128	14927.92	34.32557413	23420.45	33.186403
6434.75	32.8946165	14958.69	34.16521304	23442.38	34.9360248
6454.362	32.86769929	14976.43	33.39269588	23471.91	34.96674695
6474.465	33.65802615	14999.14	33.07031328	23492.8	32.37192862
6508.577	34.19429836	15019.79	33.94186884	23509.52	33.37875062
6529.27	34.20863776	15051.93	33.3580655	23533.8	34.9059725
6557.581	33.85633052	15071.1	33.02972876	23566.29	34.16491801
6579.995	35.29616429	15091.35	34.54631978	23583.64	33.35820612
6608.109	34.36940772	15118.53	35.99083036	23607.57	33.72171319
6624.526	32.8946165	15148.86	34.6879192	23631.41	34.42802694
6645.416	33.94900441	15169.21	32.65434137	23659.18	34.6728714
6665.765	34.3988419	15189.21	33.05677403	23680.81	32.94858342
6694.912	32.92157785	15208.04	34.0712099	23698.41	33.02945302
6715.212	32.92829083	15236.1	34.38419321	23719.1	34.95902273
6743.671	33.15206006	15259.06	33.36509837	23753.95	33.9276067
6760.677	34.2160339	15285.06	33.93473627	23770.86	32.90816008
6788.891	34.77022858	15308.31	34.5759068	23792.98	33.14539438
6813.712	32.34612413	15330.92	33.47604623	23815.24	34.83773824
6832.292	33.13831503	15347.58	32.26816736	23844.78	34.72521493
6854.754	34.28898287	15368.72	32.99570916	23866.06	32.93514364

Analysing the Effect of Speed Variation
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6885.966	32.46356833	15397.32	34.60584724	23889.02	33.18612464
6898.844	33.13151614	15431.53	33.97057498	23909.02	33.84199542
6924.943	34.6281093	15447.41	32.9014553	23938.56	33.58074989
6955.565	34.96674695	15468.35	33.11099767	23958.67	32.73417753
6983.975	33.65788298	15489.19	34.39869236	23980.29	33.37185273
6999.359	33.04324586	15522.22	34.24520585	24004.08	34.30355053
7020.151	32.53564908	15541.49	32.43083733	24033.43	33.79935159
7041.286	34.59087054	15559.77	33.56693194	24053.97	32.45065432
7076.921	34.0496579	15583.95	34.44301285	24071.91	32.86114745
7093.535	33.04987052	15613.94	33.55995606	24093.93	33.89171339
7116.734	33.6157016	15637.14	33.79227878	24129.27	32.91473068
7142.588	33.49687798	15660.19	32.84764253	24147.46	32.3136294
7163.773	33.05677403	15680.34	34.36925843	24172.38	32.94186216
7184.073	32.95517017	15708.85	33.82781706	24194.3	34.10719058
7210.27	34.56880734	15728.17	33.09064297	24222.02	33.5387615
7234.454	34.02067175	15752.25	33.05677403	24241.19	31.92279918
7259.619	33.51092213	15772.55	33.82073234	24264.1	33.04310788
7284.49	33.27544082	15803.76	32.65447612	24288.08	33.6720625
7305.675	32.54220559	15819.69	32.22939535	24315.76	32.65434137
7325.925	33.99918362	15843.67	33.71424189	24334.73	32.62149371
7356.154	34.61341615	15872.92	33.58074989	24362.75	33.22751323
7377.978	32.84764253	15894.35	33.97757672	24387.86	34.43551826
7399.998	34.12175128	15921.23	32.03069973	24417.26	34.17244283
7423.443	34.14339466	15939.08	32.37868428	24434.51	32.50944947
7450.378	32.70752213	15962.08	33.44138418	24454.02	33.44831085
7463.354	33.28915982	15991.37	32.80066656	24477.12	35.00449014
7492.207	34.23053962	16011.92	32.21653577	24511.97	32.6875253
7520.616	34.53154525	16037.72	32.96862631	24527.55	32.12654435
7543.472	35.6243078	16062	33.60185488	24550.75	33.42753945
7569.08	32.07536462	16089.19	33.07722534	24577.05	34.74000316
7588.889	32.74067883	16107.62	31.61553767	24605.31	34.47978352
7606.583	34.42098807	16129.98	32.98896866	24626	32.92157785
7640.892	33.41356508	16154.12	34.40632052	24647.04	32.48302531
7655.342	33.90623594	16186.11	33.93459074	24666.06	33.89171339
7682.13	32.81413287	16206.46	32.54220559	24697.42	31.87855787
7705.28	32.84764253	16227.99	33.46910807	24713.69	31.57844327
7729.906	33.48298727	16253.16	35.25747564	24738.02	33.33066558
7751.778	32.53564908	16283.34	35.04278046	24769.63	34.46491572
7772.619	33.07031328	16302.01	32.21666694	24797.05	33.74242024
7791.198	36.45527631	16324.67	33.2340724	24813.76	31.64056877
7835.583	34.22328522	16346.84	34.56125792	24833.08	32.04354112
7848.264	33.34428965	16380.26	33.90623594	24855.49	33.63713654
7870.775	33.51078022	16393.98	32.85418898	24887.39	33.42739823
7892.156	33.74256412	16416.1	32.19726562	24909.66	32.60831939
7915.503	35.7826667	16439.64	33.51078022	24930.89	34.8228667
7946.42	34.76289638	16471.15	33.56693194	24961.91	35.7190255
7970.8	34.3182794	16489.58	32.12015425	24988.6	35.41274139
7988.101	34.78551395	16507.77	32.86087451	25007.03	33.39974336

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8015.823	33.06354227	16527.82	34.83037754	25026.64	33.52497807
8030.47	32.40467347	16570.29	32.9014553	25048.27	35.31175809
8052.638	34.2306877	16584.93	32.63454408	25083.17	34.97401082
8079.475	35.17300238	16609.21	33.33726554	25102.43	33.84185068
8108.081	34.98963064	16627.35	34.70282787	25122.63	34.8682877
8128.283	33.20004867	16656.94	35.44399054	25146.38	35.84637269
8150.008	33.15206006	16685.4	33.07708707	25173.56	34.20878565
8167.555	34.25246955	16707.27	33.28915982	25189.14	33.50411138
8198.422	33.78506469	16725.31	34.77053416	25210.13	33.94885876
8218.672	33.47604623	16754.12	32.64800901	25230.47	35.77473958
8243.297	34.62826084	16768.62	33.26173312	25263.55	34.77786959
8269.791	36.02294455	16797.47	33.98472732	25284.3	33.77093398
8296.825	33.69328246	16825.43	34.64326994	25307.25	34.26700618
8310.636	32.19071641	16851.68	33.60199757	25328.68	35.57689714
8333.049	33.17930612	16864.71	31.68389778	25356.45	34.85308303
8354.43	34.17229525	16884.96	33.08386363	25373.31	33.66504286
8388.345	33.74976008	16908.65	34.53169595	25394.3	34.27427913
8406.237	32.40454076	16946.5	32.61450193	25420.45	34.36194513
8429.436	33.02283654	16963.01	31.72136767	25446.3	33.40825948
8452.882	34.99690402	16981.69	32.85418898	25463.55	33.38095525
8479.669	34.54631978	17010.98	33.6720625	25484.74	33.34654592
8498.298	32.28778599	17035.36	33.74270801	25511.82	33.18201054
8516.485	33.6440015	17058.27	32.06249772	25541.56	33.15864655
8545.484	34.0712099	17080.09	32.41104453	25559.6	33.13344975
8578.859	34.07839996	17100.19	34.3401729	25578.87	32.94922177
8592.916	34.29626515	17134.7	32.77431006	25600.34	32.9116422
8619.901	34.66542832	17147.82	32.43083733	25629.34	32.88345085
8640.692	36.62112629	17175.64	34.10013532	25651.31	32.69495254
8673.624	35.07322435	17205.63	34.48714708	25676.58	0
8692.498	32.8946165	17231.13	34.46521595		

Analysing the Effect of Speed Variation
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Distance (m)	mm in Can	Distance (m)	mm in Can
4	212	200	237
8	222	204	238
12	243	208	245
16	220	212	246
20	210	216	242
24	210	220	251
28	199	224	264
32	200	228	245
36	205	232	244
40	206	236	241
44	207	240	247
48	215	244	251
52	220	248	255
56	210	252	248
60	211	256	267
64	213	260	269

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

68	224	264	258
72	215	268	245
76	210	272	254
80	204	276	241
84	205	280	237
88	206	284	256
92	201	288	241
96	215	292	258
100	214	296	255
104	213	300	245
108	207	304	248
112	207	308	249
116	194	312	255
120	210	316	245
124	215	320	251
128	215	324	253
132	220	328	252
136	225	332	256
140	228	336	260
144	229	340	251
148	224	344	249
152	226	348	248
156	230	352	255
160	228		
164	227		
168	232		
172	233		
176	234		
180	236		
184	230		
188	232		
192	228		
196	227		

Distance (m)	Pressure (Kpa)	Distance (m)	Pressure (Kpa)
4	255	200	250
8	255	204	250
12	255	208	250
16	255	212	250
20	255	216	250
24	255	220	247
28	255	224	247
32	255	228	247
36	260	232	247
40	263	236	247
44	260	240	247
48	254	244	247

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

52	254	248	247
56	254	252	249
60	254	256	245
64	254	260	245
68	254	264	245
72	254	268	245
76	254	272	245
80	254	276	245
84	254	280	245
88	254	284	245
92	254	288	245
96	260	292	245
100	263	296	248
104	259	300	249
108	255	304	249
112	255	308	248
116	255	312	242
120	255	316	238
124	255	320	238
128	255	324	238
132	255	328	238
136	255	332	238
140	255	336	238
144	255	340	238
148	255	344	237
152	255	348	237
156	255	352	242
160	259		
164	262		
168	264		
172	260		
176	254		
180	254		
184	254		
188	254		
192	254		
196	254		

