Ergonomic Planter

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Summary

Having watched “Living on one Dollar” a documentary about the struggles encountered by people in developing countries as they struggle to eat, live and survive on 1$ a day, we were inspired to see if we could come up with something to lessen their load. In truth we were embarrassed that we living in in houses, with a roof over our heads, food in our bellies and schools to go to, have so much when so many others have so little, we endeavoured to make this project about enabling others to help themselves.

Having watched the documentary, we realised that we were not in a position to rebuild houses or cure diseases, we could do something to improve the growing of crops. Initially we researched the types of crops as well as the methods and implements employed by farmers in developing countries and set about designing a tool that would allow farmers improve their yields, reduce crop failure and reduce the strains associated with subsistence farming.

And so our quest begun, we decided to utilise our engineering knowledge to manufacture a device we referred to as the “Ergonomic Planter”, we have been fortunate in the people we met along the way who have assisted and encouraged us to stick to our aims and we are delighted with the way the device has turned out. We have completed the patenting procedure and added some additional features to our device, we look forward to demonstrating its effectiveness.

Table of Contents

Summary 2
Table of Contents 3
List of Figures 4
List of Tables 5
Acknowledgments 6
Introduction 7
Research 9
  Agriculture in Developing Countries 9
  Women in Agriculture 13
  Ergonomics 15
  Ergonomics in Agriculture 17
  Crops 17
Our Solution 19
  Finished Product 20
  Drawings 21
  Laser Unit 30
Testing of Soil 34
  Bulk Density – Measurement 34
  Background 34
  Measuring bulk density 35
  Calculations 36
    Soil volume 36
    Dry soil weight 36
    Bulk density 37
    Critical values for compaction 37
Problems we encountered 38
Accessories 39
Experiment 1 40
Experiment 2 42
Experiment 3 43
Experiment 4 44
Experiment 5 46
Conclusion 47
Bibliography 48
  Web References 48
  Book References 49
Appendices 50
Patent 51
    Abstract 51
    Summary 51
    Patent Drawing 52
Patent Application Receipt 54

List of Figures

Figure 1 World rural and urban population (1960-2050) 10
Figure 2 Agricultural population (1990 and 2010) 10
Figure 3 Agriculture, value added as share of GDP (percent, 2008-2011)........ 12
Figure 4 Female employment in agriculture, share of female employment 15
Figure 5 Ergonomics........ 16
Figure 6 Initial Concept 19
Figure 7 Ergonomic Planter 20
Figure 8 Laser Nozzle 21
Figure 9 Laser End Cap 21
Figure 10 Door 22
Figure 11 Spring 22
Figure 12 Lever 23
Figure 13 Main Shaft 23
Figure 14 Solid works - Depth gauge 24
Figure 15 Solid works - Completed Device 24
Figure 16 Solid works - Side Profile 1 25
Figure 17 Solid works - Side Profile 2 25
Figure 18 Solid works - Top Profile 1 26
Figure 19 Solid works - Top Profile 2 26
Figure 20 Solid works - Full On Profile 1 27
Figure 21 Solid works - Full On Profile 2 27
Figure 22 Solid works - Shaft Profile 28
Figure 23 Solid works - Lever Mechanism 28
Figure 24 Solid works - Laser Unit 29
Figure 25 Solid works - Door Profile 29
Figure 26 Laser Wavelength Comparison 30
Figure 27 Laser Module 31
Figure 28 Flexible Nozzle 32
Figure 29 Open Circuit 32
Figure 30 Closed Circuit 33
Figure 31 Completed Laser Unit 33
Figure 32 Bulk Density of Soil 35
Figure 33 Soil Sampling Ring 36
Figure 34 Original Design of Device 38
Figure 35 Seed/ Fertiliser Tray 39
Figure 36 Manual Counter 39
Figure 37 Mini Digital Counter with Strap 39
Figure 38 Magnet Torch 39
Figure 39 Drying Cabinet 41
Figure 40 Pour soil into container 44
Figure 41 Soil in container 44
Figure 43 Push to correct depth 45
Figure 42 Planter in soil 45

List of Tables

Table 1 Crop Type/ Depth of Planting / Depth Apart........ 18
Table 2 Laser Comparison........ 31
Table 3 Ring Volume........ 40
Table 4 Bulk Density Measurement........ 41
Table 5 Soil Cohesive Strengths........ 42
Table 6 Laser Distance Measurement........ 43
Table 7 Planter/ Hand Comparison Test........ 46

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Ms. Heather McCarthy of the Desmond College science department, who with the local horticultural centre assisted us with the growing of plants as part of one of the experiments. Thanks also to Mr. Jim McNamara of an tAonad Glas who assisted us by allowing us to use their facilities.

Thanks to James and Gordon O'Donovan, for aiding us with the construction of our device.

A special word of thanks to Tara McGrath of GOAL for providing vital information on the current crop tools being used in developing countries as well as Mary McCarthy of WorldWise Global Schools, Dorothy Jacobs of Gorta and Kate Brady of Irish Aid who were kind enough to respond positively to our emails and who assisted us by providing information not accessible through normal channels.

And finally, to you the judges/s many thanks for taking the time to review our project.

Introduction

With limited access to technology and increasing demand for both crops and food, farmers in developing countries face difficulties in planting & harvesting their crops more productively in a time efficient manner. Given that limited resources are available to those in the agrarian society, coupled with dis-improving weather patterns, crop success can mean the difference between life and death. Our project aims to minimise plant wastage, improve production by ensuring consistency of planting, increase land usage by guiding farmers in their planting, all whilst reducing back strain and increasing speed of planting.

We first noticed the plight of small-time farmers whilst studying agriculture in developing countries during our geography class. Through this class, we discovered how time consuming and inefficient hand-planting was for the indigenous farmers of these areas. Upon a frank discussion between us, we decided to embark on the creation of a cheap, efficient device that would boost crop production for these farmers.

We have carried out extensive research into the horticultural conditions in developing regions, such as India, and Central Africa. We have also analysed what plant types habituate these areas, as well as the soil types that are typically located here. In-depth investigation has gone into developing the most suitable type of planting device to create for this project.

We have worked with local engineers James and Gordon O'Donovan in developing the prototype Ergonomic Planter, who have been extremely helpful in both the design consultation and manufacturing of the prototype. Having used this device over the summer holidays to prove that it works, and along with the assistance of Mr. Jim McNamara of an tAonad Glas, the local horticultural society, we have modified and incorporated features into the device to ensure that it is both functional, and fit for purpose. As the planter has the capability of being used by amateur gardeners in developed countries, we have added some technological features, such as the automatic counter to track the amount of seeds planted, and a laser guide to ensure alignment. However, these are not required to operate the device, as the farmers who will be utilising these may not have access to batteries to charge the laser, etc.

We have designed an experiment in which we compared the speed and efficiency of our device with that of planting by hand. We chose hand planting as our control as this is the most common method of planting in India, due to the fact that the average farm size is 1.4 hectares. We repeated this experiment 5 times alternating roles each time.

We intend on testing the durability of the device by using it in a real-life scenario, to see if it can effectively do the task required.

- Does it break the ground easily?
- Does it address the health issues?
- Is the growth of the of the plants affected?
- Will the device also work in an horticultural setting?

Research

Agriculture in Developing Countries

More than 3 billion people – almost half of the world's population – live in rural areas. Roughly 2.5 billion of these rural people derive their livelihoods from agriculture. For many economies, especially those of developing countries, agriculture can be an important engine of economic growth. Approximately three-quarters of the world's agricultural value added is generated in developing countries, and in many of these, the agriculture sector contributes as much as 30 percent to gross domestic product (GDP). According to the World Bank, 1 percent growth in GDP from agriculture increases the expenditures of the three poorest deciles by at least 2.5 times as much as 1 percent growth from the rest of the economy. Agriculture can also provide an important haven against global economic and financial turmoil, often more effectively than other sectors.

In many poor developing countries, primary activities such as agriculture still constitute the backbone of the economy. However, the sector often faces many challenges. A profound and prolonged lack of investment in agriculture is evident in many countries. Notably, infrastructure is missing or weak in rural areas, agricultural productivity is stagnant, and lack of opportunities for income diversification combines with poorly functioning markets to undermine economic growth. There is often a gender divide. Although women make significant contributions to the rural economy, they often have less access to productive resources than men, and families often rely on children's work for survival.

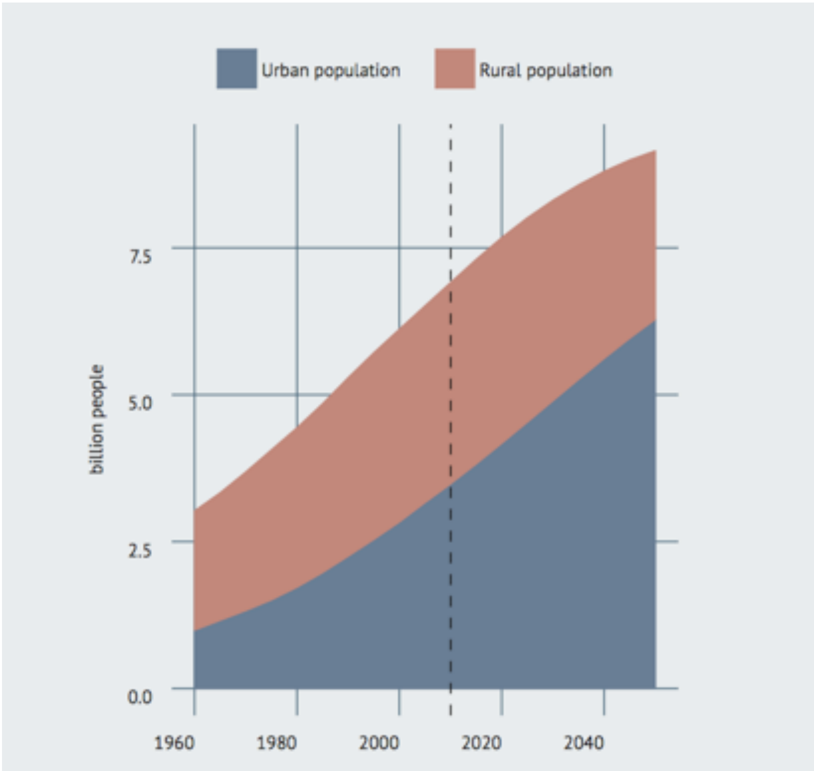

Figure 1 World rural and urban population (1960-2050)

Source: United Nations Population Division. Data after 2011 are projections.

