Sustainable Cultivation of Asparagus using Sub Surface Drip Irrigation in the Desert of Peru

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Planting the desert with green asparagus by using SDI and organic matter, and to improve water retention.

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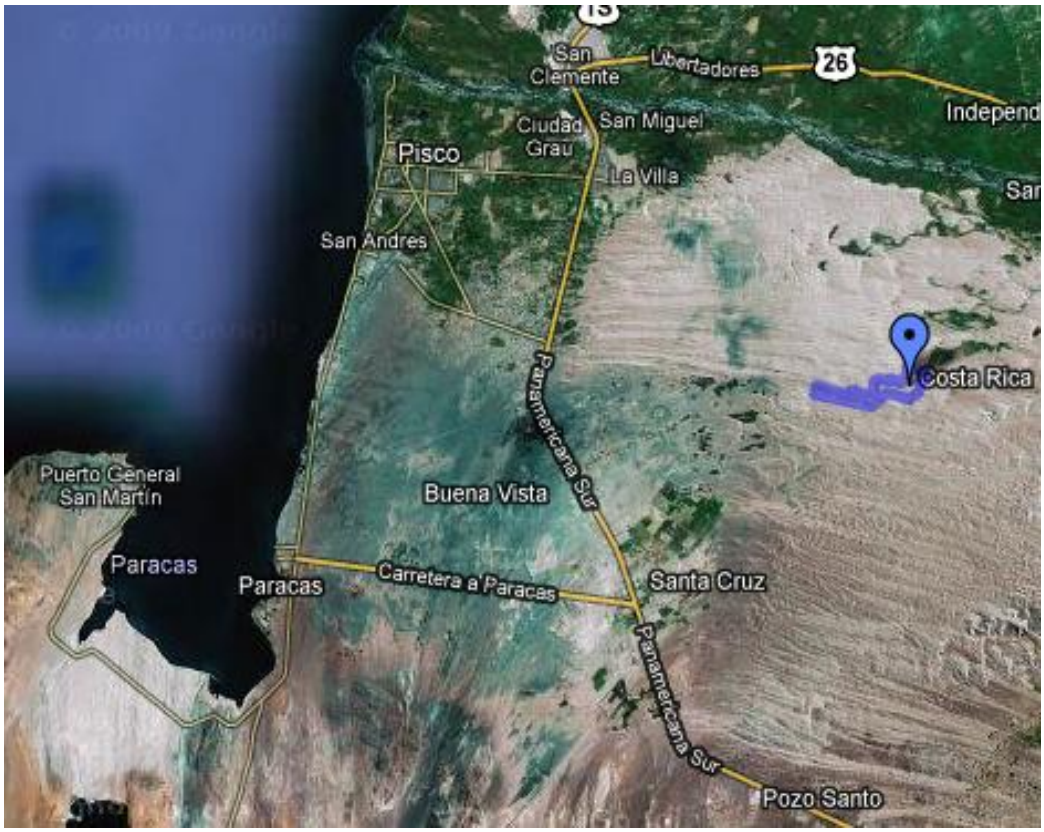
1 Introduction

1.1 Background

Fundo Fangelica SAC is a company locates in Peru, Ica km 240 from the ¨pan Americana sur.¨ (as you are able to see in the two satellite photos below) Fundo Fangelica is recently starting up with the cultivation of asparagus, by using drip irrigation. The company was set up by Sjeng Hoefsloot, the general manager from the company, together with other investors. The main reason for Fundo Fangelica to start up is to produce fresh green asparagus, which they have the ability already to do since they have a sister company which produces green asparagus, but in a completely different region. The reason that this is beneficial for the company to grow green asparagus, in a desert like area, is because green asparagus responds well to the desert like growing conditions, and the possibility to harvest twice a year. Since the farm is recently developing they have required for a student to make a research.



A research was required for the management of Fundo Fangelica S.A.C. The managers want to know which irrigation system would be more favorable to grow asparagus in a desert area. The managers want to keep pest and diseases to a minimum so that they have the opportunity to grow organic asparagus. The management team decided to investigate the effectiveness of two different yet similar sorts of drip irrigation this being subterranean drip irrigation (SDI) and conventional drip irrigation.

“Today all asparagus growers in Peru use surface (drip or furrow) irrigation, which must be periodically halted to break the life cycle of the gall midge (Prodiplosis longifila), a very harmful insect that uses surface water for breeding and survival. Unfortunately, this periodic water deficiency comes at the expense of the yield of the asparagus plants. Subsurface drip irrigation (SDI) has the great advantage that irrigation does not need to be interrupted for this reason. The technology is new to Peru. Its introduction is expected to result in a 15% yield increase, whereas water consumption will be much reduced and nutrients will be more efficiently applied. Indeed, the introduction in SDI will be an important innovation for Peruvian horticulture at large.”’1

1 Management Team, Fundo Fangelica S.A.C.

Peru has a long and extended coast which is composed of desert sand. In the area that Fangelica S.A.C. is located is a place where there is a lot of blown in sand. This activity has happened throughout several years, meaning that the farms soils are composed of sand. There are no different soils to be found, as explained on the following quotation" Sand that is transported long distances by water or wind will be rounded, with characteristic abrasion patterns on the grain surface. Desert sand is typically rounded." 2

According to Malheur Experiment Station: "Drip irrigation can help you use water efficiently. A well-designed drip irrigation system loses practically no water to runoff, deep percolation, or evaporation. Drip irrigation reduces water contact with crop leaves, stems, and fruit. Thus conditions may be less favorable for the onset of diseases. Irrigation scheduling can be managed precisely to meet crop demands, holding the promise of increased yield and quality."3

"Subsurface drip irrigation has been used in Arizona for at least 25 years. However, its adoption has proceeded slowly for a number of reasons, including the high initial capital cost–often $2500/Ha. or more–and the intensive management needed.
Subsurface drip irrigation provides the ultimate in water use efficiency for open-field agriculture, often resulting in water savings of 25-50% in comparison with surface drip irrigation, a flood irrigation. The use of SDI offers many other advantages for crop production, including less nitrate leaching compared to surface irrigation, higher yields, a dry soil surface for improved weed control and crop health, the ability to apply water and nutrients to the most active part of the root zone, protection of drip lines from damage due to cultivation and other operations, and the ability to safely irrigate with wastewater while preventing human contact."4 As explained there are certain benefits of having subsurface irrigation as mentioned by the University of Arizona, never the less there is a steep price tag for the implementation of technology.