Appendix E

Test 4

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Average Velocity (m/hr)	Time (s)	Velocity (m/hr)	Average Velocity (m/hr)
4271.751	31.14	47.69300558	17019.57	98.25854584	55.31902534
4272.341	35.4348	48.19909336	17019.62	98.25854584	55.31763399
4273.422	36.8424	48.20452431	17085.19	145.6625947	54.94048802
4273.472	35.5212	47.8019868	17085.33	145.7151696	54.93113104
4273.717	41.2344	47.65014847	17085.43	145.6625947	54.93148355
4273.767	35.2296	47.81271872	17086.66	127.161462	53.02884716
4273.914	35.5536	47.3136298	17086.71	85.90047124	52.49008293
4274.012	36.468	47.31389366	17086.76	89.80592441	50.84839884
4274.258	35.514	47.813252	17220.7	44.5836324	51.66938359
4274.307	359.208	43.74638497	17220.75	38.31824068	51.0409522
4274.405	36.8424	44.20555608	17220.89	38.26265387	51.24422823
4274.504	35.54352	44.20510024	17220.94	38.26273431	51.23244521
4274.553	37.0332	43.74344359	17220.99	38.17196791	51.23244521
4274.651	29.74761154	43.41271674	17221.09	38.14052912	51.23215025
4274.798	24.49836044	43.29382708	17221.24	33.86080919	50.92440716
4274.848	19.17265572	42.99189088	17242.23	27.98914849	51.04645692
4275.143	14.74459204	42.99298693	17289.36	34.11006327	51.65066515
4275.192	14.1540394	42.98751614	17289.41	32.79547342	51.54465472
4275.339	12.92269206	42.89706462	17628.91	75.00341235	53.73258949
4275.388	12.92267965	42.88832723	17695.7	72.36975082	53.52498426
4356.096	18.08097101	42.89619338	17696.54	71.89587419	53.60260583
4363.862	15.83873175	42.91477251	17696.59	71.895602	53.60227621
4401.512	16.39751553	42.9581077	17697.77	72.19131684	52.6844034
4886.446	23.44039851	44.19660498	17698.26	72.21822081	53.23384784
5017.682	27.32971102	44.82274647	17758.72	70.633708	53.62113817
5017.731	31.05499805	44.44382637	17892.46	138.9307348	53.66251538
5241.127	36.08501256	44.03351039	17892.51	138.631549	53.10665484
5281.48	39.21912746	44.2211031	17892.61	138.5809672	53.00029757
5316.28	46.07504955	44.01194359	17892.65	138.5809672	52.71863366
5316.33	46.00668402	44.4767237	17914.38	139.988648	53.18955538
5318.885	46.27097831	44.02273236	17960.68	144.3283174	52.65799122
5462.95	69.72735764	44.705955	17960.73	142.6243691	52.65735366
5463.146	69.76325915	45.17901581	17960.83	142.5697619	52.65766258
5527.831	108.408381	45.4939756	17961.22	142.7283454	52.65960821
5567.791	132.0281649	45.32402368	18027.58	144.870011	53.09910164
5603.77	169.977895	45.10556856	18029.15	143.8985247	53.02527846
5745.476	163.3580405	45.79908368	18029.49	143.7373317	52.50216843
5745.525	162.2955896	45.79908368	18029.64	143.8451167	52.50250306
5745.623	87.70210898	44.88843846	18029.69	143.8462063	52.50250306
5746.311	76.7478943	44.87432733	18050.04	141.5264001	52.63570891

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5746.41	68.17852835	44.28547401	18092.26	138.8819658	52.91497367
5746.655	30.86737447	44.45170306	18093.88	140.1911961	52.92348614
5746.705	27.51121992	44.44794369	18094.03	139.6335402	52.37170867
5746.803	20.73301808	44.44817804	18094.28	139.6859209	52.92546633
5747.589	23.97802386	44.45170306	18158.67	260.8902077	53.35662797
5748.081	18.77634422	43.63181176	18161.12	326.0182423	53.00752438
5895.635	31.07593269	44.80551596	18161.62	268.5035629	53.01048744
5896.667	31.12600062	44.81005544	18161.66	133.6461713	53.01014631
5971.182	42.76065377	45.16913498	18161.71	132.1810791	53.00916305
6004.064	45.48081935	45.32723446	18184.22	189.318615	52.4216729
6024.954	40.89268513	44.93768438	18229	50.02060803	52.1813737
6361.891	161.6330533	46.7799667	18229.35	49.79785825	52.37348873
6436.995	329.6633707	47.18097471	18230.04	49.82871537	51.4807513
6471.942	192.3367984	46.76739253	18230.23	49.84717263	51.47008165
6506.594	219.6029205	46.55485224	18231.46	11.33705886	51.38596952
6506.644	160.3704223	46.55485748	18231.51	10.47321242	50.92966236
6506.742	113.9393067	45.95238697	18232.34	10.46979422	50.93243197
6506.791	59.91122496	45.82475581	18303.76	10.52312173	51.37829116
6507.823	47.57726315	45.49325368	18305.38	12.72653863	51.93269782
6508.609	60.23789737	44.46992275	18305.43	10.52513966	51.38800459
6508.708	62.74800879	44.57280173	18624.48	12.78386991	53.16129773
6508.757	62.74800879	44.09838934	18626.59	12.79657585	53.16833717
6509.003	62.75796213	43.78608858	18627.04	12.79998275	53.17103464
6595.363	63.54726881	44.18551152	18627.08	12.79995686	53.17001709
6600.278	64.385973	44.68180371	19976.36	141.0617484	64.31448703
6634.93	59.44110577	44.85002075	20044.78	298.5601739	65.142681
6673.416	56.31161608	44.65435026	20046.2	106.0520771	65.15527563
6823.772	114.0703125	45.29037159	20108.43	13.36518674	65.27265682
6823.821	114.0703125	45.45801987	20108.48	10.52679892	64.9966625
6823.871	95.45392542	44.96248919	20109.75	8.882818595	65.00873222
6823.969	79.85435522	45.34950827	20110	8.883641341	65.00973482
6824.018	65.23173735	44.86457889	20110.64	9.686902803	64.50578481
6824.214	65.26469173	44.55721697	20110.69	8.016747148	63.80826623
6968.918	34.77027683	45.27254914	20110.74	8.016418895	63.66416508
6968.967	43.92034968	45.27254914	20110.98	8.01359094	63.85421432
7034.29	51.7294806	45.60244647	20111.03	8.013259564	62.67388818
7038.763	65.4415535	46.11594909	20232.73	7.859697916	63.86444018
7038.812	54.46825851	45.62430784	21588.54	21.63695887	81.94953188
7038.861	54.46825851	45.62380146	21611.84	22.11977409	82.32762457
7039.402	65.4415535	45.61550658	22247.67	43.54266772	93.49724853
7071.695	71.82615326	46.27404944	22247.72	52.25120126	92.19838076
7115.145	85.09065933	46.10448564	22479.52	87.98960956	73.6473652
7115.194	85.01810947	46.10294814	22479.57	87.98960956	73.6473652
7401.308	382.1298604	47.51922383	22479.72	87.85596276	68.85009841
7401.357	308.4449775	46.29461876	22480.8	68.38434741	68.72293073
7401.406	222.2864737	46.29279799	22480.95	56.35462601	68.16918563
7401.505	142.7294181	45.68905782	22648.95	84.63679756	69.52295894
7401.996	90.06231564	46.19126013	22649.09	84.67340223	63.94350974

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7402.045	88.03085367	46.18556867	22649.24	84.6930384	64.64058577
7402.144	61.7928336	45.36573961	22701.98	110.2649976	65.18616865
7402.193	64.20484091	45.35135681	22702.03	87.29312307	64.4826986
7403.422	50.17769824	44.75437488	22704.34	111.6996047	64.35906362
7403.717	64.16025044	44.81987163	22704.39	85.70747734	64.53400433
7465.5	81.97207459	45.13230286	22704.88	68.34685343	64.01693989
7468.057	82.7416517	45.1451081	22816.36	143.7917484	64.5899754
7493.959	114.0877446	41.89964768	22817.93	143.5254996	65.30904665
7534.559	123.5980709	42.07814945	22873.33	173.4253346	65.89432561
7612.858	251.8696534	42.42800067	22873.38	164.0246732	65.18268483
7617.773	141.4736842	42.44863021	22873.47	157.8364154	65.02329559
7645.446	144.7066354	42.57372921	22874.21	145.6341985	65.21716125
7685.652	140.8044605	42.7569017	22874.26	163.9712543	30.83421912
7687.274	141.0607006	42.76118092	22874.36	153.9124365	45.02526625
7687.373	71.01810607	42.29150442	22925.97	145.2745135	44.91123185
7687.52	61.6557375	42.46373032	22982.74	135.6752341	44.78293305
7688.012	62.33205983	42.46528475	22982.79	156.2356121	45.0096595
7688.159	48.16551013	41.99885226	22982.84	175.0253693	45.12443741
7688.208	48.03856867	41.9935792	22982.93	66.02314025	45.17446722
7688.257	62.15668282	42.46017904	22983.03	84.36251037	45.31551343
7752.008	80.4202065	42.74992575	22983.08	83.98023174	45.31635225
7776.682	90.65003098	42.25532384	23035.63	65.81385677	45.33153415
7820.525	86.73421341	42.54547652	23035.72	50.99859283	45.57531501
7821.902	87.2862261	42.55104876	23035.77	138.5809672	45.61660152
7899.07	137.3397528	42.90306968	23035.87	138.5809672	45.72891269
7931.363	105.6700091	43.52404608	23036.95	139.988648	45.73012456
7967.293	145.0325154	43.40823913	23037	144.3283174	45.87209477
7967.441	12.34860752	43.40824382	23037.39	142.6243691	46.01927631
7968.228	12.33385582	43.31369021	23037.89	142.5697619	46.02221088
7968.326	12.33347902	42.81282353	23037.98	142.7283454	46.29978063
7968.473	12.33423264	42.90736877	23038.03	144.870011	46.41119767
7968.719	12.33574785	41.40054089	23038.13	143.8985247	46.31818969
8030.355	10.08118149	41.37843427	23055.34	143.7373317	46.27526933
8030.405	11.84122511	41.37506959	23091.46	143.8451167	46.33745016
8031.584	11.83904005	41.37991131	23092.3	143.8462063	46.43557617
8103.592	11.75977529	42.14247089	23092.4	141.5264001	46.47361119
8103.69	9.137932187	41.68368239	23092.54	138.8819658	46.57428646
9569.403	77.73721063	48.83644903	23146.22	140.1911961	46.67794268
9572.106	78.63439049	48.06731337	23146.32	27.57184611	46.67831241
9572.253	60.78984829	48.06787953	23146.41	34.18904152	46.67856312
9572.302	16.3091668	48.06759645	23146.51	28.66880615	47.05941173
9572.351	16.30015684	48.06759645	23146.56	34.18194284	47.06596082
9600.171	15.61181745	48.10282817	23146.66	34.1820381	47.0737596
9634.185	13.1602538	48.0318452	23148.13	34.25004957	47.1072874
9635.66	12.81739915	48.04007257	23148.38	34.259521	47.45582209
9718.48	16.27095071	49.05425501	23605	94.44699849	46.30364909
9748.955	16.74721444	49.23393756	23863.69	53.75908689	45.90535451
9793.339	15.08924485	48.78302372	23863.74	53.75163103	45.90761017