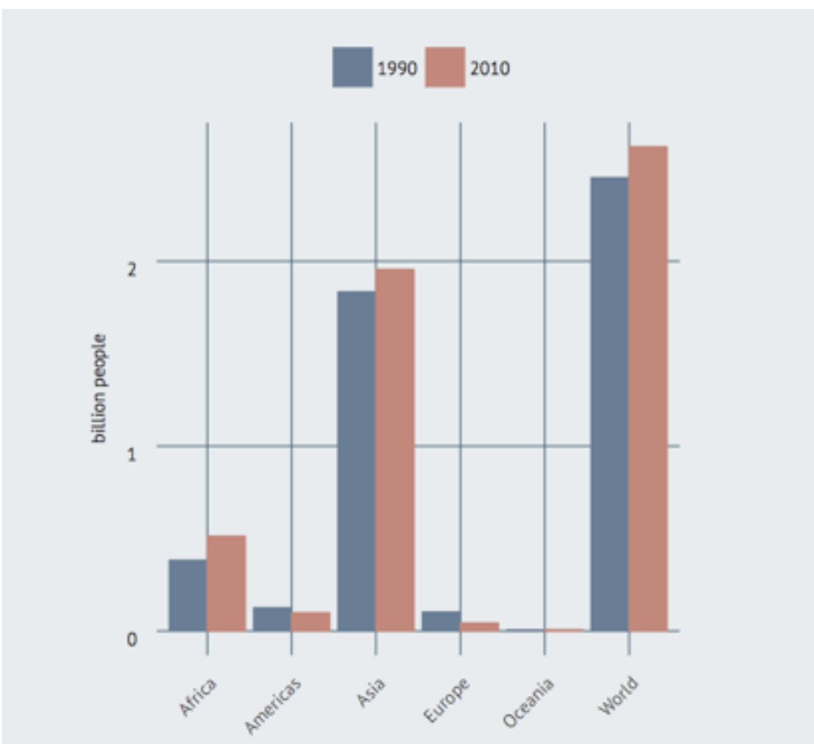

Figure 2 Agricultural population (1990 and 2010)

Source: FAO, Statistics Division (FAOSTAT)

Although demographic growth rates have been slowing since the late 1970s, the world's population has doubled since then – to approximately 7 billion people – and is projected to increase considerably over the coming decades. In many developing countries, a combination of declining mortality rates, prolonged life expectancy and age structures characterized by youth and high fertility suggests that considerable population increases are likely to continue until the end of the twenty-first century.

The agricultural population is defined as all people depending on agriculture, forestry, fishing and hunting for their livelihoods. It comprises all the people economically active in agriculture and their non-working dependents, but the agricultural population does not necessarily live exclusively in rural areas. More than a third of the world's population relies on agriculture for its livelihood, with the largest portion being in Asia.

The trajectory of the world's future population rests heavily on assumptions about fertility rates. If rates in high-fertility countries continue to grow as projected, there will be an additional 2 billion people by 2050, with a much larger pro- portion living in urban settings. This situation emphasizes the importance of empowering women through education, expanded economic opportunities and access to finance and family planning, especially in the poorest countries where population growth rates are currently the fastest.

Worldwide, people can expect to live longer than ever be- fore. In the past decade, average global life expectancy has risen by three years, to 70 years. In all countries, the wealthy generally live longer than the poor, and in most populations women usually outlive men. Many African countries, including several that have suffered from war in recent years, have increased their populations' life expectancy consider- ably. Improved access to clean water, better nutrition, living and working conditions, and greater access to health services can account for increases in life expectancy. These factors have also led to declines in mortality rates, with world averages for under-five mortality dropping significantly.

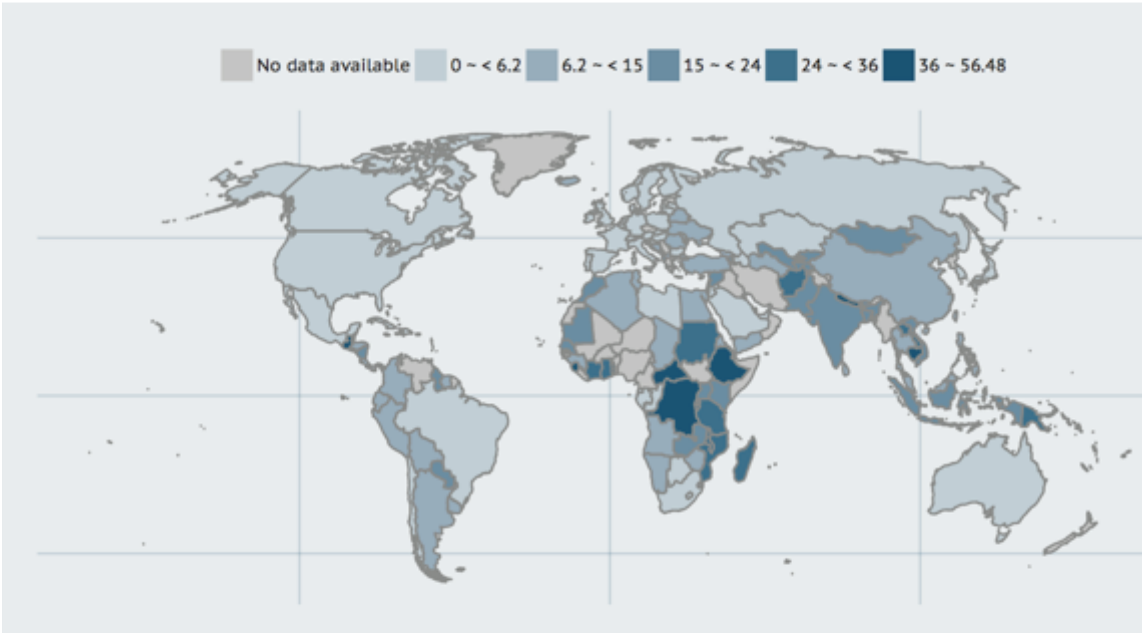

Figure 3 Agriculture, value added as share of GDP (percent, 2008-2011)

Source: World Bank (WDI).

There is little scope for easy expansion of agricultural land. At present, more than 1.5 billion ha (The hectare (ha) is a unit of area equal to 100 acres (10,000 m2)), 12 percent of the world's land area is used for crop production (arable land plus land under permanent crops). Although considerable amounts of land are potentially suitable for agriculture, much of this land is covered by forests, protected for environmental reasons or used for urban settlements.

Potentially accessible agricultural land is very unevenly distributed among regions and countries. Some 90 percent is in Latin America and sub-Saharan Africa, with half concentrated in just seven countries – Brazil, the Democratic Re- public of the Congo, Angola, the Sudan, Argentina, Colombia and the State of Bolivia. At the other extreme, there is virtually no spare land available for agricultural expansion in Southern Asia, the Western Asia and Northern Africa.

So far, land and water management systems have been able to meet the rapidly rising demands placed on them. This situation has been made possible through gains in yields resulting from increased use of inputs, technology and irrigation.

World agricultural production has grown on average between 2 and 4 percent per year over the last 50 years, while the cultivated area (permanent cropland and arable land) has grown by only 1 percent annually. More than 40 percent of the increase in food production has come from irrigated areas, which have doubled in size. Not only is the land that could be brought into production unevenly distributed over a few countries, but also much of it is characterized by significant agronomic and suitability constraints.

In the same period, global cultivated land per person has gradually declined from 0.44 ha to less than 0.25 ha – a clear measure of successful agricultural intensification. However, the distribution of land suitable for cropping is skewed against those countries that have most need to raise production.

Women in Agriculture

As part of our research we contacted various NGOs in relation to our project, we wanted to ensure that our device would meet the needs of potential users. Kate Brady of Irish Aid suggested that our device would have potentially huge benefits to farmers in developing countries, especially those in Malawi and especially women. This in turn caused us to further investigate the role women play in the agrarian communities in which they live. In developing regions, employment growth is driven mostly by demographic changes. The majority of workers do not enter into formal wage employment but instead are engaged in self-employment or unpaid family work, such as in agriculture, especially subsistence farming. As a large share of the working poor are involved in agriculture, developments in this sector have a major impact on welfare throughout much of the world. Nearly eight out of ten working poor with less than US$1.25/day live in rural areas. This means that most jobs in rural areas do not ensure sufficient levels of income for workers to afford adequate food for themselves and their families (ILO, 2012). Labour force participation rates are usually highest in the poorest countries. In these countries, low unemployment in conjunction with high labour participation rates results in large swathes of the population being engaged in vulnerable employment and many people in working poverty. In Southern Asia, the region with the highest vulnerable employment rate in

2011, 51 percent of workers were in the agriculture sector. Women make up approximately 43 percent of the agricultural labour force in developing countries.

Their contribution varies greatly, depending on the type of crops produced and the specific crop activities. However, women often have less access than men to productive activities because of their limited access to resources, education, extension and financial services and labour markets.

The agriculture sector also has the highest incidences of both unpaid child labour and early entry into the workforce, which often occurs between the ages of five and seven years.

Around 60 percent of all child labourers – about 129 million girls and boys – work in agriculture. According to ILO, more than half of these children engage in hazardous work.

Youth account for a disproportionate share (23.5 per cent) of the working poor (ILO, 2012). The majority of these poor youth live in rural areas (ILO, 2012). Rural youth are more

likely to be underemployed and less likely to be in school than urban youth. Rural youth also have higher rates of vulnerable employment and food poverty (OECD et al., 2012; ILO, 2012). Because of limited job prospects, many young people leave rural areas to seek employment opportunities elsewhere. However, agriculture and the rural economy have much potential as an engine of inclusive growth and youth employment.

Decent employment and social protection are essential to achieving food security and reducing rural poverty. However, unemployment, underemployment, poor working conditions and exposure to occupational hazards continue to prevail in many rural areas. Less than 20 percent of agricultural workers have access to basic social protection (ILO, 2012). These challenges negatively affect the labour productivity of agricultural workers. Economies around the world are not generating sufficient and quality employment opportunities to absorb additions to the working-age population and ensure gainful and decent employment for all.