Sandy soils is a major point that has to be taken care of, since it's really important to know what type of sandy soil will be irrigated. Some information given by EAIS "Sandy Soils have a gritty texture and are formed from weathered rocks such as limestone,

2 http://en.wikipedia.org/wiki/Sand,The Free Encyclopedia.

3 Malheur Experiment Station, http://www.cropinfo.net/drip.htm

4 University of Arizona, Department of soil, water, and environmental science, http://ag.arizona.edu/crop/irrigation/azdrip/SDI.htm

quartz, granite, and shale. If sandy soil contains enough organic matter it is easy to cultivate, however it is prone to over-draining and summer dehydration, and in wet weather it can have problems retaining moisture and nutrients."5

1.2 Problem definitions

Irrigation research about drip and subsurface irrigation has shown that there can be certain negative effects if the technique is not used properly. As mentioned on an internet site by drip irrigation: "Too much water: The reason sprinkler water is not absorbed deep into the soil has to do with the way that water moves in to the soil. Water moves by gravity and by capillary action."6 This can in fact be a problem for Fundo Fangelica S.A.C. because for sandy soils there is a large capillary force.

There are certain points which have to be kept in mind before making any tests. There have to certain analysis made to obtain information of what would be the best configuration of both systems and finally analyze the benefits of both compared to each other.

1.3 Objective

To know which irrigation, being drip or subsurface, is most suitable for sandy soils and complies with the plant's needs,

1.4 Research questions

How to use sub-surface or drip irrigation for asparagus cultivation in the Peru desert area in a sustainable way?

Sub questions:

- What are the soils and its properties in relation to irrigation (drainage, evaporation, capillary rise, water management)
- What should be the fertilizer management system under application of subsurface drip irrigation to guarantee satisfactory nutrient availability at the one hand and prevent salinization at the other hand?

5 EAIS, http://www.eais.net/soil/#1

6 Is Drip Irrigation Right For Me?, http://www.dripirrigation.ca/HowTo_ForMe.asp

- How can the water retention capacity of the soil be improved by adding organic fertilizers?
- What are the water needs for asparagus plants in relation to the development of, of both the drip and subsurface irrigation, and in relation to weather conditions?

1.5 Limitation

There are several elements which concerns the full research of this thesis. This means that there can be some odd ways to calculate, the total amount of water with in the soil, meaning that there is not the right equipment to make all measurements, even though with Mr. Henk van Hoof has taken the time and liberty to teach me some artisanal ways of how to measure water retention within the soil. There will not be enough time to grow a full asparagus plant with in the time limit, so another test crop has to be put in.

1.6 Report structure

This report has been divided into eight chapters. The first chapter is the introduction of this research which explains the reasons and objectives. The second chapter will describe literature review done for the thesis. The third chapter will give the reasons of the importance of investigating sandy soil water retention in Peru. Then the fourth chapter will give an idea about the methodology of this research which are the main aspects of the research. The analysis will be presented in chapter five. After that there will be the discussion of the analysis in chapter six. Chapter seven is the conclusion of the research, and finally there will be the recommendation on further research and the improvement possibilities of the standard in the last chapter, being number eight.

1.7 Definitions

To give a clear idea from the beginning of this thesis some words which possibly need to be defined, to avoid any misinterpretation.

***Drip irrigation**:* also known as trickle irrigation or micro irrigation, is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters.

***SDI**:* Stands for Subsurface Drip irrigation. Subsurface drip irrigation is a method of irrigation similar to drip irrigation only with the water emitters placed beneath the soil.

Soles: Currency in Peru 1€ (EUR) = S/. 3.63 soles (PEN)

2 Literature regarding to: soils, retention of water, irrigation, and Asparagus.

2.1 Literature review about soils

2.1.1 Soils

“The Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment.

The upper limit of soil is the boundary between soil and air, shallow water, live plants, or plant materials that have not begun to decompose. Areas are not considered to have soil if the surface is permanently covered by water too deep (typically more than 2.5 meters) for the growth of rooted plants.

The lower boundary that separates soil from the non-soil underneath is most difficult to define. Soil consists of horizons near the Earth's surface that, in contrast to the underlying parent material, have been altered by the interactions of climate, relief, and living organisms over time. Commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biological activity. For purposes of classification, the lower boundary of soil is arbitrarily set at 200 cm.”[7]

2.1.2 Climate

“Soil formation greatly depends on the climate, and soils from different climate zones show distinctive characteristics. Temperature and moisture affect weathering and leaching. Wind moves sand and other particles, especially in arid regions where there is little plant cover. The type and amount of precipitation influence soil formation by affecting the movement of ions and particles through the soil, aiding in the development of different soil profiles. Seasonal and daily temperature fluctuations affect the

7 Soil Taxonomy, second edition, 1999, By Soil Survey Staff

effectiveness of water in weathering parent rock material and affect soil dynamics. The cycle of freezing and thawing is an effective mechanism to break up rocks and other consolidated materials. Temperature and precipitation rates affect biological activity, rates of chemical reactions and types of vegetation cover."[8]

The climate data of Peru is the following for year round:

2.1.3 Characteristics

To define the characteristic of the soil we have to look at three aspects which are important to define the characteristics of the soil. These three aspects would be the following. The different percentages of clay, sand, and silt. If you are to know this information then you are able to specify what sort of soil you have.