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9793.487	18.26772476	48.77458881	23863.79	46.40484801	46.0354415
9793.536	18.26052144	49.30529638	23863.89	40.82928245	46.31983999
10639.69	94.48182077	54.35636298	23864.13	43.35555761	46.37657943
10640.33	121.2003197	54.36070304	23864.18	55.03806728	46.60915512
10715.23	240.4343805	54.76506552	23864.28	54.97561074	46.61061612
10716.46	133.2852906	54.9363256	23864.33	55.25071352	46.6157192
10746.89	31.59010748	55.15170426	23864.38	55.44897661	46.87620138
10788.37	35.5182494	55.58380841	23864.72	55.76894501	46.98320474
10788.42	35.5182494	55.58230961	23864.82	112.6444036	46.98749903
10789.7	35.58366998	55.10627883	23866.74	151.0063806	46.98307727
10789.75	28.36764508	54.61236008	23866.83	151.066546	47.21846463
10790.19	31.41709032	55.20689149	23866.88	149.1231779	47.35429528
10790.44	27.2569288	55.20835944	23866.98	149.1806289	47.35913646
10790.49	21.5753982	54.61345659	23867.03	75.4725056	48.1892748
10790.93	20.61563102	54.45042795	23867.13	74.95249431	48.22167336
10853.01	20.62086579	55.05377989	23867.18	74.95311168	48.33018991
11323	44.10595449	58.79756823	23882.91	79.52528064	48.2917358
11323.05	34.51761986	58.79210304	23927.29	83.24798229	48.27289314
11323.1	44.09526809	58.79086032	23927.39	78.75424548	48.32103068
11323.39	44.10574071	58.78292005	23987.26	53.75908689	48.30077229
11347.62	57.03682346	59.62644988	23987.31	53.75163103	48.54243399
11394.66	55.60841913	59.51628994	23988.93	46.40484801	48.54539869
11487.17	76.04135468	59.70039366	23988.98	40.82928245	48.57582423
11487.31	91.9017029	59.68746951	24108.17	43.35555761	48.61278859
11520.2	105.6482645	60.6225956	24109.94	55.03806728	48.60931741
11735.58	261.6839738	59.20112606	24109.99	54.97561074	48.60996086
11735.63	155.0424861	59.18338538	24111.76	55.25071352	48.60610563
11735.68	75.9366363	59.81633711	24126.9	55.44897661	48.70063787
11735.83	63.19138537	59.18085186	24168.53	55.76894501	48.78454619
11736.02	75.81779507	49.49199373	24340.51	112.6444036	48.34468339
11736.07	63.18169768	48.9791734	24340.61	89.1757616	48.60724679
11736.17	62.94427227	48.97134619	24398.17	170.8075048	48.57108159
11736.91	75.68725728	48.61165637	24454.1	176.9080001	48.42784268
11737.01	63.00321035	48.6119351	24454.94	176.3445413	48.42998662
11737.4	51.99153712	48.60680818	24454.99	176.3445413	48.66749854
11811.18	63.87348001	49.03747868	24455.43	176.9887883	48.80252428
11888.74	61.83469176	48.96290774	24455.48	221.1308803	48.80725354
12048.29	129.9585982	50.47546071	24469.39	253.7862023	48.53764066
12048.88	52.2752785	50.47882914	24509.05	381.5519288	48.62202959
12049.12	41.3847094	49.93488863	24509.1	469.1760084	48.62202959
12049.17	28.08756768	50.47882288	24509.2	469.184702	48.62596591
12050.45	31.41598985	49.73591786	24509.35	470.029515	48.89037008
12050.55	22.06297449	42.20678782	24561.45	55.02770115	48.863028
12050.99	21.93109501	42.10589343	24562.63	47.34927263	48.86418137
12117.88	23.48449348	40.0873612	24562.68	58.26804124	49.0979541
12120.88	26.51960769	40.0990349	24562.73	46.37160996	49.09859621
12144.67	24.92573751	39.71627485	24562.83	46.36421343	49.51109352
12194.42	19.81913335	39.56707352	24562.93	72.65825615	49.51966469

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12412.16	34.70560911	40.42225582	24562.97	56.85231532	49.52576424
12412.4	34.6987606	40.41890349	24563.07	57.41517549	49.83588144
12584.44	52.79807832	41.56401385	24563.17	169.7457503	49.94275477
12629.75	63.98273116	40.70491695	24563.22	111.9013673	50.18302888
12696.11	83.37543464	41.4162962	24563.32	106.7134187	50.23124777
12700.43	63.82834557	41.43368064	24576.74	116.6563467	50.19681335
12724.37	68.92552406	41.31407142	24613.6	84.70294879	50.4158063
12777.31	89.93691868	41.62260127	24665.41	125.4266746	50.28219299
12843.07	130.5293835	41.89043318	24666.88	79.6590604	50.28351505
12913.07	251.3795568	42.1896761	24667.03	60.30867726	50.28325224
12913.75	153.8332928	41.83221903	24667.08	60.30896454	50.28338633
12914.1	129.870613	41.71702098	24667.42	28.99650127	50.33836555
12914.15	129.7845208	41.71060154	24679.71	29.6216382	50.30533741
12914.2	102.7460789	41.03847569	24718.79	19.1470486	50.29427545
12914.39	129.7836338	41.47941494	24719.03	19.14829231	50.29705209
12985.57	23.98457165	41.7775762	24719.18	18.7664159	50.38814622
12988.42	29.06435237	41.78650579	24772.41	23.22601394	50.24439912
12988.46	24.04871865	41.34290813	24772.66	23.17508424	50.24414039
12988.56	24.04874911	41.78650579	24875.48	27.82421157	49.92396955
12988.61	22.02777784	41.56969634	24876.96	27.87845513	49.92017723
13016.63	22.06801665	41.44975203	24877.01	25.95502393	49.92044087
13060.33	21.98139928	41.63208569	25240.49	40.7289553	49.20127666
13060.47	21.98389298	41.63250107	25240.68	51.44682269	50.65025727
13060.52	21.95268618	41.72068676	25503.99	179.2084552	50.06759234
13060.72	21.04156647	41.63270247	25504.19	178.3752407	50.07008269
13777.35	121.0817859	44.87345142	25520.31	178.8742371	50.02896234
13777.94	62.29052503	44.14793666	25555.99	167.0869062	50.13551963
13778.14	61.38024357	44.62209933	25557.96	170.0040167	50.25270439
13778.24	54.80895997	44.62233552	25558.01	86.96765054	50.48701108
13850.74	41.30870256	44.97406714	25558.15	111.1905082	50.25322889
13877.18	44.16927825	45.09859342	25608.68	157.3610943	50.11850567
13924.27	32.97711271	45.42763777	25609.62	75.10498514	50.1162806
13924.32	21.29066108	45.42592297	25609.81	58.63553279	50.3510026
13925.6	21.32268515	45.42983629	25609.96	55.02770115	50.11824749
13925.65	17.44585468	45.52584613	25610.65	47.34927263	50.11732657
13927.66	22.34302011	45.53567052	25626.48	58.26804124	50.07563329
14006.6	24.73570042	45.93316524	25664.91	46.37160996	49.88094766
14010.19	24.85522071	45.86402541	25665.01	46.36421343	50.15417545
14038.11	31.45367095	45.82244393	25721.78	72.65825615	49.77036933
14253	40.37587816	46.83289213	25721.83	56.85231532	50.00328878
14253.39	35.07023976	46.83443928	25724.34	57.41517549	49.99859359
14332.18	40.51397161	47.2548894	25851.94	107.0068518	49.43115956
14741.96	120.7769114	49.25717892	25852.72	93.08029262	49.42950211
14742.01	120.7769114	49.25688001	25868.79	102.2281555	49.38777942
14742.06	84.12055494	49.25659283	25911.46	138.5525131	49.04693733
14742.21	65.59590918	49.25689173	25911.66	118.8584018	49.18496648
14742.36	59.47379039	49.25746611	25972.06	292.4610655	49.02942719
14742.41	61.21162384	49.25717306	25972.21	291.4914352	49.02943489