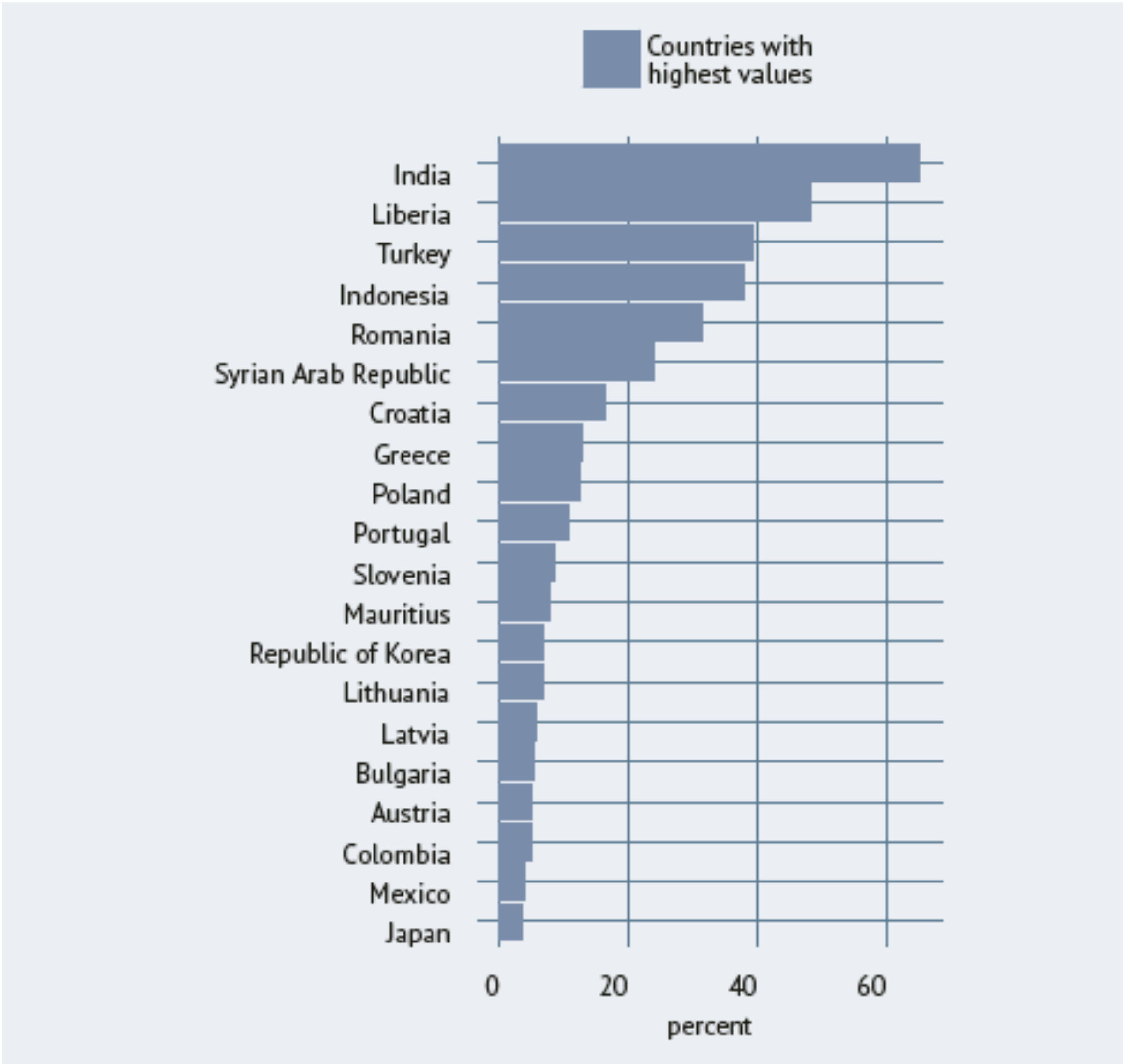

Figure 4 Female employment in agriculture, share of female employment

Source: World Bank (WDI).

Ergonomics

Ergonomics (from the Greek word ergon meaning work, and nomoi meaning natural laws), is the science of refining the design of products to optimise them for human use. Human characteristics, such as height, weight, and proportions are considered, as well as information about human hearing, sight, temperature preferences, and so on. Ergonomics is sometimes known as human factors engineering.

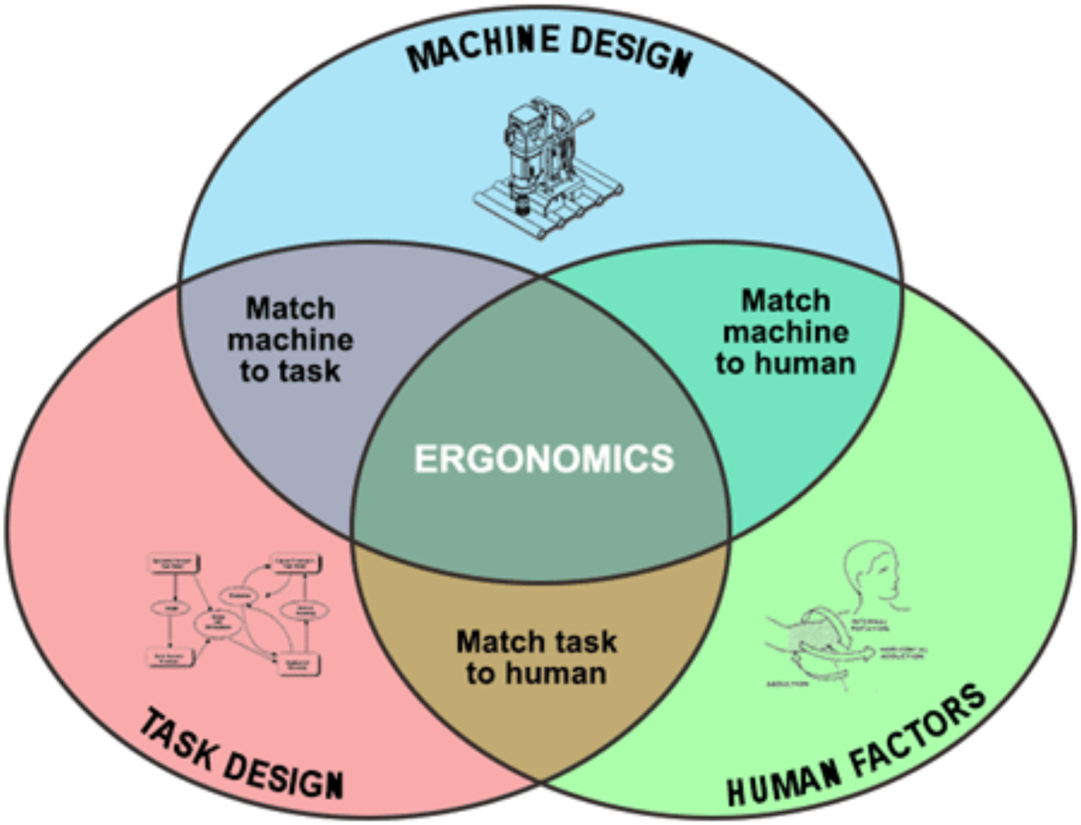

Figure 5 Ergonomics

Farming involves hard physical work, and over time, it takes a toll on the bodies of farmers and farmworkers. That can lead to lost work time, which reduces individual income and farm profitability. Understanding the ergonomics of farm work can help avoid common injuries that farm work can cause.

Ergonomics is the study of efficiency in working environments; by finding the best fit between workers and job conditions one can also avoid injuries. Much of the following information is adapted from a publication of the National Institute of Occupational Safety and Health (NIOSH) titled Simple Solutions: Ergonomics for Farm Workers.

Farm workers get backaches and pains in the shoulders, arms, and hands more than any other health problem. These are typically a result of chronic exposure to physical stresses related to working in a stooped position, carrying heavy weights in awkward positions, kneeling often, working with arms above shoulder level, moving hands and wrists repetitively, or vibration from farm equipment. In general, any work performed with high force or in a position that feels awkward may put a worker at risk of injury, especially if it's repeated a lot.

To reduce the chance of sprains and strains you may need to reposition work items in relation to worker's bodies, redesign the way a job is done, modify a tool or use a different tool altogether. Our focus was to make a tool that enabled farm workers to maximize their efforts, reduce their sprains and increased land usage whilst improving crop production.

Ergonomics in Agriculture

According to the International Labor Organization (ILO), around 160 million work-related illnesses per year occur around the world, in which work-related musculoskeletal disorders (WMSDs) have a prominent role in terms of occupational health and also economics (Niu, 2010).

One of the working activities that threaten the workers by related risks is agricultural work. The agricultural sector is acknowledged to be one of the most important sectors worldwide, not only in terms of supplying food but also in terms of the number of employees.
Agriculture is regarded as one of the most unsafe sectors in both the developing and the developed worlds. Therefore, it is attracting increased attention concerning the application of practical actions in agricultural settings to help reduce work-related accidents and illness.

Crops

The crops grown in the differing countries are as varied as the countries themselves, with variations in crops frequency and selection of crop depending on rainfall, land availability, soil type, weather conditions, economy of country, availability of labour, seeds and local tastes all having a bearing on the crop itself. Our research gave rise the list of crops as per the table below. If consistency of planting, to include depth of planting and distances between plant could be achieved, then greater efficiencies and higher crop yields could be achieved.

Table 1 Crop Type/ Depth of Planting / Depth Apart

Crop Name	Depth in soil	Depth apart
Rice	1 inch	4 inches
Wheat	2 inches	6 inches
Sorghum (Jowar)	3 inches	6 inches
Millet	0.25 inches	3 inches
Corn	2 inches	5 inches
Maize	2 inches	4 inches
Beans	1 inch	2 inches
Sugar Beat	0.5 inches	2 inches
Soybeans	2 inches	3 inches
Coffee	2 inches	4 inches

Our Solution

Our device which we called the "ergonomic planter" is our attempt at designing a device that will allow people with limited access to technology, maximise their efforts in relation to planting and farming especially in developing countries.