In the case of Fundo Fangelica we are able to see that we have a sandy soil, since we have 95%sand, 5%clay, 50%silt.

On the chart located in the appendix (chart2) you are also to recognize the soil from Fundo Fangelica as a single Grained soil. Thus once more proving that the soils is recognized as a sandy soil.

2.1.4 Classification

"The naming of soil horizons is based on the type of material the horizons are composed of; these materials reflect the duration of the specific processes used in soil formation." [9] Soils or also known as sols, are described and classified by their color, size, texture, structure, consistency, root quantity, pH, voids, boundary characteristics, and if they have nodules or concretions, not all the major horizons covered below; soils may have few or many horizons. In Fundo Fangelica you are bound to only find sandy soil wich means that it lacks "lack well-developed horizons" [10]

8 http://en.wikipedia.org/wiki/Soil

9 http://en.wikipedia.org/wiki/Soil

10 http://en.wikipedia.org/wiki/Soil

Soils are classified into categories. This is done in order to understand the relationships between different soils, and to determine the utility of a soil for a particular use.
This is the order of the list of the different types of soils.

- Entisol - recently formed soils that lack well-developed horizons. Commonly found on unconsolidated sediments like sand, some have an A horizon on top of bedrock.
- Aridisol - dry soils forming under desert conditions. They include nearly 20% of soils on Earth. Soil formation is slow, and accumulated organic matter is scarce. They may have subsurface zones (calcic horizons) where calcium carbonates have accumulated from percolating water. Many aridisol soils have well-developed Bt horizons showing clay movement from past periods of greater moisture.

The soil classification that Fundo Fangelica has is the Entisol, and an Aridisol. This sol is distinguishable right away when entering the location of the farm.

2.2 Literature regarding to "ways of how to measure water retention"

2.2.1 Capillary Force

"The pore space in soil is usually at least partly filled with water. When all pores are water-filled, the soil is said to be water-saturated. Unsaturated conditions occur when water is present only in the finer pores while the larger pores are air-filled. This phenomenon can be explained by considering the capillary processes. When capillaries of different sizes are placed in water, the water will rise to the highest level in the smallest capillary as shown in the appendix section of photos recognized as figure 1

The smaller the capillary, the greater the suction by which water is held. Stated in another way, the pressure head (h) is more negative in the smaller capillary. It is more difficult (requires more energy) to remove water from finer pores than from larger pores. It is important to know how strongly water is held by the soil at any given time, because this governs not only the rate of water movement but also the availability of water to plants."[11]

2.2.2 Tensiometer

"Tensiometers, devices that measure how tightly water is held in the soil, more accurately indicate soil moisture. A Tensiometer consists of a sealed water-filled tube equipped with a vacuum gauge on the upper end and a porous ceramic tip on the lower end, as depicted on figure 2. As the soil around the Tensiometer dries, water moves from the tube through the tip, creating in the tube a vacuum, or tension, that can be read on the gauge. When the soil water content increases through rainfall or irrigation, water enters the tube through the tip, lowering the gauge reading.
Soil tension levels used to schedule irrigation vary with soil texture. In a sandy loam, irrigation should begin when soil tension reaches 20 centibars (a unit of pressure) and cease when it falls to 10 centibars. A soil tension reading of zero indicates complete

[11] http://edis.ifas.ufl.edu/ss109

saturation. In a finer-textured soil, such as silt loam, there is no need to irrigate until soil tension reaches 30 centibars."12

2.2.3 Gravimetric Method

"With the gravimetric method, soil moisture is determined by taking a soil sample from the desired soil depth, weighing it, drying it in an oven (for 24 hours at 220 degrees F), and then reweighing the dry sample to determine how much water was lost. This method is simple and reliable. Unfortunately, it is not practical for scheduling irrigation because it takes a full day to dry the sample. In a sandy soil that dries quickly, irrigation may be needed before the results of the measurement are obtained. The gravimetric method is most useful for calibrating other devices for measuring soil-water."13