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14742.5	47.78597526	48.7273972	25972.26	225.2509252	49.02942976
14742.95	61.14067828	49.25025807	25972.36	291.7405732	49.02955306
14817.46	81.53870968	47.10871856	25972.41	290.7805636	49.02980737
14820.46	61.73193946	46.26168642	25985.04	171.4312725	49.00986366
14899.2	87.87077609	46.2764392	26031.24	342.8422877	49.14361497
14899.25	87.85085812	46.2764392	26031.34	342.8237206	49.14766084
14967.82	127.5983659	47.22413675	26031.39	341.9225437	49.15057212
14971.4	129.8715012	47.2418948	26031.49	113.8716699	49.16525731
14995.14	131.5957896	47.86252442	26031.59	87.37391304	49.4624105
15039.73	124.3539927	47.70623886	26031.93	86.78536175	49.46292217
15040.56	124.9973343	47.71049382	26031.98	69.46562149	49.46611191
15040.61	53.0432961	47.71049923	26032.03	54.62992773	49.51216974
15040.66	53.0432961	47.70890421	26032.28	51.94888841	49.51178493
15115.27	66.99635573	48.11520332	26086.59	63.72227184	49.37135516
15115.32	52.64615352	47.60384546	26086.64	49.17819187	51.29015615
15115.42	48.45154304	48.10494407	26086.74	49.03746045	51.29001664
15116.65	51.14917751	48.11142019	26086.93	63.49403655	51.28960928
15117.63	32.38876253	48.11628668	26198.26	106.8378544	54.29819743
15139.46	35.88583053	48.73879697	26212.71	87.55782898	54.25395538
15192.44	33.64100965	48.63152839	26250.76	87.99713329	54.63060039
15192.49	30.1120239	48.63152278	26305.36	169.6142555	56.11497386
15398.63	35.23484318	49.20609739	26307.23	172.2991281	56.10889605
15398.68	44.45601386	49.15598446	26321.68	199.2843064	56.06101765
15398.73	44.45590979	49.25853246	26359.78	371.2768154	56.03920397
15400.89	44.66155865	48.92749424	26360.17	372.6546605	56.03871858
15425.72	44.9786839	49.58126357	26361.05	192.1048798	56.03610227
15472.46	45.27906727	49.43202757	26361.1	176.7364894	56.29756049
15679.54	88.41364284	50.66361034	26361.2	176.7416385	59.92361775
15756.85	138.087212	50.40956182	26411.53	344.745127	59.51313263
15756.95	137.8406509	50.39947144	26412.61	178.4433768	59.45497659
15823.16	141.3715273	50.80184222	26412.66	137.9217384	65.59324624
15825.32	173.1048113	50.80425772	26412.86	121.092662	65.59257071
15825.86	143.7917484	50.18662818	26413.01	113.3690648	65.35008883
15825.91	143.5254996	50.35700742	26413.06	65.56716709	65.65519813
15826.11	173.4253346	49.34099637	26413.25	65.5039492	132.8783277
15847.93	164.0246732	49.98357409	26464.03	112.5787197	131.3328636
15891.87	157.8364154	49.49115684	26464.08	97.13410734	131.7055256
15894.33	145.6341985	49.18195029	26464.17	97.10336632	149.9356255
15894.38	163.9712543	48.66516395	26464.32	71.54964794	149.2398082
15894.72	153.9124365	49.17912356	26514.6	12.11255438	148.0647412
15957.49	145.2745135	49.53981554	26515.93	12.12287377	150.2759081
15957.88	135.6752341	49.02576037	26530.48	9.718335807	155.9758109
15957.93	156.2356121	48.94592137	26566.56	8.132576458	155.6286265
15958.23	175.0253693	49.13083557	26618.22	9.931562878	53.25957812
15958.43	66.02314025	48.61882911	26618.61	9.660774298	53.29788882
15958.47	84.36251037	48.61853913	26618.66	6.123091725	53.53325548
15958.62	83.98023174	49.13140441	26618.86	7.82428354	53.57203047
15960.79	65.81385677	48.84612729	26619	7.824613207	53.61092713

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15960.88	50.99859283	48.33017108	26718.68	6.752782196	53.56821436
15960.93	47.41879101	48.83998869	28017.13	15.95585012	50.67592814
15961.28	48.01470185	48.84166373	28017.18	18.577473	50.71275929
15983.74	51.32420938	49.58236879	28403.17	28.21736724	49.93793276
16172.92	105.7963113	50.38621455	28415.21	28.71402944	49.94935415
16173.32	16.85918014	50.38828654	28450.7	31.73450307	50.05740769
16174.15	20.6212375	51.02000853	28502.46	34.7359237	49.98668064
16174.2	15.93368663	50.49696759	28944.78	181.5625837	49.12610505
16175.33	15.94853506	51.02628576	28944.88	125.5643343	49.33919174
16237.31	17.21239232	51.51087769	28944.92	116.8030909	49.37464265
16240.17	21.33884669	51.44558521	28945.07	35.08487244	49.40989116
16261.3	21.91422833	51.76872109	28959.38	44.55184509	49.41679118
16307.36	19.99691125	51.41829425	28996.83	44.62026324	49.51929309
16307.5	23.40213172	51.41013191	29048.14	44.53384266	49.45213327
16307.55	23.39915298	51.93411625	29049.03	44.56161015	49.48576447
17018.14	270.4667925	56.75849585	29049.13	44.80739572	49.69795516
17018.34	220.0541561	56.29876673	29049.18	44.80971186	49.73325421
17018.44	278.1667179	56.20918132	29049.37	44.77741198	49.76825384
17018.78	279.3656771	56.15424101	29064.61	44.75052684	49.77304497
17018.83	94.07540608	56.15280438	29100.74	44.91974208	49.87724266
17018.88	97.99472923	55.69650915			

mm in Can	Distance (m)	mm in Can	Distance (m)
36	4	227	200
40	8	197	204
36	12	193	208
38	16	195	212
50	20	228	216
53	24	160	220
54	28	238	224
59	32	218	228
66	36	123	232
80	40	108	236
86	44	131	240
90	48	171	244
94	52	181	248
107	56	312	252
122	60	315	256
117	64	175	260
110	68	114	264
110	72	158	268
124	76	92	272
124	80	102	276

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122	84	184	280
120	88	154	284
114	92	214	288
190	96	168	292
125	100	182	296
121	104	208	300
109	108	170	304
108	112	212	308
118	116	166	312
118	120	127	316
139	124	168	320
213	128	104	324
114	132	102	328
168	136	92	332
287	140	96	336
244	144	102	340
173	148	111	344
152	152		
194	156		
161	160		
182	164		
108	168		
106	172		
192	176		
268	180		
223	184		
170	188		
188	192		
153	196		

Distance (m)	Pressure (Kpa)	Distance (m)	Pressure (Kpa)
4	570	200	560
8	570	204	554
12	566	208	555
16	564	212	553
20	567	216	551
24	563	220	548
28	564	224	547
32	564	228	553
36	567	232	551
40	576	236	534
44	575	240	541
48	570	244	552
52	578	248	555
56	569	252	550
60	575	256	555
64	568	260	548
68	570	264	553
72	563	268	550

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76	562	272	547
80	561	276	543
84	567	280	537
88	564	284	527
92	564	288	526
96	569	292	521
100	568	296	526
104	567	300	524
108	564	304	523
112	554	308	524
116	557	312	525
120	561	316	537
124	563	320	536
128	571	324	535
132	570	328	532
136	567	332	534
140	562	336	533
144	561	340	536
148	559	344	536
152	560		
156	567		
160	562		
164	564		
168	567		
172	565		
176	554		
180	562		
184	565		
188	558		
192	560		
196	557		

Appendix F

Test 5

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)
1833.992	37.33439022	12702.63	32.78069151	23920.74	32.87452689
1854.833	37.62249133	12728.48	33.08386363	23944.97	32.28765424
1881.424	38.06719778	12748.83	32.92171482	23972.64	33.44831085
1898.627	36.94893885	12771.1	32.33303913	24001.79	34.92106924
1917.01	35.51430392	12792.23	32.84777889	24022.04	34.8455624
1932.886	35.35830626	12824.92	34.07825319	24040.77	32.82093824
1959.231	36.4799823	12843.5	33.69328246	24062.59	33.39974336
1978.892	36.30724052	12869.01	32.69414317	24094.74	34.74778347
2000.175	34.62068543	12895.65	33.24091344	24112.53	33.86343017
2018.411	34.52431336	12926.03	35.51414453	24135.09	33.1656775
2045.936	35.51430392	12944.02	35.49869002	24161.44	34.26700618
2065.154	34.72521493	12967.66	35.87839216	24190.04	35.49072903
2089.288	33.26173312	12989.19	36.4799823	24209.21	35.02742327
2112.782	34.34002387	13015.83	36.521402	24228.38	33.37185273
2139.816	35.7033922	13033.13	34.09998836	24249.12	33.76416121
2156.675	35.24224366	13057.11	33.82073234	24281.86	35.09609201
2176.139	33.47604623	13078.35	33.35117615	24299.5	33.89200372
2196.832	33.69328246	13111.03	35.95877338	24322.46	33.09742509
2228.732	34.6879192	13133.69	39.00832639	24346.2	33.97057498
2247.606	33.87749335	13148.83	34.73283616	24373.67	35.18817455
2268.742	32.92157785	13166.92	35.01223446	24392.35	34.6728714
2293.023	33.29602356	13188.2	34.05683887	24413	33.46924964
2327.183	35.61645069	13206.09	32.92144087	24435.11	34.13617715
2343.207	34.86060692	13232.49	33.46217279	24465.49	35.30403823
2361.442	32.8946165	13265.17	35.77473958	24483.48	34.42068861
2381.201	33.01608495	13291.08	37.04234253	24507.32	33.6298456
2412.511	34.12175128	13315.6	37.84344765	24532.97	34.74000316
2431.68	33.49687798	13331.09	35.15737466	24561.53	36.18487541
2456.846	33.07708707	13336.54	33.30975955	24579.13	35.56906092
2481.177	33.9562887	13376.65	35.93444171	24598.54	33.91321119
2509.095	35.24993652	13392.92	34.61326474	24620.56	34.6281093
2530.673	35.18833104	13420.54	34.47242311	24649.42	35.56138798
2549.35	33.37889142	13446.45	35.97463117	24666.91	34.42083834
2570.191	33.6720625	13468.96	36.83901785	24689.62	33.69342593
2601.992	35.07322435	13486.36	36.38938965	24713.36	34.51693392
2620.866	34.04233351	13504.69	33.57391072	24742.61	35.87839216
2644.41	33.38579222	13524.7	33.10434848	24760.75	35.38186371
2667.905	34.11454291	13556.15	34.74030821	24780.21	33.63699355
2696.069	35.24993652	13574.09	34.28140664	24801.59	34.0713566