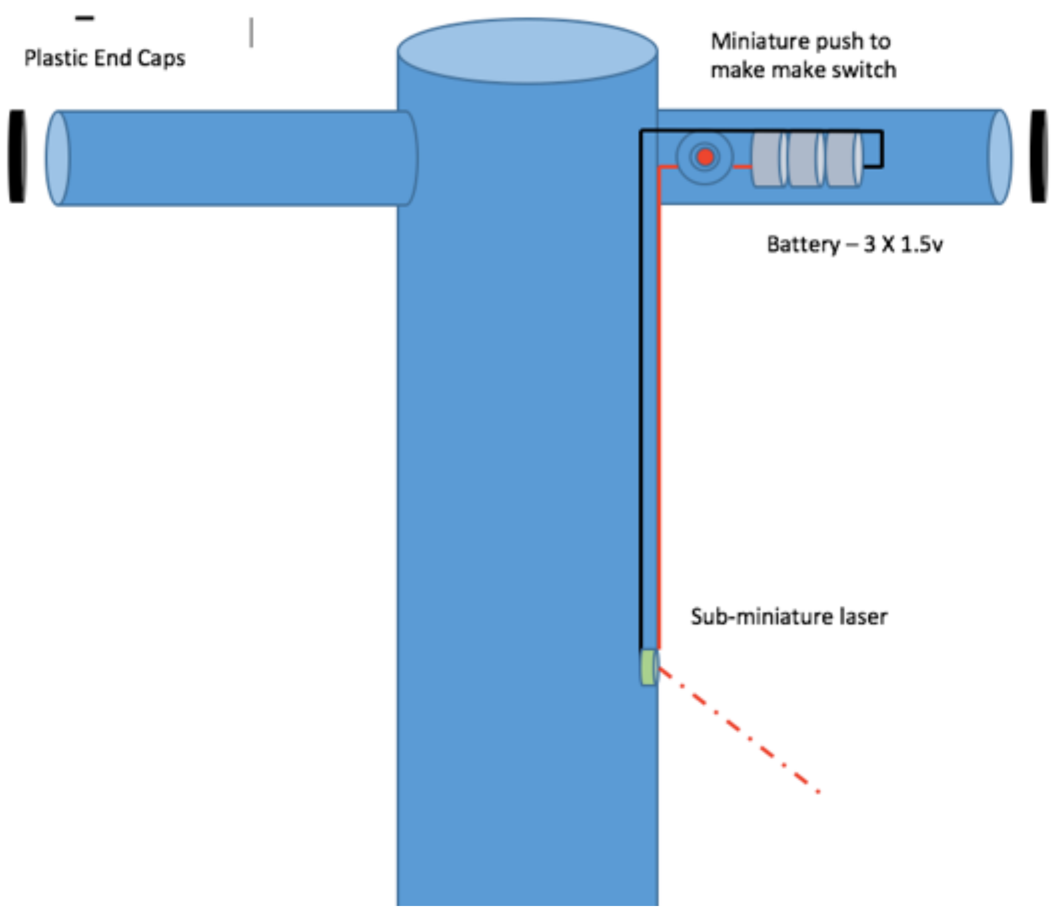

Figure 6 Initial Concept

Finished Product

Figure 7 Ergonomic Planter

Drawings

Sketches were done using a combination of MS Word and MS Publisher, drawing were done using SolidWorks.