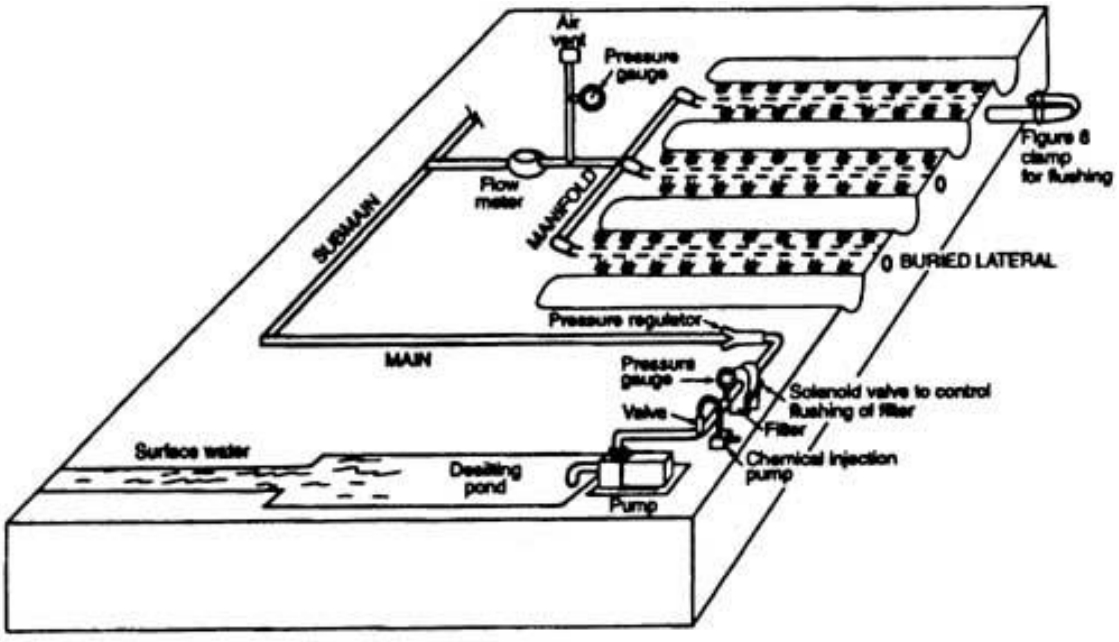
2.3 literature about irrigation

2.3.1 SDI

"Subsurface drip (SDI) is a low-pressure, high efficiency irrigation system that uses buried drip tubes or drip tape to meet crop water needs. SDI technologies have been a part of irrigated agriculture since the 1960s; with the technology advancing rapidly in the last two decades. A SDI system is flexible and can provide frequent light irrigations. This is especially suitable for arid, semi-arid, hot, and windy areas with limited water supply. Farm operations also become free of impediments that normally exist above ground with any other pressurized irrigation system. On the figure next page (figure 3) you are able to appreciate a mockup of what the subsurface irrigation may look like when installed.

12 To Water, or Not to Water?, by Steve Upson

13 MEASURING SOIL WATER FOR IRRIGATION SCHEDULING: MONITORING METHODS AND DEVICES, Prepared by: Robert Evans, Extension Agricultural Engineering Specialist, D. K. Cassel, Professor of Soil Science, R. E. Sneed, William Neal Reynolds Professor



(Figure 3)

Since the water is applied below the soil surface, the effect of surface infiltration characteristics, such as crusting, saturated condition of ponding water, and potential surface runoff (including soil erosion) are eliminated during irrigation. With an appropriately sized and well-maintained SDI system, water application is highly uniform and efficient. Wetting occurs around the tube and water moves out in all directions.

Subsurface irrigation saves water and improves yields by eliminating surface water evaporation and reducing the incidence of disease and weeds. Water is applied directly to the root zone of the crop and not to the soil surface where most weed seeds winter over. As a result, germination of annual weed seed is greatly reduced, and lowers weed pressure on beneficial crops. In addition, some crops may benefit from the additional heat provided by dry surface conditions, producing more crop biomass, provided water is sufficient in the root zone. When managed properly, water and fertilizer application efficiencies are enhanced, and labor needs are reduced. Field operations are also possible, even when irrigation is applied."14

14 Subsurface Drip Irrigation (SDI), by D. Reich, R. Godin, J.L. Chávez, I. Broner1 (3/09), doc no. 4.716

2.3.2 Drip irrigation

"Drip Irrigation, also commonly referred to as micro-irrigation, trickle irrigation, low volume irrigation. This is a method of irrigation which very efficiently delivers water to the soil surface or the root zone; this is done by having water drip slowly from emission devices, most commonly called "drip emitters" or "drippers".

Early forms of drip irrigation can be traced back to ancient times where clay pots were filled with water and then buried in the ground, this allowed the water to gradually leak out and into the root zone of nearby vegetation. The first formal development of drip irrigation supplies began around 1866 in Afghanistan, where they tested drip irrigation and drainage systems by using various types of clay pipe. A researcher at Colorado State University, Mr. E.B. House, began applying subsurface water directly to the root zone in 1913. Perforated Pipe was first used for irrigation in Germany around 1920. After WWII the ability to mold plastics became widespread and more cost effective. This helped pave the way for innovations in the manufacturing of drip irrigation system components. At this time, Polyethylene (PE) tubing, also referred to as "micro tubing" or "spaghetti tubing", and early versions of emitters (drippers), became more common and was installed throughout the US and Europe. In Israel, Simcha Blass & Yeshayahu Blass were innovating in the area of emitter design. They created a method for water to flow through longer and wider passageways inside of the emitter. These "labyrinths" allowing for less clogging. The velocity of water moving through the labyrinth, and resulting turbulence, helps to slow it down, creating a "drip". "[15]

2.4 Asparagus Crop

Asparagus spears are straight shoots with scale-like tips. Although green varieties are most commonly grown, there are also many purple varieties. Shoots continue emerging from the soil throughout the year. As the weather warms, shoots end to grow into the mature ferny foliage.

2.4.1 Soil for Asparagus

Asparagus grows in most any soil as long as it has good internal drainage. Asparagus roots do not like waterlogged soils that will lead to root rot. It prefers a soil pH of 6.5-7.5.,

15 http://www.irrigationdirect.com/tutorial/irrigation/view/drip-irrigation-system-design-and-installation-guidelines/expert-advice/id/12

and will not do well if the pH is less than 6.0. Have the soil tested to determine phosphorus and potassium needs.[16]

2.4.2 Climate requirements

Asparagus gardening is popular because this vegetable grows well in a variety of climates. It thrives in mild to cold climates and can even withstand frosts. Asparagus prefers full sun, but will grow in partial shade.[17] Which would fit perfectly with the climate conditions of Peru since it is composed of an average temperature of 18 to 20 degrees Celsius, and has a full year round of full sun.

2.4.3 Cultivating Asparagus

Weeds are the biggest problem with asparagus since they offer too much competition for the developing shoots, and in an untidy asparagus patch they can develop very quickly. Frequent cultivation and light mulching are good preventatives. First cultivation should be during the periods of summer, thus being during December and February. At this time, lightly apply fertilizer, preferably well-rotted manure, to each plant. Also, watering is extremely important any time there is lack of adequate water during the growing season. When harvesting has been completed, which can be done twice a year in Peru, incorporate the asparagus bed with a well balanced fertilizer to encourage a generous crop of succulent spears the for next harvest.