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2714.206	34.56125792	13596.85	34.2160339	24831.87	34.88335185
2733.572	32.54220559	13621.53	34.75526196	24849.07	32.84096239
2755.543	32.90802322	13650.08	34.9741654	24871.93	23.97404085
2786.41	33.84185068	13666.4	34.6879192	24896.8	24.11417113
2805.187	33.17944525	13683.75	32.77403856	24924.47	24.7671274
2827.6	32.67429761	13703.81	33.44816946	24942.61	24.7671274
2853.306	33.72142577	13740.38	35.37379689	24963.15	24.11424462
2881.421	34.59843291	13763.72	35.68745067	24984.39	24.35861916
2899.853	34.35463493	13783.92	34.61326474	25015.45	24.98231966
2920.546	32.88108407	13804.91	34.36224357	25033.83	24.48077964
2943.156	33.46217279	13828.11	35.08099912	25058.71	24.20119954
2976.727	34.98947592	13849.2	34.05669229	25090.02	25.23294748
2995.995	33.99932971	13876.33	34.14339466	25201.98	35.36636602
3020.227	33.48312895	13894.52	34.4133534	25224.94	35.75081778
3043.672	34.05669229	13925.19	34.56125792	25243.96	33.89882788
3069.772	34.8003536	13940.38	32.78748301	25262.1	33.94885876
3087.958	34.19415059	13964.07	31.65284595	25291.29	35.01982722
3110.125	32.9753585	13985.45	32.52909522	25309.23	34.09998836
3130.18	33.3030303	14012.53	34.12896269	25332.19	33.19990937
3161.195	34.5390817	14035.19	34.43551826	25357.06	33.84185068
3179.626	33.76387307	14053.67	33.00933613	25385.66	34.93633329
3202.875	33.13831503	14081.54	34.25246955	25403.61	34.25246955
3228.729	34.12896269	14108.08	35.17300238	25425.72	32.60805064
3256.549	35.20351644	14124.45	34.34747694	25446.27	32.95530743
3276.014	34.94389317	14154.14	34.15783885	25477.38	34.369557
3297.149	33.74976008	14181.71	35.79853147	25495.18	33.68625398
3319.366	34.3988419	14214.05	37.24792408	25517.24	33.06340412
3350.086	35.59290013	14228.7	36.43043604	25541.28	33.52497807
3367.78	34.49451378	14244.38	34.23779709	25570.53	34.92122335
3390.292	33.6440015	14264.98	34.26700618	25590.88	34.48729739
3413.983	34.12896269	14293.38	35.50633593	25612.16	32.99584675
3441.656	35.29632174	14312.55	35.08862174	25634.62	33.60171219
3460.579	35.06560842	14333.05	33.2615933	25668.39	35.31175809
3481.322	33.30989977	14354.83	31.8974483	25686.38	34.61326474
3502.457	33.72156948	14385.79	34.28170369	25707.61	33.78520894
3531.604	34.56865632	14402.75	34.5390817	25730.07	34.30355053
3549.397	33.2273737	14426.49	33.75695911	25756.57	35.08115465
3572.4	32.57516189	14445.9	34.41365273	25777.31	34.7099825
3597.173	33.3030303	14475.49	32.9148676	25797.12	32.92829083
3625.484	34.40602131	14495.89	33.30289014	25820.32	33.65115547
3645.833	34.28883429	14516.24	32.54220559	25851.97	35.45177174
3665.838	32.39817226	14538.06	32.96189687	25870.11	34.69552406
3686.236	32.47649263	14570.95	34.65798845	25892.47	33.99217297
3718.873	33.7568151	14602.9	36.47174325	25914.98	34.29626515
3737.108	32.77403856	14616.61	33.65101236	25941.82	35.18817455
3760.505	32.32656663	14631.85	33.20673636	25960.74	34.94389317
3787.538	33.50382765	14660.89	34.28883429	25982.12	33.524694
3815.309	34.63553635	14675.84	32.99570916	26005.28	34.10748461

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3834.773	34.45021072	14715.9	34.64311827	26037.42	35.48308984
3855.467	32.82761024	14733.49	34.57620897	26055.46	34.43551826
3876.602	33.01608495	14759.4	35.46734439	26075.17	33.29588346
3910.074	34.52416273	14778.12	34.74778347	26098.17	34.17967569
3929.883	33.70749183	14799.26	33.19308519	26125.25	34.97401082
3953.279	33.2822989	14819.85	33.39269588	26145.7	34.96643791
3978.543	34.53154525	14851.75	34.39869236	26166.69	33.47590461
4005.282	35.73515664	14870.13	33.3580655	26187.19	33.93459074
4023.714	35.60074686	14891.66	32.62135922	26218.15	35.05054174
4043.768	33.70031389	14915.65	34.30340181	26237.27	34.17967569
4064.461	34.14354199	14944.3	35.1189895	26260.42	33.51759369
4096.508	35.51430392	14962.34	32.54876474	26285.24	34.55371179
4116.267	34.92106924	14982.5	30.50141853	26312.82	35.94243977
4139.27	34.3840438	15005.84	31.06043061	26329.68	35.52195656
4164.632	35.56906092	15037.64	32.44373557	26351.5	34.17244283
4191.027	36.64605766	15056.81	32.19084737	26372	34.54647061
4207.69	35.87042259	15081.78	31.49197657	26403.06	35.67972657
4226.711	33.58773442	15107.34	32.8543254	26420.36	34.47993377
4245.979	33.56678955	15134.23	33.56678955	26443.91	33.80642736
4278.567	34.31813056	15146.32	32.27474813	26468.78	34.89088881
4296.212	33.22723417	15169.62	31.03655212	26496.5	36.28276789
4319.314	32.70752213	15205.45	33.38579222	26514.24	36.08783892
4342.858	33.61584441	15241.92	35.30403823	26532.97	34.24520585
4369.4	34.3401729	15260.6	34.11454291	26552.44	34.57605789
4387.095	34.02081802	15281.54	32.77417431	26583.06	35.6639669
4406.952	32.06262764	15302.62	32.93514364	26601.05	34.54662144
4428.284	32.45691034	15333.05	34.80785473	26624.84	33.84185068
4462.297	34.24505765	15348.19	34.14354199	26649.85	34.97431999
4481.712	33.65101236	15369.96	30.38616325	26677.97	36.30724052
4509.139	33.81365058	15391.49	30.48990066	26695.56	36.11996166
4534.354	34.93633329	15424.57	32.35260446	26714.59	34.37687355
4561.24	36.11171961	15442.46	33.01608495	26733.51	34.47227293
4578.247	35.45971526	15466.05	31.57214335	26764.03	35.58473681
4599.824	34.20139264	15492.55	32.39803961	26781.29	34.20893354
4619.682	34.09998836	15522.97	33.44138418	26804.93	33.27516096
4653.744	35.79059732	15542.88	33.70017036	26830.09	34.2886857
4672.078	34.77771673	15560.38	31.89731972	26858.65	35.73499526
4693.361	33.78520894	15579.94	32.01786863	26876.1	35.42812114
4716.855	34.3767242	15630.37	36.34843564	26895.91	33.80642736
4743.151	35.35830626	15651.01	34.41350306	26914.63	33.84185068
4760.846	34.92862251	15669.15	32.20368644	26944.77	34.97431999
4780.36	33.19308519	15682.13	31.35073456	26963.05	33.97042914
4801.396	33.55967139	15716.68	33.67922842	26986.4	33.05691213
4831.183	34.67302333	15736.78	34.21618186	27012.6	34.19415059
4851.729	34.14354199	15759.59	31.29592862	27042.73	35.81457241
4874.83	33.41356508	15777.68	31.30211877	27060.86	35.69533914
4899.603	34.29626515	15808.45	31.62804827	27080.08	33.77828624
4927.57	35.31175809	15827.08	31.47343802	27099.45	34.06387623

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4947.034	35.3428292	15848.06	30.71083426	27129.97	34.99690402
4966.94	33.71424189	15880.95	32.32009672	27148.45	33.89185855
4987.388	33.8776384	15914.86	34.30340181	27171.01	32.72077675
5018.747	35.18066504	15934.52	33.43431911	27195.98	33.77814205
5037.179	34.40617092	15951.63	31.88472372	27225.77	35.2420867
5059.395	33.34414914	15968.04	31.80283592	27244	34.91367329
5083.48	34.28883429	16012.43	34.70267568	27263.66	33.43446038
5111.644	35.50633593	16030.47	33.51092213	27282.54	33.44831085
5130.322	35.28860862	16058.63	33.51092213	27314.34	34.6281093
5151.654	34.03515865	16078.49	33.74256412	27331.74	33.45524038
5170.921	33.59472185	16105.72	34.71774937	27356.07	32.70752213
5201.642	35.01223446	16125.77	34.45756165	27381.92	33.81365058
5220.958	34.07839996	16145.53	32.56189097	27412.84	35.32705023
5243.666	33.36495769	16171.19	33.42739823	27430.24	34.99705881
5267.161	34.04233351	16199.79	34.26700618	27450.29	33.38593308
5296.702	35.30419574	16216.85	33.09756353	27470.64	33.96328456
5314.249	34.92122335	16240.44	32.48302531	27500.33	35.02726822
5334.5	33.15900634	16266.59	33.33726554	27519.11	34.31813056
5354.553	33.41342398	16294.76	34.23764895	27542.85	33.6440015
5384.143	34.35478409	16312.99	33.61598722	27568.26	34.39869236
5406.458	33.92048012	16333.64	31.52886799	27598	36.01491063
5427.643	33.0704515	16355.41	31.87239442	27615.94	35.38138909
5453.152	34.07839996	16388.54	32.98910619	27636.83	33.46217279
5480.825	34.94389317	16407.9	32.01165119	27656.34	33.79213447
5499.601	34.86060692	16430.71	31.15655848	27687.3	35.09609201
5520.834	32.86101098	16455.93	31.70268516	27703.62	34.10719058
5540.839	33.04987052	16484.04	32.8812207	27726.23	33.29630378
5573.132	34.19415059	16503.95	32.40467347	27749.68	34.04233351
5591.368	33.18626382	16525.87	30.92918901	27778.04	35.08862174
5614.469	32.8812207	16548.38	31.64664288	27798.29	34.62826084
5639.733	33.84908905	16584.61	32.83428496	27817.71	32.69414317
5666.914	35.0579958	16603.68	32.34585968	27839.58	33.14539438
5685.346	34.63553635	16628.4	31.94819038	27873.3	34.96674695
5707.268	33.53179732	16655.09	33.09756353	27890.5	34.23809338
5726.585	33.76401714	16684.68	34.44286293	27912.77	33.60884819
5761.63	35.54557298	16705.52	33.41356508	27935.62	34.31813056
5780.259	34.73283616	16724.69	31.6903693	27963.88	35.43589537
5804.54	34.13617715	16748.13	32.18443166	27982.12	34.99705881
5829.804	35.04278046	16781.71	33.69342593	28003.55	33.30274998
5855.117	35.59274003	16798.42	32.70738694	28026.8	33.93488181
5873.5	35.44383178	16825.6	32.29397937	28059.73	35.59290013
5892.62	33.25474374	16848.31	33.1656775	28078.31	34.92091512
5913.805	33.85633052	16876.08	33.65086925	28099.59	33.70031389
5943.247	34.80785473	16894.16	33.00259006	28121.61	34.36209435
5960.941	33.74256412	16914.42	31.76542848	28148.2	35.32720795
5984.24	33.17944525	16942.33	32.99570916	28166.19	34.74046073
6008.078	33.93473627	16974.38	34.40602131	28187.18	33.08386363
6036.341	34.99705881	16993.99	33.44110152	28208.22	33.4623143