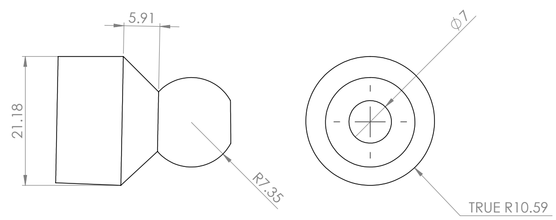

Figure 8 Laser Nozzle

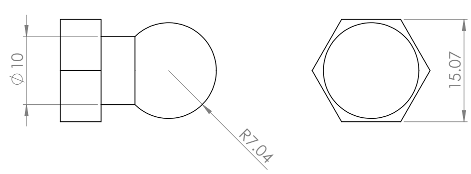

Figure 9 Laser End Cap

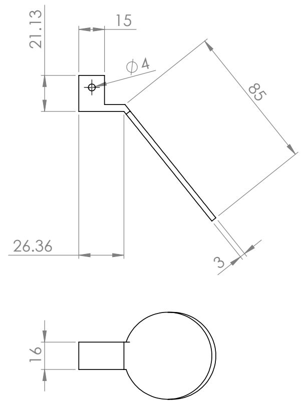

Figure 10 Door

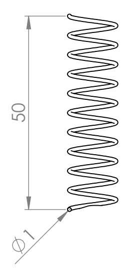

Figure 11 Spring

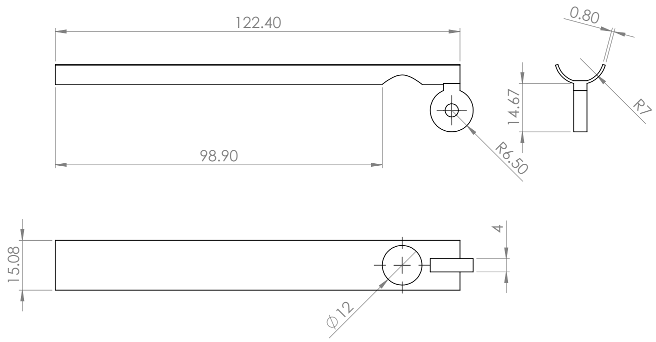

Figure 12 Lever

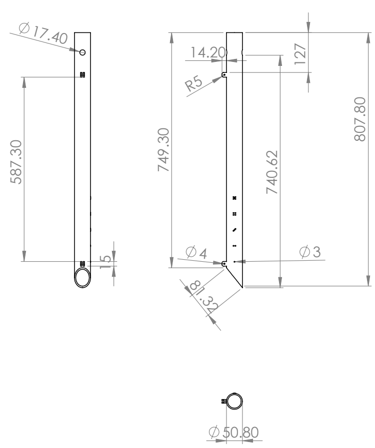

Figure 13 Main Shaft

Figure 14 Solid works - Depth gauge

Figure 15 Solid works - Completed Device

Figure 16 Solid works - Side Profile 1

Figure 17 Solid works - Side Profile 2

Figure 18 Solid works - Top Profile 1

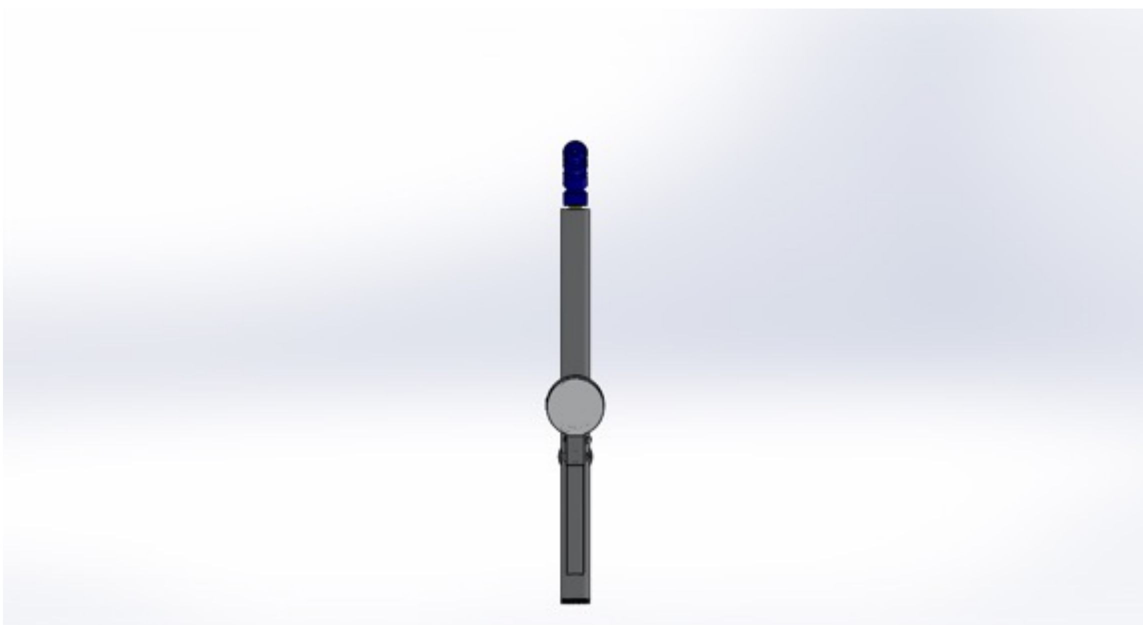

Figure 19 Solid works - Top Profile 2

Figure 20 Solid works - Full On Profile 1

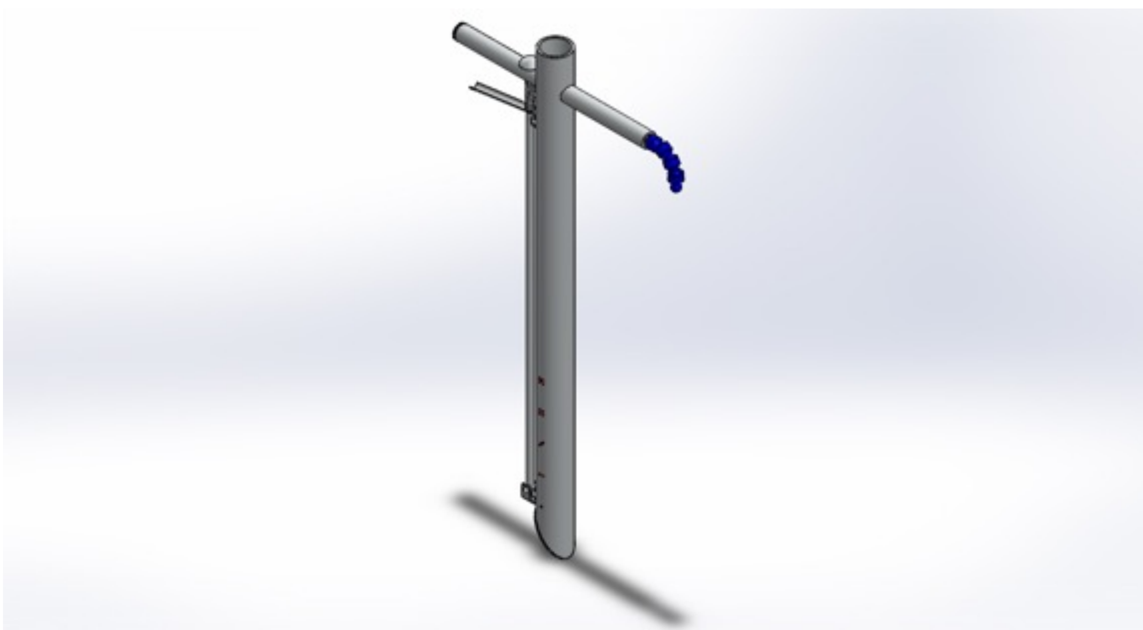

Figure 21 Solid works - Full On Profile 2

Figure 22 Solid works - Shaft Profile

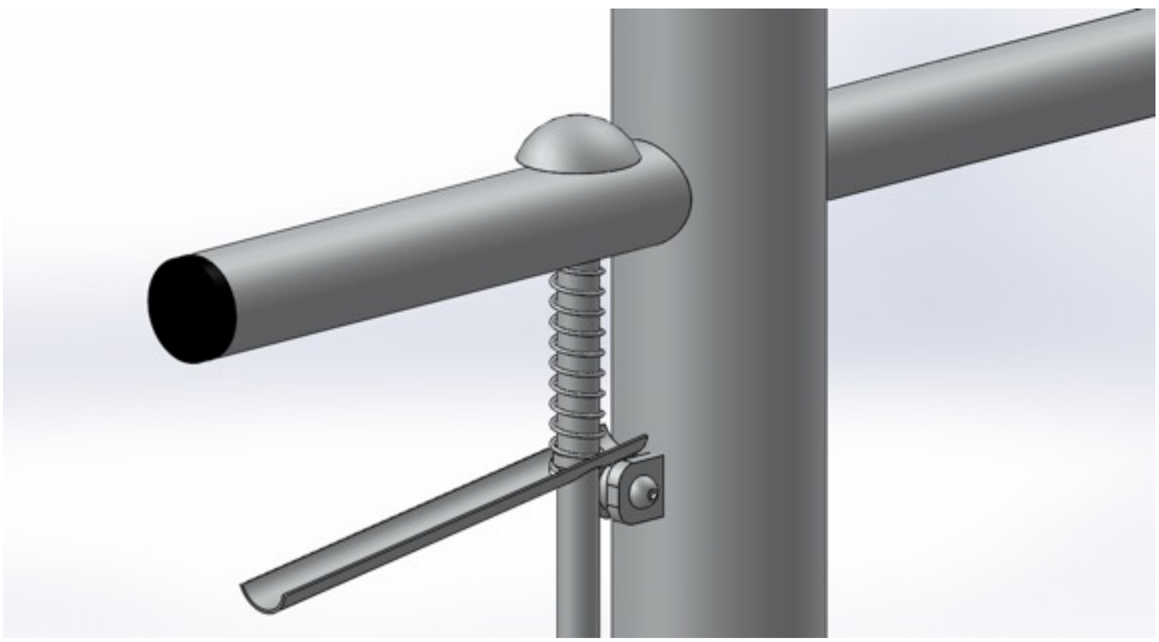

Figure 23 Solid works - Lever Mechanism

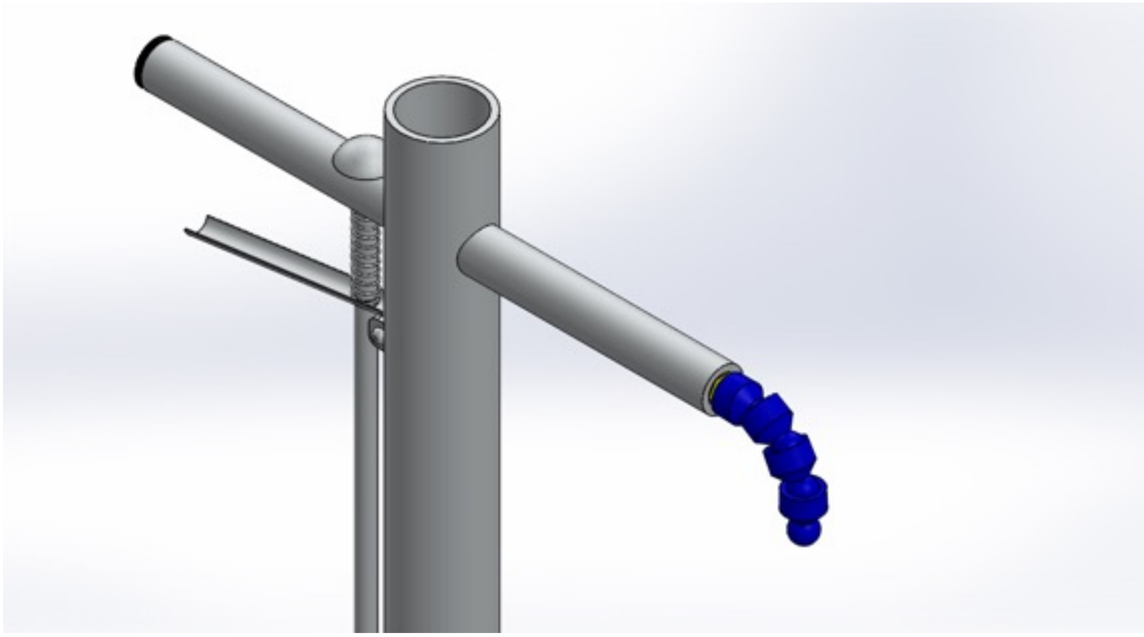

Figure 24 Solid works - Laser Unit

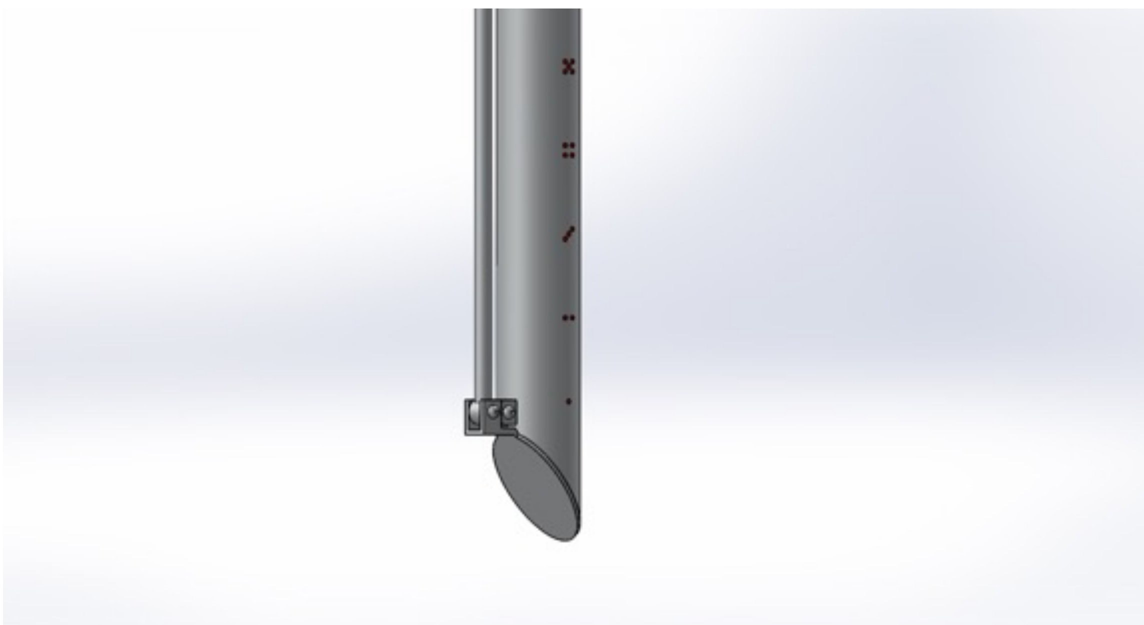

Figure 25 Solid works - Door Profile

Laser Unit

One of the features of our product is the inclusion of a 'laser unit' into the handle of the device. The purpose of this is to increase the utilisation of available soil. Our research indicated that crops planted by hand lack the uniformity and spacing that are achieved using modern planting machines. Given the increasing world demand for food and the available arable land available, it makes sense to fully utilise what land is available. Using a laser will guide the user to ensure consistency of planting.

The user checks the optimum distance for the particular plant, using our easy to use multi lingual chart, distances can be adjusted by moving the nozzle in the required direction. Inside the nozzle is a red laser capable of reaching distances of over fifty feet, (***see experiment 3 for more details)***

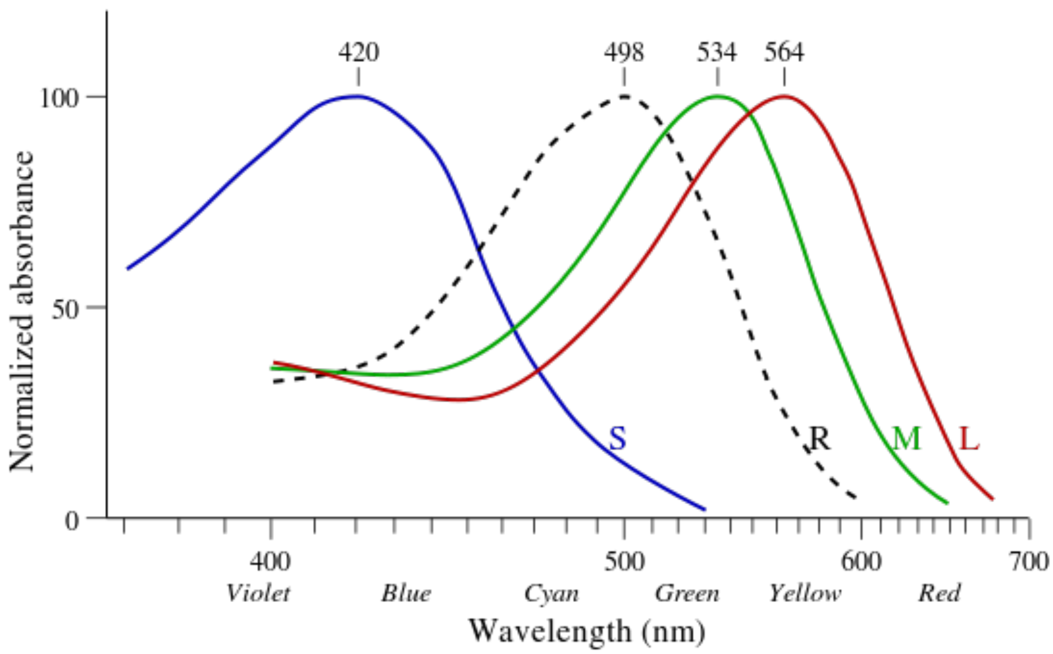

Figure 26 Laser Wavelength Comparison

The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation, mw stands for milli watts and is the measure of power. "nm" stands for nanometers and is the wavelength of the laser. A laser's wavelength determines its color. Specs: **Red** laser is 50mw 650mn **Green** laser is 50mw 532nm **Blue** laser is 20mw 405 nm.