2.4.4 Pest and diseases

Problem: Asparagus Aphids
Affected Area: Entire plant

Description: Green plant sucking insects that stunt fern and reduce plant vigor

Control: Use insecticidal soaps or labeled insecticides

Problem: Root Rot Diseases
Affected Area: Fern tip

Description: Fungal diseases that reduce plant vigor and stands. Tips of ferns turn yellow and die followed by rest of stems and eventually plants. Spears are small and

16 http://ohioline.osu.edu/hyg-fact/1000/1603.html

17 http://www.howtogardenadvice.com/vegetables/grow_asparagus.html#climate

skinny.

Control: Reduce plant stress which may be caused by insects, over-watering, over cutting, drought and weed pressure. This can be controlled by the use of tensiometers in the soil which can show how much water is being retained in the soil.[18]

2.4.5 Harvest

Harvest spears 5 to 8 inches in length by cutting or snapping. To cut a spear, run a knife into the soil at the base of the spear and carefully sever it. Because the spear is cut below the point where fiber develops, it becomes necessary to remove the fibrous base from the tender stalk. Cutting may damage some spear tips that have not yet emerged from the ground. To snap a spear, grasp it near the base and bend it toward the ground. The spear breaks at the lowest point where it is free of fiber.[19]

18 http://www.essentialgardenguide.com/garden-vegetables-problems/2/Asparagus/

19 http://urbanext.illinois.edu/veggies/asparagus.cfm

3 Reasons of importance of sandy soil water retention in Peru

3.1 Water availability

In the region of Peru, Ica there is a greater need of clean fresh water to irrigate crops. Generally there are wells made by the company to extract the water from the subsurface rivers. The availability of rainfall is close to none and it is insufficient to keep a crop well irrigated at least in the region of the coast, when referring to the mountain range and jungle you are able to get a lot of rain in the rainy season. In most situations this wells do not have the right paper work, therefore there has been several scandals the last couple of years with boring new wells into the ground, thus complicating the water availability to the different companies.

3.1.1 Wells

In Fundo Fangelica we have the benefit of having wells, which are operative, and working properly, never the less there is an increasing number of illegal wells being made, which could limit the size of the farm in the future. In the article below on is able to see that this is becoming more and more of a concern in the region where Fundo Fangelica is situated.

3.1.2 Stream or River

There is the possibility of buying hours of water from the river Pisco. Generally there are certain months to which we are able to do this, since there is an abundance of water on those months. During this period we are able to buy water at a cost price of forty soles and hour, an approximate amount of ten euros and hour. The water is able to reach our farm by gravity canals. Fundo Fangelica is looking forward to make an investment on flexi tubes which allow us to have no loss of water throughout the trajectory when reaching the farm.

3.2 Technology

The Drip irrigation has been recently introduced into the Peru. The main use of SDI irrigation is normally applied for sugar cane plantations, meanwhile conventional drip tape irrigation is used for high end crops, such as asparagus, grapes, citrus, olives, etc. If possible to apply SDI technology for organic asparagus this can cause better yields and income for the company, always when its suitable for the area that SDI is going to be applied too.

4 Methodology

There are several experiments, and information that has to be done, and analyzed, so that we can reach our main research question. This is the following question:

How to use sub-surface or drip irrigation for asparagus cultivation in the Peru desert area in a sustainable way?

By knowing the research question we know what has to be achieved, therefore there are sub questions to reach the main question. With this information it is possible to separate the test and information needed into different categories, and from there being able to analyze the information and come to a conclusion. The following categories would be:

- Soil properties
    - Permeability
    - Capillary rise
    - Water quality and in combination with drainage and use
- Water Retention
    - Organic fertilizer
        - Manure
        - Compost
- Asparagus Growth
    - Root system

4.1 Soil properties

The way that it is most convenient to get this information would be by sending the soils samples to a test lab where they can professionally find the different aspects such as:

- Drainage
- Evaporation
- Capillary rise
- Salinization and ways to desalinate the soils

The soil sample shall be sent with different amounts of organic matter with in each test, for example:

1Ha = 4,800Tn (of sand)

10Tn(of organic matter)/4,800Tn(of sand per hectare) = Ration .00208

.00208 / 20Kg(of sand) = .04166Gram(organic matter)

One sample will have the ratio of 10 TN with in the soil sample so this would imply that if I had 20KG of soil that would mean that I need 04166 grams. This would be applied to all soil samples till reaching the 100Tn. The formula above shows how I reached this conclusion.

4.2 Water Retention

For the water retention test it was best to use buckets with drainage holes on the bottom, and with the required amount of organic matter with in each bucket. When the buckets are complete, with the right amount of organic matter on each bucket, and then apply 8 litters of water in each bucket. When this is completed then weight the buckets in a constant manner to see the weight difference on each bucket, thus showing the relativity of water retention versus. The different amounts of organic matter within each buckets ranging from 10tn to 100tn

4.3 Asparagus Growth

The best test trial for this would be to make different scenarios of irrigation, and growing asparagus within each scenario. There is a test on site where they have been growing asparagus with SDI. This would mean that the test is already working for a long period of time, and it's ready to inspect the root system growth. While inspecting the root system one is able to appreciate the different scenarios where the SDI system has been put to the test. With this information one is able to comprehend the growth of the plant. The lay out of the test scenario is the following:

INSTALLATION OF AN EXPERIMENT - PRIMARY - UNDERGROUND- DRIP - IRRIGATION - CROP - GREEN ASPARAGUS.