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6055.608	34.52416273	17016.55	32.53551531	28241.15	35.11930124
6077.432	33.17262948	17040.34	33.24105309	28259.97	34.45021072
6096.749	33.07722534	17070.62	34.34032193	28282.04	33.65802615
6130.565	34.8153591	17086.89	33.51106406	28304.9	34.36209435
6147.522	33.81350609	17111.22	32.26185234	28334.39	35.73499526
6170.575	32.96203418	17133.93	32.60805064	28351.89	35.21134908
6195.446	33.92048012	17163.52	33.43417784	28372.19	33.04310788
6222.725	34.74778347	17182.15	32.33964639	28393.96	33.4827039
6241.255	34.36194513	17204.36	31.35707068	28426.36	34.8682877
6262.44	32.72077675	17230.61	31.98628836	28444.69	34.12866829
6284.804	33.15206006	17259.76	32.95517017	28466.46	33.3030303
6315.966	34.20139264	17278.39	32.53578286	28489.66	33.94915007
6335.971	33.51078022	17301.04	31.0783636	28517.14	35.05054174
6357.844	32.66108061	17323.02	30.82845032	28535.18	33.71438554
6381.535	33.33052518	17356.49	32.24883542	28555.82	31.84673898
6410.633	34.66542832	17376.59	31.25945649	28576.61	31.88459524
6428.721	34.35478409	17400.19	30.55937466	28611.66	33.33768691
6450.446	32.60146758	17426.82	31.70891022	28630.29	32.29437477
6471.533	33.03648593	17456.71	32.82733786	28653.29	31.74032684
6504.268	34.38419321	17477.99	32.88791724	28676.54	32.2811999
6523.486	33.74270801	17499.87	31.85956153	28704.06	33.39946141
6547.325	33.05000856	17521.59	32.41104453	28722.74	33.11099767
6572.098	33.96343034	17555.65	34.2160339	28742.89	31.34464933
6600.114	35.18833104	17579.69	34.03501226	28769.88	32.68766033
6618.939	34.85292952	17601.86	33.14539438	28804.29	34.19444612
6638.895	33.17944525	17629.72	34.77756388	28824.78	33.63713654
6659.047	33.44124285	17659.12	36.12804252	28849.01	33.14497786
6693.159	35.19600037	17676.37	35.23439726	28875.31	34.35478409
6711.05	34.04233351	17697.75	33.92775217	28902.59	35.12678457
6734.397	33.09064297	17718.59	34.06387623	28921.66	34.77802244
6757.99	34.14339466	17748.23	35.25763274	28940.98	32.81426895
6786.744	35.49072903	17765.73	33.8776384	28961.72	33.26858556
6805.078	35.05038648	17786.91	32.67443253	28995.34	35.02742327
6824.984	33.30975955	17812.18	33.39974336	29011.95	34.00648946
6845.973	33.72156948	17840.59	34.48714708	29035.69	33.38565136
6877.38	35.14207296	17857.25	33.68639738	29060.02	34.15783885
6895.665	34.1579863	17878.14	32.38517767	29087.74	35.30419574
6917.98	33.34428965	17900.95	33.19990937	29105.63	34.71774937
6943.49	34.46506584	17930.98	34.24490944	29127.85	33.33726554
6973.522	36.12804252	17950.88	33.37903222	29149.18	33.90594537
6989.742	35.17284604	17972.66	32.39167366	29182.12	35.56906092
7009.698	33.40665279	17999.3	33.39974336	29199.56	34.59828163
7030.833	33.65802615	18029.08	34.94373885	29221.24	33.56664715
7062.536	35.06560842	18049.09	34.83053086	29244.64	34.29596786
7080.624	33.94186884	18070.03	33.22723417	29272.7	35.45177174
7102.546	33.07031328	18092.15	33.89171339	29291.68	35.07322435
7127.318	33.693139	18122.47	34.99690402	29311.88	33.38565136
7155.286	34.9741654	18139.28	34.04247996	29333.55	34.12896269

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7173.079	34.3401729	18162.04	33.14539438	29365.21	35.60859704
7192.543	32.61463636	18187.94	34.26700618	29382.56	34.6507035
7214.711	33.07031328	18216.94	35.77490133	29404.58	33.62298642
7246.561	34.20139264	18236.21	35.38945937	29428.27	34.27427913
7265.927	33.79227878	18255.53	33.58773442	29456.97	35.43621276
7288.193	32.58173433	18276.27	33.94885876	29475.36	34.92122335
7313.752	33.33052518	18308.17	35.09609201	29495.9	33.42725702
7341.818	34.65798845	18325.62	33.81379508	29517.28	34.08573989
7362.167	34.71028702	18348.57	32.93486947	29548.89	35.35056603
7381.533	32.84096239	18371.72	33.54572857	29565.4	34.08544623
7403.503	33.37889142	18400.77	35.05023122	29587.42	33.01622271
7435.158	34.78536103	18418.86	34.6952198	29610.92	33.35131672
7453.983	33.9562887	18438.13	32.48956062	29639.92	34.86045333
7477.92	33.44124285	18459.8	32.67429761	29659.14	34.54662144
7500.087	34.01350602	18491.11	33.52497807	29680.27	33.24105309
7531.053	35.61645069	18509.35	32.76101204	29701.95	33.57391072
7551.156	35.50649525	18533.63	32.03082939	29732.62	34.96674695
7570.129	33.78520894	18559.63	32.72077675	29749.43	33.87053279
7590.134	33.96343034	18588.83	33.83490475	29772.73	33.08386363
7622.476	35.20367306	18607.6	33.39974336	29797.55	33.84214015
7640.563	33.92033471	18626.53	31.46730507	29827.09	35.09609201
7662.633	32.84096239	18646.93	31.59067227	29848.17	35.09609201
7687.012	33.72846895	18681.68	32.84082608	29866.9	33.44831085
7714.538	34.7928557	18701.97	31.87200928	29888.18	33.91335653
7732.724	34.42817674	18727.14	31.52258784	29918.31	35.01998221
7753.22	32.76738832	18750.88	32.15199954	29937.63	34.11424876
7774.011	32.96189687	18780.67	33.61584441	29958.91	33.00933613
7804.338	33.74976008	18801.46	33.77078985	29983.05	33.75667109
7823.114	32.95517017	18822.69	32.33964639	30011.9	34.98189631
7847.248	32.29424297	18844.52	32.82733786	30031.36	34.95902273
7873.839	33.34428965	18877.99	34.28883429	30052.55	33.68625398
7903.576	34.65055176	18897.4	33.19308519	30073.63	34.12896269
7921.615	34.14339466	18922.62	32.55546047	30103.47	35.19600037
7941.964	32.70089885	18950.24	33.72142577	30121.51	34.20848987
7962.559	33.15900634	18978.16	34.56110696	30144.27	33.33052518
7994.704	34.65814025	18996.99	34.0713566	30169.58	34.05683887
8014.07	34.10013532	19016.06	32.1072514	30198.63	35.50633593
8038.793	33.13845381	19035.77	32.05639281	30217.45	35.33493795
8063.222	33.91350188	19067.37	32.98910619	30238.1	33.85633052
8092.27	34.85308303	19085.56	31.67793618	30257.71	33.763729
8111.145	34.75526196	19108.76	30.98878376	30287.45	34.85308303
8131.936	33.49687798	19135.79	32.04354112	30305.48	33.66504286
8153.367	33.74990403	19165.68	33.37875062	30328.29	32.76074077
8183.939	34.78536103	19184.89	32.99570916	30352.82	33.49701978
8201.191	34.09998836	19207.11	31.73408944	30381.67	34.48714708
8223.014	33.32364721	19229.23	32.24883542	30401.92	34.46521595
8246.116	34.05669229	19262.51	33.75695911	30421.48	32.7141481
8277.573	35.64019296	19282.61	32.69414317	30441.39	32.75409592

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8296.545	35.08084359	19307.23	32.17788767	30471.81	34.09278919
8319.303	33.81350609	19335.35	33.26830581	30492.07	33.44831085
8338.817	33.81350609	19364.1	34.22328522	30514.48	32.76738832
8368.161	35.02757833	19382.73	33.71438554	30540.53	33.92048012
8387.821	34.47242311	19402.74	31.9926253	30569.82	35.24240062
8411.414	33.53890365	19424.71	32.24883542	30589.04	35.07322435
8433.238	33.86343017	19456.46	33.43431911	30611.11	33.90594537
8460.467	34.77022858	19474.6	32.37192862	30631.51	34.09278919
8478.458	34.00648946	19496.91	31.35073456	30663.36	35.74322768
8499.592	32.22296428	19524.63	32.50277264	30682.97	34.94373885
8522.104	32.9148676	19553.14	33.23421199	30703.91	33.80642736
8553.316	34.2961165	19573.2	32.83428496	30728.63	34.77022858
8572.83	33.58787699	19595.31	31.29592862	30755.96	35.91845628
8594.063	32.72754345	19617.43	31.62792185	30773.8	35.40497731
8617.361	33.39269588	19650.07	32.87452689	30794.35	33.82044323
8647.343	34.85308303	19670.07	32.03718399	30814.65	34.03530505
8666.906	34.66542832	19693.13	31.10230649	30844.49	35.00479984
8688.041	33.19990937	19719.03	31.81549522	30863.61	34.15783885
8711.143	34.02798682	19749.31	33.13859259	30884.74	33.30289014
8745.156	35.84637269	19768.08	32.9013185	30909.42	34.20893354
8762.506	34.70267568	19791.23	32.01165119	30937.97	35.50633593
8784.036	33.67220579	19814.19	32.8812207	30956.21	35.14987828
8808.415	34.44301285	19848.15	34.50188363	30976.26	33.49687798
8835.841	35.18817455	19867.62	33.70734824	30997.3	33.96328456
8854.323	34.71028702	19890.77	33.11792674	31028.31	35.1344271
8874.376	32.97549592	19917.06	33.87053279	31047.14	34.27427913
8895.168	33.45524038	19947.54	35.42082598	31070.54	33.61598722
8926.379	34.59087054	19967.74	35.15768708	31095.26	34.57605789
8943.681	33.58074989	19988.09	33.62284355	31122.34	35.4749768
8965.898	32.48969402	20008.58	33.75695911	31140.72	35.01238938
8990.523	33.23421199	20038.42	34.65024829	31160.83	33.19322443
9019.031	34.65055176	20054.84	33.2273737	31181.32	33.39974336
9038.151	34.54631978	20077.49	32.18456257	31212.49	34.66542832
9060.712	33.35820612	20102.37	32.6477396	31230.28	33.47590461
9082.29	34.04247996	20129.69	33.44831085	31253.53	32.701034
9114.336	35.44383178	20150.68	33.42033907	31278.01	33.51078022
9131.687	34.61326474	20170.93	32.03057007	31305.92	34.59828163
9155.133	34.08559306	20192.8	32.6477396	31324.11	34.16536055
9179.316	34.8003536	20223.43	33.11085911	31345.39	32.72104736
9209.446	36.25816207	20242.99	32.41117728	31366.72	33.23393282
9228.615	35.67956568	20266.78	31.67793618	31399.21	34.54631978
9247.391	33.21356615	20292.98	32.36557293	31418.24	33.6720625
9267.2	33.55284081	20323.35	34.04921835	31440.75	32.79414142
9297.919	34.53893094	20344.73	33.77814205	31466.65	33.97072082
9314.729	33.19977008	20366.26	31.42406684	31495.5	35.28058426
9337.585	32.32656663	20387.45	31.91648986	31514.13	35.01238938
9360.293	32.61463636	20417.97	33.39974336	31534.63	33.37875062
9387.278	33.23421199	20435.17	32.7408143	31555.71	33.80628292