Table 2 Laser Comparison

Colour	Power (mw)	Wavelength (nm)
Red	50	564
Green	50	532
Blue	20	405

Given the little difference between any of the colours and the fact that we only needed to project the laser 1 metre we opted to use the more traditional red one, primarily because it was more available and cheaper. We purchase online 'A Laser Dot Diode Module',

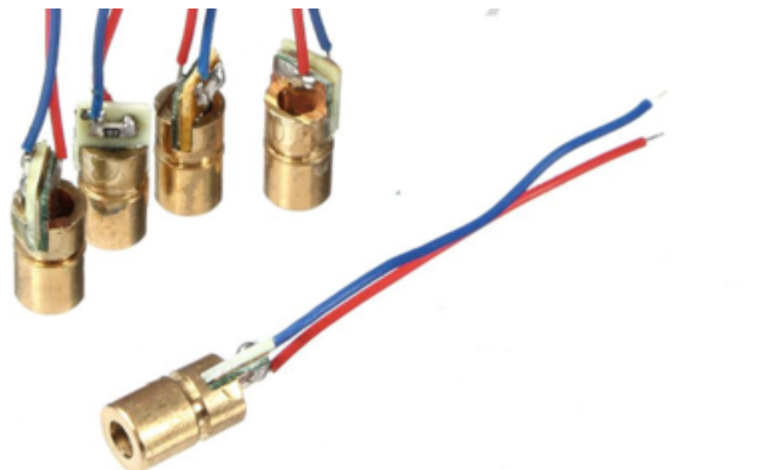

Figure 27 Laser Module

Specification:
Wavelength: 650nm
Operating current: less than 40mA
Working voltage: 3V
Output power: 5mW
Working temperature: -10°C to +40°C
Laser shape: dot
Housing material: copper
Dimensions: 6.5 x 18mm

We inserted this in a flexible nozzle used in milling machines to direct coolant onto the drill bits.

Figure 28 Flexible Nozzle

Using a micro switch which we positioned into the left handle of the device, the user can easily activate the laser without having to remove their hand from the device.

Using http://www.falstad.com/circuit/, we designed and simulated our circuit.

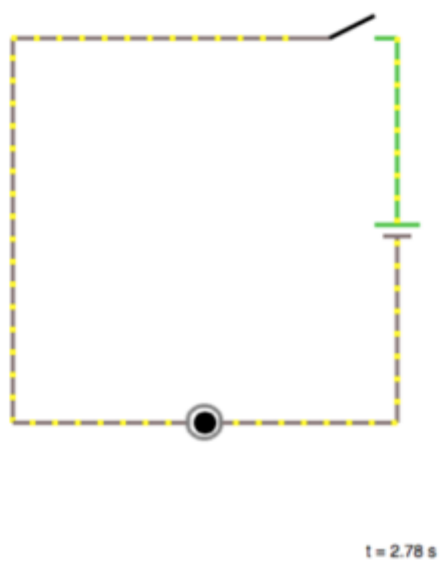

Figure 29 Open Circuit

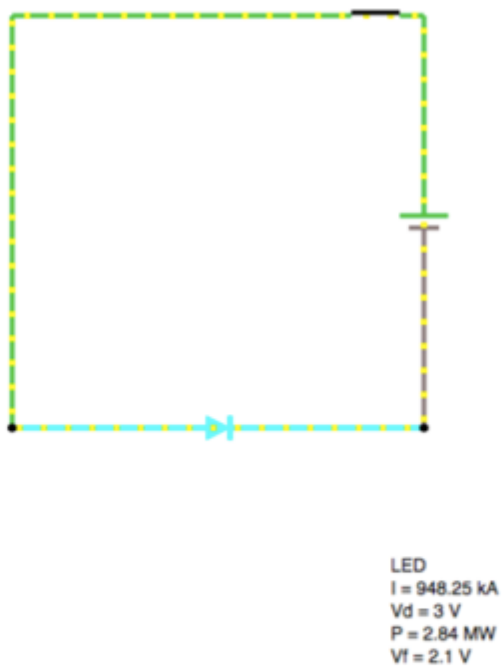

Figure 30 Closed Circuit

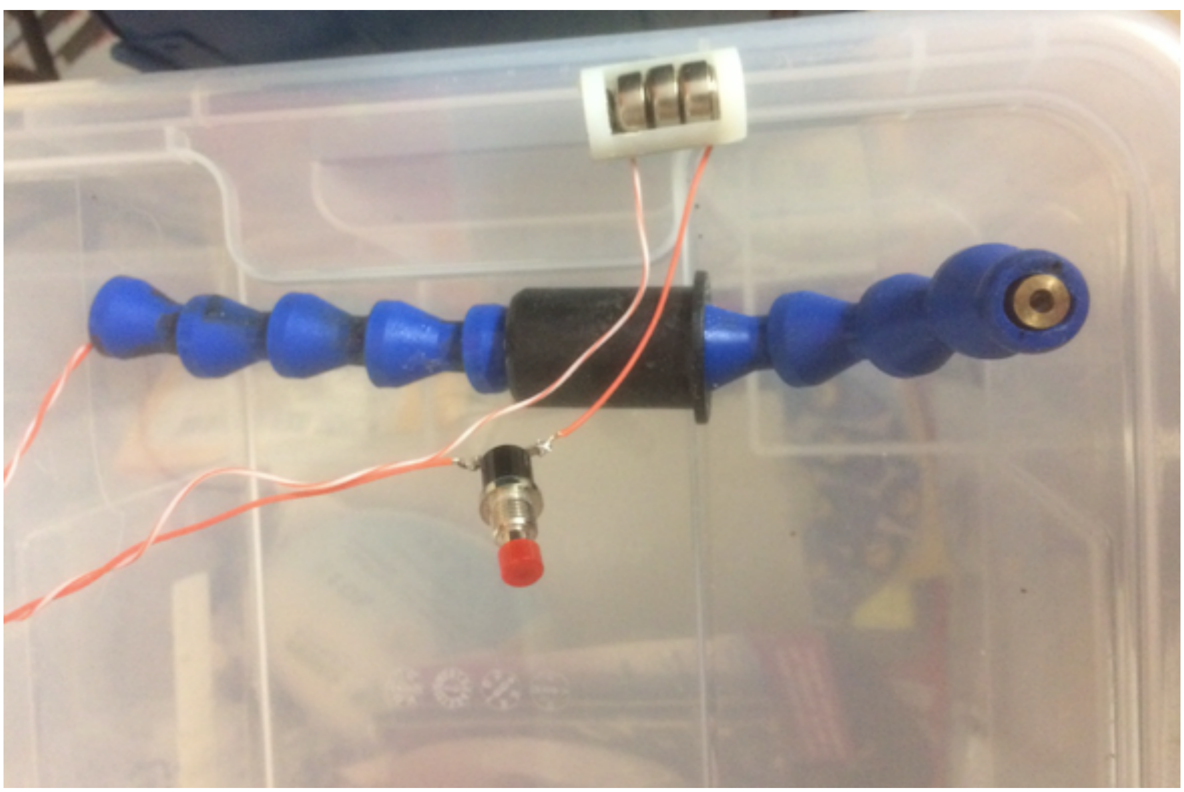

Figure 31 Completed Laser Unit

Testing of Soil

Bulk Density – Measurement

- Bulk density is the weight of soil in a given volume.
- Soils with a bulk density higher than 1.6 g/cm3 tend to restrict root growth.
- Bulk density increases with compaction and tends to increase with depth.
- Sandy soils are more prone to high bulk density.
- Bulk density can be used to calculate soil properties per unit area (e.g. kg/ha).

Background

The soil bulk density (BD), also known as dry bulk density, is the weight of dry soil (Msolids) divided by the total soil volume (Vsoil). The total soil volume is the combined volume of solids and pores which may contain air (Vair) or water (Vwater), or both. The average values of air, water and solid in soil are easily measured and are a useful indication of a soils physical condition.

Soil BD and porosity (the number of pore spaces) reflects the size, shape and arrangement of particles and voids (soil structure). Both BD and porosity (Vpores) give a good indication of the suitability for root growth and soil permeability and are vitally important for the soil-plant-atmosphere system (Cresswell and Hamilton, 2002; McKenzie et al., 2004). It is generally desirable to have soil with a low BD (<1.5 g/cm3) (Hunt and Gilkes, 1992) for optimum movement of air and water through the soil.