AREA TO BE USED: 24.00 M2
Soil: SAND FROM FUNDO FANGELICA

Pictures
Pictures can be found in the appendix under photos. The explanations of the following photos are:

- Photos 1,2 consist of the test site
- Photo 3 is the checking of the root system
- Photos 4,5,6 is when there was only one SDI line used
- Photos 7,8 is when two SDI lines are used

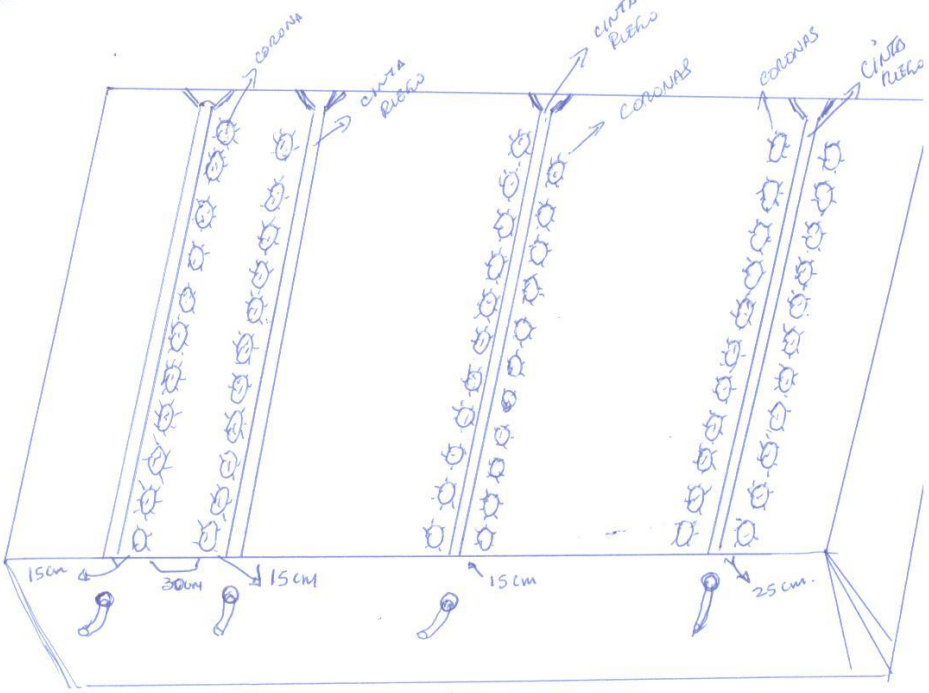
DESIGN - USED
1 .- A SDI buried 25 cm deep, and crowns to the side even distance of 25 cm, with a planting depth of 30 cm. 22 crowns used for the experiment.
2 .- The second SDI buried 30 cm deep, and the crowns planted at the side to a distance of 15 cm. 22 crowns used for the experiment.
3 .- Double SDI lines to a depth of 30 cm and planting of crowns between lines. 22 crowns were planted for the experiment.

As shown on the following diagram below:

INSTALACIÓN – PILOTO –

RIEGO – GOTEO – SUBTERRANEO

DISEÑO – CAMPO



TRATAMIENTO 03

* DOBLE CINTA.
* 1/2 HILERA CORONA - 30cm
- CORONA HACIA - CINTA 15 cm
* Profundidad = 30cm

TRATAMIENTO 02

* UNA SOLA CINTA
* SEMBRIO : 15 cm distancia HACIA CINTA RIEGO

Profundidad = 30cm

TRATAMIENTO – 01

01

- UNA SOLA CINTA

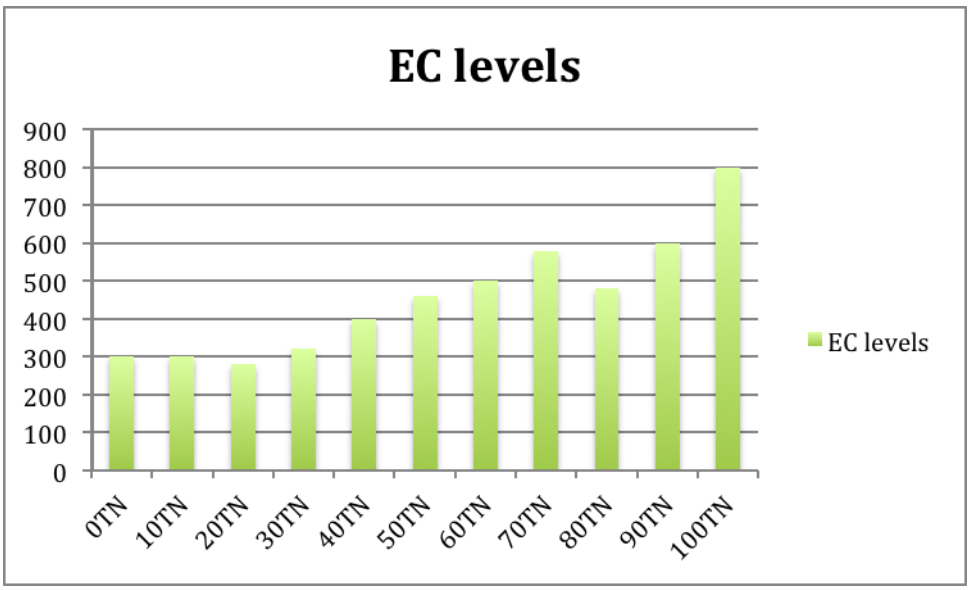
* PROFUNDIDAD = 25 cm

(Diagram 1)

5 Results

5.1 Soil properties

the soils properties can be found in the appendix under lab results you will be able to find the soil samples, which were sent to Chile to be analyzed from the different trials. As shown below the electric conductivity, also known as EC levels can be appreciated on the bar graph:



(Chart 3)

5.2 Water Retention

Within the water retention test there were 11 buckets used. All these buckets had different amount of organic matter with relation to the tons that where set to be used with in a Ha. These where the following amounts seen on chart 3:

	Dosis	SAND	Organic matter	Water/Bucket
Test	Amount/Ha	Bucket	Doses/GRM/Bucket	litters,
Trial	TN	KG	GRM	LT
T1	0	20	0	8
T2	10	20	41,66	8
T3	20	20	83,32	8
T4	30	20	124,98	8
T5	40	20	166,64	8
T6	50	20	208,30	8
T7	60	20	249,56	8
T8	70	20	291,62	8
T9	80	20	333,28	8
T10	90	20	374,94	8
T11	100	20	416,60	8

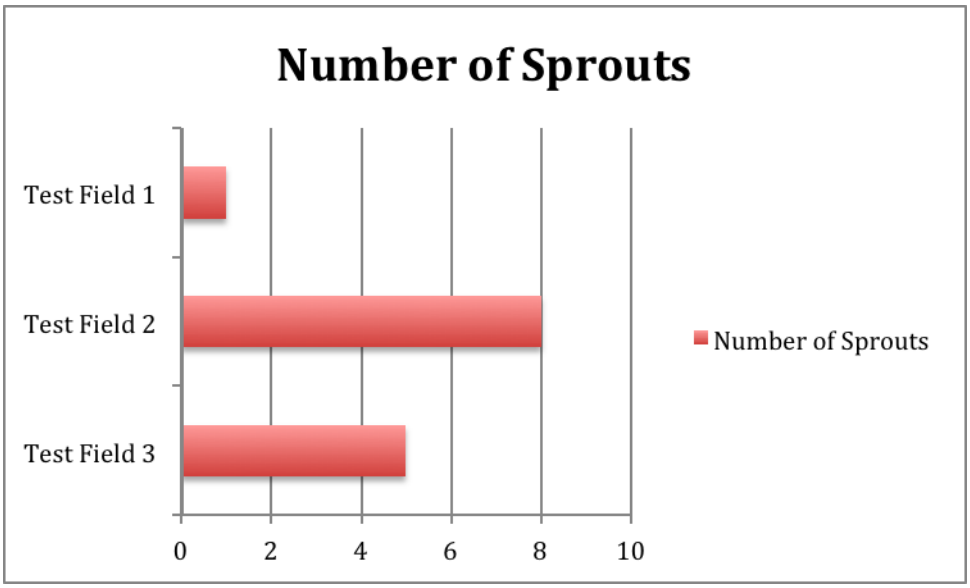
(Chart 3)

As appreciated on the chart there were 8 litters of water used within each trial as a fixed amount of water to be used. Another constant amount was the 20 kilos of sand used. When preforming the test there where constant measurements taken throughout the period of time. This was the data taken on chart 5, which is located in the appendix under charts

On these charts one is able to see the total weight of the buckets after a period of time. Within the charts one can appreciate the volume of water that has drained out of the bucket, and in the same chart information you can see what sort of weather the information was taken. For analyzing the information better there are these graphs which were made by the information taken from the charts as you can see on graph 1, graph 2, bar graph1, chart 5 located in the appendix.

5.3 Asparagus Growth

the asparagus have responded well to the experiment, this can be seen on the log located in the appendix under asparagus test trial log. There have been some promising amounts of sprouts that can be seen by the experiment made. As you can see below on the graph, it shows the amount of sprouts that where seen with in each test trial.


Number of Sprouts
Test Field 1
Test Field 2
Test Field 3
0
2
4
6
8
10
Number of Sprouts

6 Discussions

6.1 development method

6.1.1 Soil properties

Considering the results that were sent back from the lab in chile the soils has shown and proven that water retention is possible by adding organic matter. One is able to appreciate the level of increment from each soil sample sent by focusing on the EC levels. This means thatthere has been an increament on the connectivity of the soil water through soil density, soil structure , water potential, soil aggregation, electrolytes in soil water (e.g. salinity exchangeable ions, soil water content, soil temperature.) the conductivity of the mineral phase aggects the EC reaing for example the types and quantity of minerals, degree of isomorphic substitution, and exchangeable ions. Regardless of what these multiple causes of EC variability are, what still remains is that EC measurements are consistenly correlated to soil properties that affect crop productivity, including soil texture. Cation exchange capacity (CEC), drainge conditions, organic matter level and salinity, so knowing the EC level is a great predictor of your plants health. The best range fo the asparagus plant is located between 400 EC and 600 EC which is recommended to grow aspargus.

6.1.2 Water retention

Regarding to the water retention tests that were made. It is clear by the data given that by increasing the amount of organic matter, in this case manure; there is an increase of water retention with in the soil. As you can appreciate on graph 1 located on the appendix, one is able to appreciate the slope that is given by the graph. If you are to compare the slope of the 10tns vs. the 100tns there is a significant amount of water still being held with in the soil. By also looking at the chart 5 located in the appendix, one is also able to appreciate the weight loss of the water within the soil, and how by having a greater amount of organic matter, water retention improves.

As shown within the two examples this does not mean that putting enormous amounts of organic matter in the soil this will completely retain 10 times more water. There is a gradual slope of increasing water retention, but I strongly believe that at a certain point

of adding organic matter this will come to maximum point of water retention capability. Unfortunately I could only cover to the 100tns of organic matter within one Ha. Since by putting any more organic matter this would increase drastically the costs planting asparagus within sandy soils for Fundo Fangelica.