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9406.693	32.84096239	20462.4	31.43655123	31587.22	35.18817455
9427.681	31.35694641	20487.13	31.67146974	31604.82	34.12189842
9450.389	32.04977095	20516.57	33.09742509	31628.26	33.58773442
9485.631	33.82781706	20537.46	33.42753945	31653.23	34.72521493
9503.031	32.92157785	20555.74	32.08850211	31682.04	36.04706783
9527.017	32.42432562	20578.99	32.48315866	31699.58	35.52977203
9553.068	33.60899094	20618.07	34.71028702	31719.79	33.84228489
9582.362	34.77771673	20635.37	33.63685056	31740.13	34.2160339
9602.908	34.76274366	20654.88	32.30716467	31771.69	35.39721664
9625.37	33.31663179	20676.85	32.50944947	31789.78	34.45786176
9647.636	33.82073234	20714.11	34.35478409	31812.09	33.52483604
9680.027	35.53775055	20736.97	34.6281093	31836.72	34.45021072
9697.28	34.82301995	20755.64	33.18626382	31863.85	35.40497731
9719.545	34.03501226	20774.17	33.18598546	31881.1	34.73298861
9743.384	34.70282787	20802.34	33.92033471	31901.55	33.12472005
9771.056	35.79853147	20822.59	33.04310788	31922.29	33.53193942
9788.505	35.02742327	20846.04	32.35260446	31953.6	34.59828163
9809.887	33.50396951	20870.61	33.08386363	31971.39	33.46896651
9830.531	33.8776384	20899.81	34.34747694	31995.23	32.86783581
9862.873	35.52227549	20920.25	34.07091649	32019.41	33.7568151
9881.599	34.80785473	20944.44	33.09064297	32048.12	34.98189631
9902.686	33.91335653	20965.47	33.41342398	32066.4	34.4577117
9924.509	34.49451378	20994.08	34.25958799	32087.34	32.95517017
9952.035	35.45177174	21012.61	33.17249041	32108.92	33.51078022
9971.4	35.12678457	21035.61	32.45025508	32140.43	34.82301995
9992.093	33.48298727	21062.06	33.38593308	32158.27	33.94915007
10014.41	34.23053962	21090.62	34.52431336	32182.3	33.2822989
10046.06	35.7826667	21109.79	34.12189842	32207.81	34.32542523
10064.1	34.97431999	21130.18	32.52241033	32235.98	35.53009111
10085.63	33.87749335	21152.5	33.31677207	32253.82	35.2420867
10108.93	34.56125792	21183.56	34.59117297	32274.32	33.99188092
10136.01	35.31175809	21202.29	33.64414455	32296.04	34.62068543
10153.9	34.7928557	21225.05	32.88805393	32327.45	35.62446819
10175.23	32.94186216	21251.15	33.90623594	32345.05	34.34747694
10196.66	33.42753945	21279.46	35.12694051	32367.66	33.37199347
10228.42	34.58361378	21299.07	34.89842902	32391.35	34.11439584
10245.57	33.47604623	21319.81	33.26145349	32420.05	35.23439726
10267.2	32.72077675	21341.68	33.83490475	32438.34	34.05669229
10290.35	33.17249041	21373.48	35.16534306	32458.69	32.48302531
10319.2	34.62083691	21390	33.80642736	32478.35	32.78748301
10337.88	34.05669229	21412.31	32.9753585	32507.1	33.87053279
10360.09	32.52241033	21437.48	33.94172325	32524.6	32.89475325
10381.33	32.78082731	21465.64	35.20351644	32549.57	32.4438686
10415.44	34.36940772	21484.52	34.60599858	32575.42	33.55269853
10433.38	33.54572857	21504.72	33.28915982	32604.77	35.01238938
10457.22	32.98883112	21525.81	33.65072615	32623.3	34.69506768
10481.94	33.72861271	21557.71	35.07337982	32644.63	33.29616367
10509.03	34.98947592	21575.55	33.92746123	32670.68	34.50955764

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10528.88	34.68046966	21598.5	33.22025929	32702.28	36.21717121
10547.76	33.17930612	21624.06	33.49007292	32719.68	35.28860862
10570.22	34.60569589	21652.28	34.25973632	32740.72	34.39899144
10603.4	34.6879192	21670.61	33.73565889	32765.15	35.31948133
10622.71	33.20673636	21690.42	31.94187103	32793.46	36.45527631
10645.67	32.08173691	21713.17	32.53551531	32811.25	35.94227651
10669.26	32.91473068	21742.42	33.34414914	32830.77	33.74947218
10697.08	34.55386268	21760.95	32.35260446	32851.36	34.12940431
10716.54	34.86813405	21783.31	31.57226933	32882.28	35.42812114
10735.17	32.88108407	21808.78	32.22322672	32899.97	34.70282787
10757.05	33.29588346	21836.69	31.43655123	32920.77	34.04951138
10786.24	34.42817674	21860.34	31.58449355	32943.91	34.99674924
10798.88	33.10448698	21883.24	30.35177961	32970.75	36.1115548
10831.51	34.12896269	21905.16	30.91130696	32989.18	35.7035533
10861	35.93427853	21938.14	32.21653577	33010.52	33.82781706
10892.31	37.3085138	21956.38	31.26550868	33031.41	34.26730298
10909.66	36.46367595	21979.73	30.55937466	33065.22	36.11996166
10926.08	34.02096429	22005.53	31.60328941	33083.21	35.37363875
10943.48	34.64311827	22033.94	32.6477396	33105.63	35.050697
10975.82	33.88489209	22054.34	32.74054336	33127.99	35.79820756
10994.7	33.05000856	22088.4	33.24105309	33153.16	24.21586419
11016.08	32.43083733	22110.86	33.9276067	33170.02	23.97077267
11037.9	33.15192117	22143.94	35.64822115	33189.87	23.1802882
11063.36	35.28860862	22161.15	34.25973632	33210.81	21.55665132
11081.2	33.69342593	22183.76	33.2822989	33244.43	19.28441391
11104.4	32.15226083	22209.46	27.6561091	33262.32	18.77384455
11126.67	32.87439031	22238.66	27.18446602	33284.29	18.69100598
11158.67	34.32527633	22255.91	27.02477476	33306.9	18.9373923
11171.89	33.27530089	22276.31	26.3091747	33331.38	19.15352496
11209.34	35.08846614	22296.02	26.45625063	33349.03	19.03813257
11234.12	36.46333989	22326.44	27.24427505	33479.92	24.95899468
11260.07	37.87913603	22344.09	26.67538676	33500.12	25.05231897
11276.58	37.51724661	22365.91	26.22781286	33531.23	25.65900196
11287.59	33.70734824	22392.11	26.78192471	33577.88	27.63235089
11316.05	34.92862251	22421.5	27.72753235	33654.75	33.42711581
11350.51	36.51314423	22495.58	33.63685056	33683.8	35.10403265
11367.37	35.03517775	22529.74	34.0496579	33707.64	35.75905749
11389.19	34.42083834	22548.71	34.03486587	33724.74	35.2420867
11409.69	35.01223446	22577.07	34.66542832	33744.5	33.72128206
11434.85	35.81441031	22595.11	33.56693194	33764.66	33.91335653
11451.12	35.18833104	22616.88	32.63454408	33796.95	34.95933163
11468.96	33.19308519	22640.72	33.44816946	33815.97	34.3032531
11487.49	33.02972876	22667.61	34.29596786	33839.61	33.61613003
11522.34	34.55386268	22687.56	33.78520894	33864.24	34.58376493
11542.59	34.10013532	22706.88	31.90362145	33891.47	35.76713932
11567.22	33.89185855	22730.82	32.48982743	33909.21	35.42812114
11593.22	35.28845125	22762.13	33.79920722	33928.92	33.79213447
11619.07	36.21750275	22781.2	32.94858342	33949.27	33.99188092