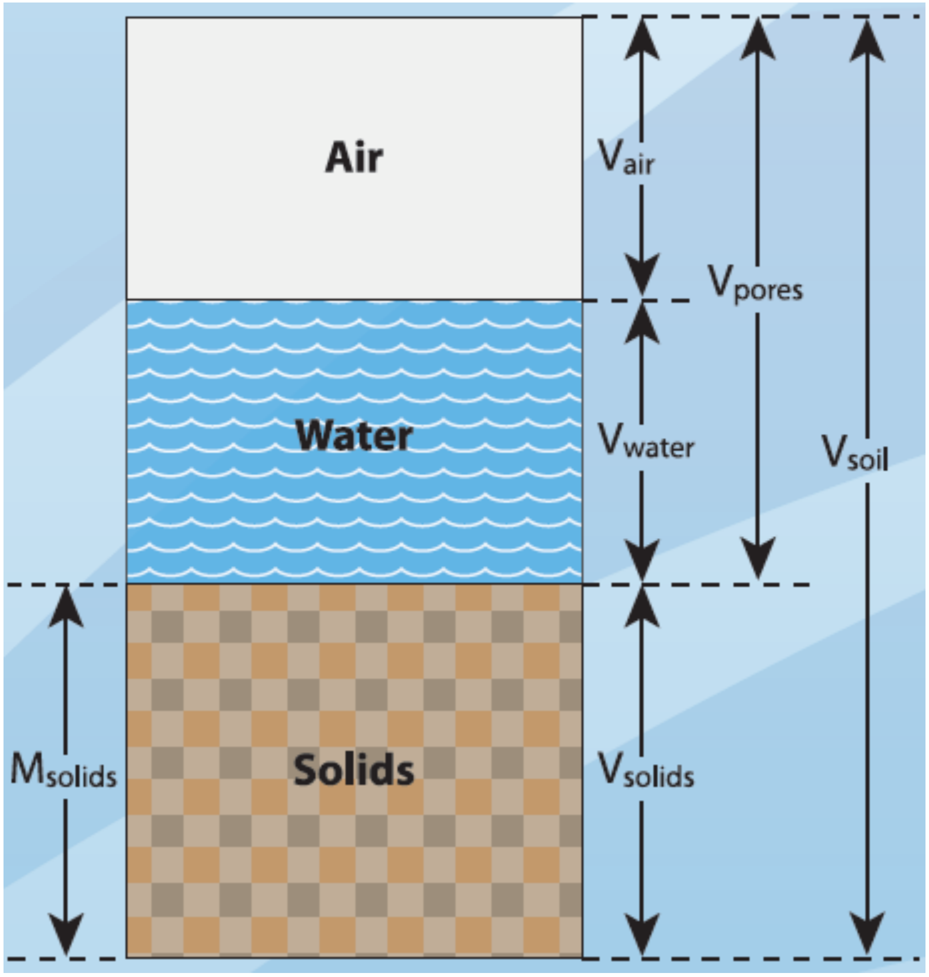

Figure 32 Bulk Density of Soil

Measuring bulk density

Bulk density measurements can be done if you suspect your soil is compacted or as part of fertiliser or irrigation management plans. (To account for variability, it is useful to take several measurements at the same location over time and at different depths in the soil, for example at 10, 30 and 50 cm depths to look at both the surface soil and subsoil. It is also useful to measure the bulk density of when comparing management practices (e.g. cultivated vs. non-cultivated) as physical soil properties are often altered (Hunt and Gilkes, 1992).

The most common method of measuring soil BD is by collecting a known volume of soil using a metal ring pressed into the soil (intact core), and determining the weight after drying (McKenzie *et al.*, 2004).

Figure 33 Soil Sampling Ring

Calculations

Soil volume

Soil volume = ring volume

To calculate the volume of the ring:

i. Measure the height of the ring with the ruler in cm to the nearest mm.

ii. Measure the diameter of the ring and halve this value to get the radius®.

iii. Ring volume (cm3) = 3.14 *x* r2 *x* ring height.

If the ring diameter = 7 cm and ring height = 10 cm Ring volume = 3.14 *x* 3.5 *x* 3.5 *x* 10 = 384.65 cm3

Dry soil weight

To calculate the dry weight of the soil:

i. Weigh an ovenproof container in grams (W1).

ii. Carefully remove the all soil from the bag into the container. Dry the soil for 10 minutes in the microwave, or for 2 hours in a conventional oven at 105ºC.

iii. When the soil is dry weigh the sample on the scales (W2).

iv. Dry soil weight (g) = W2 – W1

Bulk density

Bulk density (g/cm3) = Dry soil weight (g) / Soil volume (cm3)

Bulk density is usually expressed in megagrams per cubic metre (Mg/m3) but the numerically equivalent units of g/cm3 and t/m3 are also used (1 Mg/m3 = 1 g/cm3 = 1 t/m3) (Cresswell and Hamilton, 2002).

Critical values for compaction

The critical value of bulk density for restricting root growth varies with soil type (Hunt and Gilkes, 1992) but in general bulk densities greater than 1.6 g/cm3 tend to restrict root growth (McKenzie *et al.*, 2004). Sandy soils usually have higher bulk densities (1.3–1.7 g/cm3) than fine silts and clays (1.1 – 1.6 g/cm3) because they have larger, but fewer, pore spaces. In clay soils with good soil structure, there is a greater amount of pore space because the particles are very small, and many small pore spaces fit between them. Soils rich in organic matter (e.g. peaty soils) can have densities of less than 0.5 g/cm3.

Bulk density increases with compaction at depth and very compact sub soils or strongly indurated horizons may exceed 2.0 g/cm3 (NLWRA, 2001; Cresswell and Hamilton, 2002).

Problems we encountered

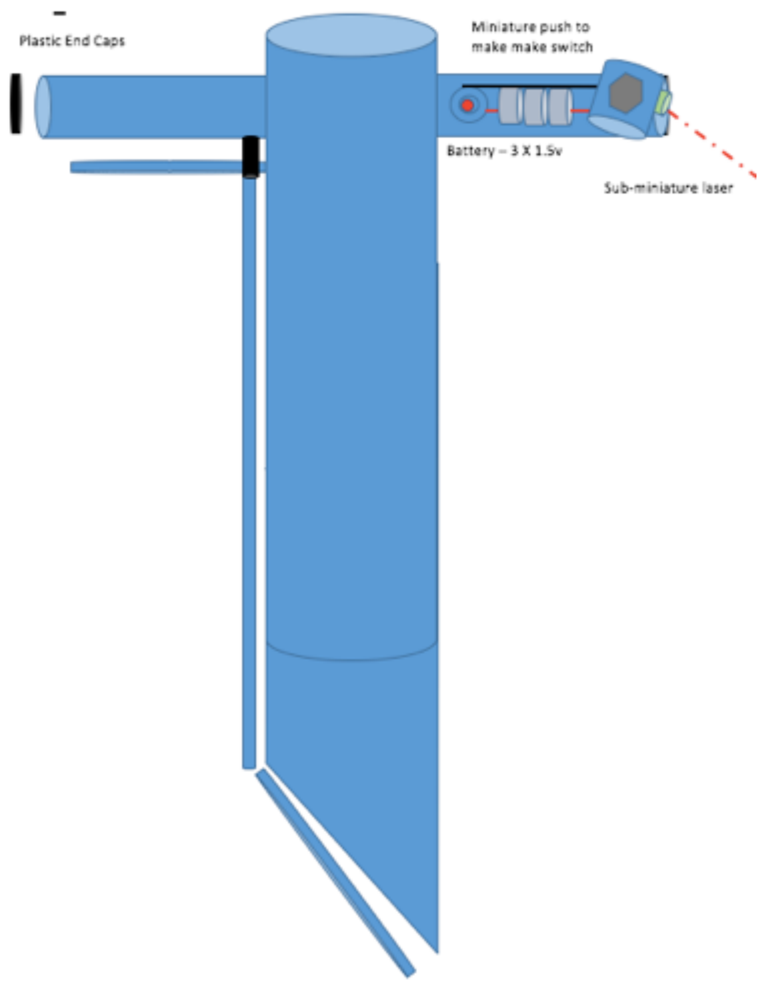

Figure 34 Original Design of Device

On the original version of our device, we proposed to house the laser parallel to the handle, whilst this did work, after tested, we discovered that it only allowed us lateral movement of the laser, so we decided to change it to the current version with the flexible and ultimately more controllable nozzle.

Accessories

Figure 35 Seed/ Fertiliser Tray

Figure 36 Manual Counter

Figure 37 Mini Digital Counter with Strap

Figure 38 Magnet Torch

Experiment 1

Aim: To Measure the Bulk Density of Soils

- **Apparatus:** Steel Ring $100cm^3$, Plastic Bags for samples, Calculator, Ruler, Pen, Scissors, Mallet, Oven Proof Dish, Convection Oven to dry samples), Kitchen Scales in grams.

Method:

1. We gathered 4 different soil types from various locations.
2. From these 4 different areas, we collected 4 samples of each soil type at different depts., typically 10cm, 30cm, 50cm and 70cm.
3. We labelled each soil type A, B, C, D. We labelled each sample 1,2,3,4. This resulted in 16 different samples, from A1 to D4.
4. We weighed each sample using a mass balance.
5. We calculated the volume of the steel rings.
   Ring volume (cm3) = 3.14 *x* r2 *x* ring height.
6. We then took the 4 results from A, B, C, D and got the mean weight of them (A1, A2, A3, A4).

Table 3 Ring Volume

HEIGHT	DIAMETER	RING VOLUME
10CM	7CM	384.65 cm3

We placed the soil samples in an oven proof bag weighing 3gms grams, we placed the samples in a drying oven for 120minutes at 105_c.

Results: Samples taken at 10cm depth

Table 4 Bulk Density Measurement

	Volume of ring	*W2 Dry weight grams*	*Bulk Density g/cm³*	*W2 Dry weight grams*	*Bulk Density g/cm³*	*W2 Dry weight grams*	*Bulk Density g/cm³*	*W2 Dry weight grams*	*Bulk Density g/cm³*
Sample		A		B		C		D	
1	384.65 cm3	416.4g	1.08	418.6g	1.088	417.5g	1.085	412.7g	1.072
2	384.65 cm3	417g	1.08	415.8g	1.08	412.4g	1.072	415.2g	1.079
3	384.65 cm3	417.4g	1.085	414g	1.076	415.2g	1.079	416.1g	1.081
4	384.65 cm3	421.2g	1.095	411.4g	1.069	415.4g	1.08	414.2g	1.076
Mean		418g	1.085g.cm³	415.85g	1.078g.cm³	415.13g	1.079g.cm³	414.5g	1.077g.cm³

Figure 39 Drying Cabinet

Conclusion:
From our experiment, we found that Soil Type A had the highest gross mean with the highest bulk density, and Soil Type D had the lowest. We repeated the same experiments on soils at 30, 50 and 70cm, whilst the results gave higher readings, it was not significant to affect the ability of our planter. We used this soil to test the capability of our planter to penetrate soil.

Experiment 2

Aim: To determine the approximate unconfined strength of cohesive soils.

The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic (F = ma) calculations are involved.

Apparatus:

- Soil Samples, we used the same soil as that used in experiment 1. These measurements were taken prior to the soil being extracted.
- Pocket Penetrometer
- The soil samples were taken on Diarmuid's farm in different fields.

Method:

1. Reset the penetrometer
2. Ensure the rubber ring is at zero
3. Place the penetrometer directly into the ground
4. Retract the penetrometer
5. Record the reading

Result:

Table 5 Soil Cohesive Strengths

Sample	A	B	C	D
Result	3	3.5	4	3.5

Conclusion: All of the soil samples taken were suitable for growing crops and were sufficiently penetrable to till and free from rocks.

Experiment 3

Aim: To measure the projection distances of Red laser

Apparatus: Our Red Laser unit, Lux Meter, Trundle Wheel

Table 6 Laser Distance Measurement

Colour	Distance	Lux	Time
Red	55 feet	432	08.00
	50 feet	650	10.00
	46 feet	758	12.00
	47 feet	689	14.00
	50 feet	654	16.00
	58 feet	405	18.00

Method: Distance Measurement Test

1) Record the time

2) Read the lux level from the meter

3) Walk backwards from a white wall until the laser is nor longer visible, measure that distance.

Result: We were not able to conduct their experiment in conditions similar to Africa/ India, we conducted the tests on December 2nd 2016, in normal conditions for this time of year, dry and not overcast. Given that the measurements never went below 45 feet, the distance we require is only 3 feet, our device will work perfectly in dry arid conditions with much stronger sun light.

Experiment 4

Aim: To see if the device actually works

Apparatus: Ergonomic Planter
Glass container
Soil
Seed potatoes

Method: Observation Test

1) Fill the glass container with the soil
2) Penetrate the soil with the ergonomic planter
3) Place seed potato into the tube, allow to freefall into the soil
4) Pull the lever, and retract the planter
5) Observe that the potato remains in the soil

Result: The device works perfectly, the depth can easily be read using the gauge, once the sequence is maintained, greater speeds can be obtained.

Note: We fitted an digital counter to the underside of the right hand handle, ever time the lever was puller, the number on the counter was incrementally increased, during this project so far, we have tested that part for functionality over 500 times without any issues.

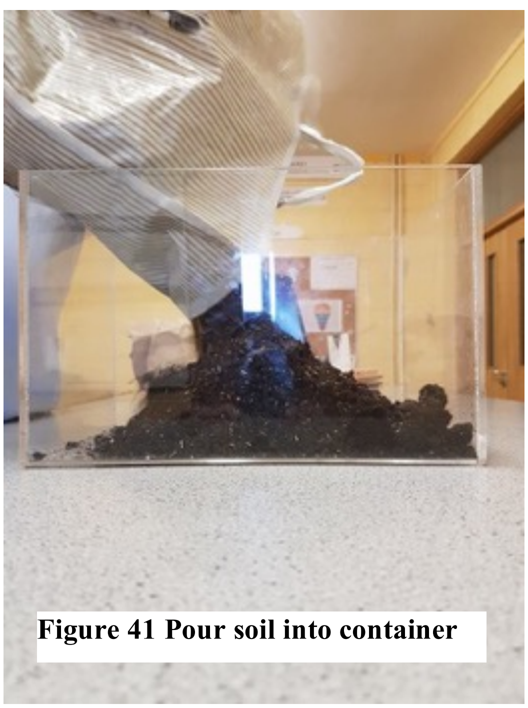

Figure 41 Pour soil into container

Figure 40 Soil in container

Figure 42 Planter in soil

Figure 43 Push to correct depth

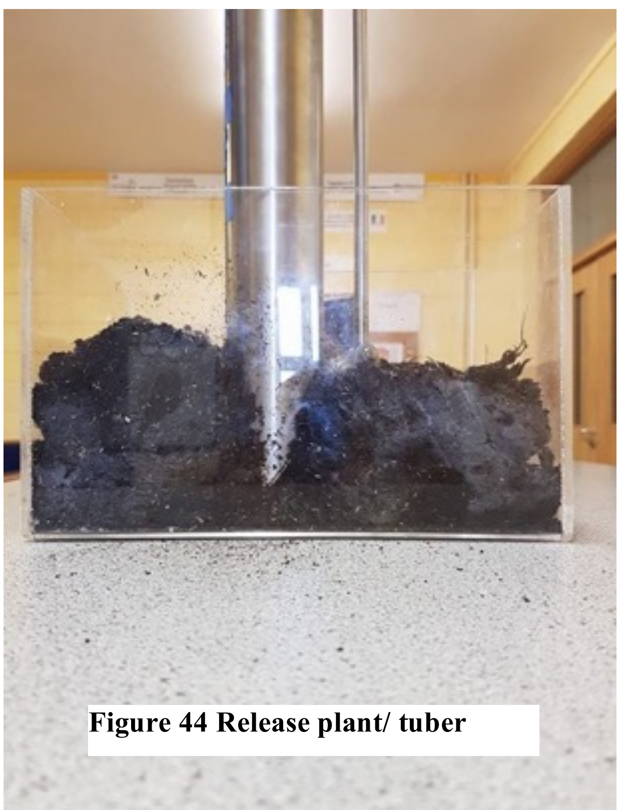

Figure 44 Release plant/ tuber

Figure 45 Pull lever, retract planter

Experiment 5

Aim: Comparative test between manual planting and using the planter

Apparatus: Ergonomic Planter

Tilled Soil

Various Plants

Stop Watch

Method: Comparative Test

1) Person A plants for 1min by hand, moves 1 step to the left after planting and person B plants for 1 min using the planter
2) After 60 sec, both stop and the plants are counted
3) Person A now plants for 1 min using the planter and person B by hand
4) After 60 sec, both stop and the plants are counted

Table 7 Planter/ Hand Comparison Test

	Planter		By Hand	
	Person A	**Person B**	**Person A**	**Person B**
60 sec	46	52	34	36
Total	**98**		**70**	

Result: Irrespective who used the planter they achieved a higher score that those using it by hand. It is envisaged that as each person gets more familiar with either type of planting that their speeds would improve.

Conclusion

In conclusion our planter has shown to improve speed, efficiency, and reduces the manual labour involved in planting. Our experiments have proven that it work's in a variety of different soil types all with different soil densities. The attached laser and counter also improve the efficiency at which it works. Our device has the potential to make the lives of farmers in developing countries much easier, with roughly 60% of farmers in India suffering from musculoskeletal disorders, our device' ability to reduce manual labour could have a serious impact on this figure. We have done all the tests and experiments possible in our own area and all that is left to do now is to look into mass producing our device cheaply. We would also love the opportunity to test out our device on soil types in developing countries to investigate its performance in those conditions.

Whilst our original design was intended for use in developing countries, our efforts in patenting our device has highlighted the fact that no similar product exists, given the need by garden enthusiasts and amateur farmers to utilise the same device, it is conceivable that a ready market exists for our device closer to home. The addition of accessories like the planting/ seed/ fertiliser tray and the torch offers the potential to enhance our device further.

Part of our aim was to ensure consistence in farming methods, we have developed a handy pocket guide to accompany our device, we have translated the seven instructions and accompanying diagram into Urdu, Somali, French, Simplified Chinese, and Arabic.

Our device is quite simple and offers the ability to improve the task of planting, seeds, fertiliser, plants and tubers alike. In fact, it could be made from recycled parts and we have plans to make a similar one from plastic piping, which will reduce both the weight and the cost. The ergonomic planter has surpassed our expectations and we have been energised by the encouragement we have received from NGOs and people with more knowledge re agrarian issues in developing countries.

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Appendices

Patent

Patent Abstract

Patent Summary

Patent Drawing

Receipt for Patent S2016/0271

Patent

Following communications with various agencies and individuals associated who assisted us with our project we decided to follow their advice and apply for a patent in order to protect our intellectual property. We engaged the services of a solicitor and with help for a patent agent we submitted our initial application on 30th November 2016. Along with the fee, application and associated drawings, we supplied detailed drawings, see below.

Abstract

An ergonomic handheld planter that allows the user to plant crops and seeds into soil. The device ensures users do not need to bend down to manually insert crops into the soil. The device breaks the soil and opens a slot to allow the crop to remain in the soil, once the device has been removed. Laser pointer shows where the next crop should be inserted. The depth gauge shows the depth of the device into the soil for planting.

Summary

The invention is specifically designed for people in developing countries to aid with planting crops in soil.
Handheld planting devices have long been known and widely used. Such devices have existed for centuries, where they are used to break soil, in a manner that allows the user to place crops and plants into the ground.
Types of these planting devices are shown, for example, in the following patents:

CN2012201393U 20120104
RU19970119417 19971126

Though such devices do indeed break the soil, there has been a continuing need for improvement, in both efficiency and ergonomics.

Fig. 1 is top plan view and end view of the door located at the end of the main body of the device.
Fig. 2 is an end view and top plan view of the laser end cap, located on the right side handle of the device.
Fig. 3 is a side view and end view of the left handle of the device.
Fig. 4 is a side view of the main body of the device, including all components.
Fig. 5 is a top plan view of PART5.
Fig. 6 is an end view of the pin located adjacent to the main body of the device.
Fig. 7 is an end view and side view of the trigger handle, located on the underside of the handle of the device.

Fig. 8 is a side view and end view of the right handle.
Fig. 9 is an end view of the spring, located.
Fig. 10 is a numbered diagram of the device, including all components.
Fig. 10:

--No. 1 refers to the main body of the device.
--No. 2 refers to the cap fastening the pin (no. 4) to the device.
--No. 3 refers to the left handle of the device.
--No. 4 refers to the pin adjacent to the main body of the device.
--No. 5 refers to the trigger handle used to open the door, Fig. 6.
--No. 6 refers to the door of the device.
- *--No. 7 refers to the laser pointer.*

Patent Drawing

The device is made of stainless steel grade 304. The main body of the device is a circular tube (fig 4; no. 1). It is hollowed throughout to allow the crop to be dropped clearly through the device. It connects two handles on either side of the device (fig 3, fig 8, no 3), which is used to carry the device. These handles are welded to the main body of the device. The pin of the device (fig 6, no 4) connects the left handle (no 3) to the trigger handle (no 5), and to the hinge mechanism connected the door (fig 1, no 6) of the device. It is welded to the left handle (no 2). There is a spring located between the left handle and the trigger handle to allow the door to be opened with ease. The trigger handle (no 5) is secured to the main body of the device, and is used to open and close the door of the device. The door of the device (no 6, fig 1) is used to break the ground, and to create space to plant the crop. The laser pointer (no 7) is secured to the right handle of the device. It rotates 180 degrees, and is utilised to provide guidance to the user as to where the next crop should be planted.

Patent Application Receipt

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jackoconnor2298@gmail.com

Date : 07/12/2016

Your Ref :

<u>PATENT APPLICATION NUMBER : S2016/0271</u>

The Controller acknowledges receipt on 05/12/2016 of the prescribed filing fee and documents purporting to be a Patent application in the name(s) of:

JACK O'CONNOR & DIARMUID CURTIN

for a patent for an invention entitled:

An ergonomic handheld planting device

The above number should, until further notice, be quoted in all correspondence relating to the matter.

Please note that this application has not yet been examined and you will receive a further communication about the application in due course.

Controller of Patents, Designs and Trade Marks

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