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11635.69	35.49088821	22805.33	32.51599541	33979.16	35.18082145
11655.79	33.78520894	22830.84	33.40651175	33997.98	34.42098807
11675.99	33.88474698	22859.35	34.60569589	34023.29	33.93488181
11707.35	34.96659243	22877.29	34.26700618	34046.64	34.6281093
11727.06	34.36209435	22898.33	32.63467868	34075	35.76665431
11751.34	33.89171339	22921.77	33.15206006	34093.04	35.21150577
11774.64	34.5759068	22954.9	34.86844135	34112.7	33.00919842
11800.69	35.41274139	22974.37	34.20139264	34132.56	33.28257889
11817.45	34.77022858	22996.24	33.32364721	34163.08	34.01365223
11837.55	32.87452689	23021.36	33.90623594	34182.05	33.24105309
11858.64	33.19294595	23048.68	34.49451378	34204.07	32.47009582
11890	34.30369924	23067.71	33.7428519	34227.86	33.05014661
11909.51	33.38579222	23088.01	32.17801852	34256.47	34.2886857
11933.65	32.98223091	23108.21	32.49636547	34275.15	33.84199542
11957.34	33.85618566	23140.79	34.01350602	34296.23	32.81399679
11984.81	35.01223446	23160.46	33.17249041	34317.76	33.31649151
12003.49	34.91367329	23181.84	31.98602976	34352.41	35.12662864
12024.14	33.53179732	23205.72	32.1137667	34370.3	34.35448578
12045.03	34.01350602	23233.69	33.12472005	34395.72	33.97072082
12078.25	35.49853076	23254.73	32.82093824	34420.1	34.91336519
12097.03	34.838045	23278.08	31.66538609	34447.77	36.04723204
12120.67	34.17967569	23302.21	32.48956062	34467.28	35.86229401
12146.52	35.42066743	23333.91	33.65086925	34487.24	34.47963328
12173.56	36.57119616	23351.71	32.58844364	34508.96	34.72536732
12191.06	35.84637269	23373.43	31.52899362	34537.38	35.67972657
12210.82	33.87778344	23398.99	32.36557293	34555.27	34.83835177
12230.13	33.86343017	23429.22	33.72861271	34577.68	34.09308298
12260.11	34.56865632	23452.12	34.00648946	34600.63	34.59087054
12277.66	33.51801962	23472.57	32.61463636	34628.65	34.87551072
12301.16	32.77417431	23495.82	33.46896651	34646.74	34.63583957
12324.16	33.38593308	23527.96	34.96674695	34667.28	34.3988419
12352.18	34.51678335	23545.76	33.65101236	34687.93	35.08815495
12369.92	33.95614299	23569.06	32.94186216	34716.73	36.30774031
12389.92	32.33951422	23594.52	33.8776384	34736.83	35.91063187
12411.8	32.7141481	23624.4	35.27303526	34759.15	35.45987416
12444.38	33.98472732	23643.47	34.90612648	34782.39	36.29075532
12463.8	33.13151614	23663.82	33.12472005	34809.77	37.45633219
12489.02	33.04324586	23684.81	33.5387615	34829.39	33.55015915
12513.74	33.65788298	23715.19	34.43566812	34855.54	33.53891798
12542.59	34.6281093	23732.24	32.9148676	34875.2	33.52883285
12561.17	34.24490944	23754.26	31.9670343	34897.31	33.54051847
12581.42	32.49623202	23780.9	32.81399679	34913.44	33.5381183
12602.95	32.8946165	23809.26	34.17967569	34934.67	33.53148053
12634.6	33.7568151	23828.09	33.74242024	34957.18	33.51840568
12653.67	32.70089885	23848.73	32.16506914	34982.3	33.50414443
12677.22	31.80296374	23870.16	32.6477396	35000.43	33.50638761
		23902.7	34.0496579	35021.03	33.51067603

Appendix G

Test 6

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)	Time (s)	Velocity (m/hr)
16960.34	86.26067998	18214.31	68.82790414	19469.35	227.3836664
16964.71	44.85460008	18214.6	47.33498439	19469.4	189.4863886
16968.06	45.26702829	18214.9	46.89400135	19572.38	187.6521
16984.38	58.40998007	18266.11	100.9526078	19572.42	240.7835
17031.96	54.62899628	18267.73	102.2792489	19572.52	225.3467
17033.28	54.52879997	18270.58	104.8080744	19573.26	210.7623
17033.33	46.33781647	18281.79	114.499045	19573.31	210.9045
17033.72	38.14086883	18325.39	164.2704902	19573.46	314.4242232
17092.51	57.96801741	18325.83	104.6740511	19573.51	304.6137855
17096.05	59.03123701	18327.5	104.7165317	19573.65	224.0147969
17112.96	47.82138725	18329.27	106.0972012	19573.75	202.2423664
17158.77	58.96901948	18381.77	198.9140271	19573.8	115.8162817
17160.34	54.98463814	18383.63	109.5652174	19573.95	115.3749696
17160.49	39.3529697	18383.68	70.88734602	19574	76.00933691
17220.26	52.15540017	18383.78	69.48000632	19574.14	106.5123166
17221.93	52.56713889	18383.83	63.28063146	19574.29	106.5635461
17238.25	57.71869358	18385.45	48.3587672	19579.16	111.6298192
17282.68	53.90190736	18397.64	51.49919622	19623.79	19.5484475
17283.61	44.49592874	18439.22	70.23860247	19625.46	19.58968599
17283.71	43.74637188	18440.85	70.88861615	19626.64	19.61859773
17344.61	58.8185447	18441.14	49.48871419	19632.44	9.309076475
17346.63	45.17031345	18441.44	48.93234143	19676.28	9.520920775
17361.81	49.18601399	18491.96	69.93256679	19676.82	9.080777498
17401.77	65.28228102	18495.31	108.0452237	19678.1	7.239158529
17402.31	65.04455332	18497.67	110.3147016	19678.15	5.980174437
17402.56	45.39941363	18508.87	77.45269814	19678.25	5.980174437
17402.76	44.68135566	18549.08	96.39881097	19678.4	6.294675086
17458.84	49.65652272	18551.29	97.65633678	20392.87	6.594373681
17461.45	50.19347145	18551.88	97.24289217	20392.92	6.594197826
17464.59	50.72004239	18552.47	71.46972155	20392.97	6.592762026
17479.14	53.56668983	18601.03	87.4330465	21587.46	5.353233929
17521.8	62.41362991	18603.15	88.23126028	21587.8	7.301189122
17522.69	51.04176074	18605.11	107.1769459	21681	8.25995022
17522.98	50.70964104	18605.16	88.69733358	22192.13	5.185369947
17523.97	50.89162826	18605.26	88.67745325	22192.18	5.185372071
17576.85	65.47693258	18713.2	141.0878378	22192.28	6.48158501
17579.85	51.10659479	18713.25	23.01017636	22192.52	6.156885437
17697.87	68.0706101	18713.35	21.46027849	22192.77	1.540275229

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17697.91	22.73172553	18714.62	21.46484375	22192.87	1.945620583
17698.6	21.98372502	18818.19	19.86340686	22193.31	1.945620583
17700.72	19.81127115	18818.24	19.67888265	23213.41	1.974908897
17711.97	20.33166661	18818.38	18.2925025	23213.46	2.057196339
17755.23	22.81871453	18819.22	12.20423681	23213.75	1.974948946
17757.04	22.91293848	18819.27	18.30641169	24633.71	2.29053358
17757.19	19.91658633	18819.42	18.30917912	24633.75	2.67977942
17758.13	19.86752972	18819.76	18.31610135	24633.9	2.310167082
17812.1	22.79945024	19366.63	116.3202305	24634.39	26.49955115
17814.11	22.18353392	19413.91	287.994759	31953.57	13.61616234
18046.01	47.14096775	19415.04	292.168519	31953.62	13.93277174
18058.54	50.7999281	19415.73	295.1160839	31954.06	13.98513604
18100.13	69.12191202	19421.38	411.9361959	32829.41	13.26356994
18101.16	69.57041622	19467.24	188.1580825	32829.46	13.56270462
18101.99	48.21438364	19467.58	226.4250286	32829.55	13.6124843
18102.39	47.85543218	19467.63	188.5957804	32924.66	13.58095128
18154.49	68.15797407	19467.68	187.3685806	33196.82	13.64571883
18156.4	63.10702066	19467.78	224.9466971	33196.92	13.69436836
18159.16	47.60094326	19468.66	226.526581		
18170.81	51.04176074	19468.86	189.0409388		
18213.86	69.6316373	19469.21	227.2726402		

Analysing the Effect of Speed Variation
on Irrigation Efficiency in Travelling Irrigators

Distance (m)	mm in Can	Distance (m)	mm in Can	Distance (m)	mm in Can
4	0	200	208	396	230
8	5	204	201	400	234
12	17	208	190	404	188
16	30	212	212		
20	82	216	227		
24	132	220	165		
28	165	224	184		
32	177	228	218		
36	135	232	214		
40	138	236	188		
44	128	240	205		
48	140	244	210		
52	200	248	183		
56	178	252	171		
60	196	256	163		
64	275	260	174		
68	242	264	159		
72	258	268	138		
76	217	272	198		
80	255	276	162		
84	280	280	132		
88	188	284	158		
92	156	288	188		
96	245	292	154		
100	214	296	179		
104	218	300	213		
108	182	304	184		
112	204	308	260		
116	182	312	176		
120	180	316	203		
124	225	320	188		

Analysing the Effect of Speed Variation
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128	225	324	148
132	164	328	148
136	196	332	190
140	206	336	138
144	208	340	150
148	168	344	140
152	215	348	164
156	171	352	186
160	180	356	166
164	197	360	188
168	168	364	208
172	215	368	183
176	152	372	354
180	162	376	244
184	215	380	250
188	198	384	300
192	108	388	237
196	140	392	283

Distance (m)	Pressure (Kpa)	Distance (m)	Pressure (Kpa)	Distance (m)	Pressure (Kpa)
4	558	204	554	404	542
8	558	208	554		
12	562	212	553		
16	564	216	551		
20	566	220	552		
24	563	224	552		
28	560	228	553		
32	562	232	551		
36	565	236	554		
40	558	240	553		
44	564	244	552		
48	563	248	551		
52	564	252	550		
56	569	256	550		
60	567	260	548		
64	568	264	549		
68	564	268	547		
72	563	272	547		
76	562	276	542		
80	559	280	551		
84	563	284	550		
88	564	288	556		
92	564	292	550		
96	564	296	545		
100	561	300	545		
104	567	304	542		
108	559	308	540		

Analysing the Effect of Speed Variation
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112	554	312	545
116	554	316	545
120	555	320	545
124	563	324	546
128	561	328	547
132	564	332	548
136	565	336	546
140	562	340	541
144	561	344	542
148	559	348	548
152	557	352	549
156	564	356	541
160	562	360	547
164	564	364	549
168	567	368	542
172	563	372	540
176	561	376	541
180	562	380	546
184	560	384	541
188	558	388	541
192	558	392	542
196	557	396	547
200	559	400	541