6.1.3 Asparagus growth

As the experiment showed the different parts of developments of the asparagus plant, it was interesting to see how the plant would react to the different scenarios that where set by the management team. It was exciting to see that when there was only one SDI line used to grow the asparagus, the root system was developing and forming itself around the SDI drip closure, thus creating the possibility of enclosing the drip surface of the pipe. When admiring the amounts of shoots that where given by the asparagus plant with only one SDI pipe the numbers where not inspiring, 1 shoot was only seen.

When you take a look at the test trial, when using two SDI pipes the root system tended to grow in a downwards face, and not tending to grow around the pipe. When the first shoots of the asparagus plants where seen the numbers seemed to be promising, 5 shoots average seen per asparagus plant, thus 5 time more than that from the 1SDI pipe installation.

When wanting to make a test trial for the conventional drip tape that is laid on top of the surface of the soil, this was not needed. The management from Fundo Fangelica where already convinced that by using subsurface drip irrigation this would allow the asparagus plant to grow without as many pest and diseases as how the plant is normally grown. This has been proven idea has been proven by different reports which state that SDI is superior to that from the conventional drip tape irrigation.

It has been proven “By the university of Arizona” that the SDI has a 15% to 30% percent better water retention depending on the soil that the line is buried under. This is because water is directly applied to the soil, and plant roots with little waste to ground water, wind, evaporation, or run off, thus making conventional drip irrigation technology seem from the past. SDI decreases the amounts of possible pest and diseases. For example the asparagus plant will have the benefit of having no Prodiplosis longifila, a very harmful

insect that uses surface water for breeding and survival, and by not having this it is expected to result in a 15% yield increase.

7 Conclusion

There are three major aspects that have to be concluded separately to have a better perspective of the complete overview of the research done.

Soil properties have shown that by adding organic matter in to the ground it has caused a huge impact in the soils fertility but also in its EC levels. By adding organic matter there has been an increase on the conductivity of the soil water through soil density. There has also been and improvement on the soil structure, a water potential, and an increase on electrolytes in soil water. This has also affected the conductivity of the mineral phase. Which means that it had an effected on the number and types of minerals, degree of isomorphic substitution, and exchangeable ions. The EC Measurement are consistently connected to soil properties which affect crop productivity, soil texture, Cation Exchange Capacity (CEC), drainage conditions, organic matter level, and salinity. So doing so the soils have improved, and indeed the soils from Fundo Fangelica do require organic matter to increase these different levels since it lacks these components. Never the less there is a thin level of when there is too much organic matter for the asparagus plant to grow in an even way.
Water retention is possible by applying large amount of fertilizer on the ground. This has been proven by the different graphs, bar graphs, charts, and also in the filed experiment that was made in Fundo Fangelica, which all the information is located in the appendix. Never the less the more organic matter that is applied on to the ground causes two problems. The first problem is related to the influence in the soils EC range, which can be beneficial to the plant, but to a certain extent. The second problem would be the cost of the organic matter. The more organic matter the higher the cost, and since organic matter is a product that with time disintegrates this could cause for an even larger investment. It would be wise for the first time when plants to incorporate a large sum of organic matter into the ground, but then keep to a schedule which you will add smaller amount of organic matter to the ground till you have reached the potential amount of water that you wish to retain together with the right EC levels, would be dependent together wit the regimen of the irrigation.

Asparagus growth has been a successful yet challenging test trial. It has proven that the asparagus plant has been successfully planted on to the ground with this system. From the three-test trial, the trial, which incorporated two SDI lines, side by side, has proven to

be the most reliable option. Since the root system of the plant has grown along the side of the SDI tube, instead of curling up around the SDI irrigation tube. This Trial has also proven to show reliable amounts of sprouts. When seeing the final product the plant was completely developed, and had 95% of its sprouts developed. The sensible, but more expensive solution: is to incorporate and use two SDI line side by side. This will guarantee a good and reliable produce of asparagus per hectare.

The results are there and have proven that water retention, and cultivation of asparagus in the desert farm from Fundo Fangelica is possible, never the less I would recommend to go for the safer option regarding to the SDI irrigation system. A use two irrigation lines, and in the middle, have the asparagus plant. This would seem as a more safer solution regarding to planting asparagus in Fundo Fangelica.

8 Recommendations.

8.1 Maintain and improve

Some of these standards can be used already, but some still need to be elaborate or improve in order to be more efficient and reliable. In the future, the standard might be changed due to the changes of all concerning aspects, therefore the standard should be regularly updated.

8.2 Further research

This research is only based on the improvements of water retention within in sandy soils by using organic matter with the use of drip irrigation or SDI, as a source of irrigation. The main point of interest is to improve the retention of water with in sandy soils. There could be further research done by using other minerals, or using ways to increase the level of clay within sandy soils, thus changing the soil structure. Other research that can be done is the feasibility of using organic matter. Since it is a component which will decay, meaning that yearly or monthly there has to be a certain dose of organic matter given to the soil to maintain the levels of water retention. In a sense there is plenty of research cases that can be done that can adjust to this concept. This information can create more awareness for farmers who are located in areas where you find sandy soils and wish to be more efficient with their crops.

References

Books

- Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys, Second Edition, 1999, By Soil Survey Staff

Internet

- MEASURING SOIL WATER FOR IRRIGATION SCHEDULING: MONITORING METHODS AND DEVICES, site: http://www.bae.ncsu.edu/programs/extension/evans/ag452-2.html Prepared by:
  Robert Evans, Extension Agricultural Engineering Specialist
  D. K. Cassel, Professor of Soil Science
  R. E. Sneed, William Neal Reynolds Professor
- Management Team, Fundo Fangelica S.A.C., http://www.donapancha.com/
- Malheur Experiment Station, http://www.cropinfo.net/drip.htm
- http://en.wikipedia.org/wiki/Sand,The Free Encyclopedia.
- University of Arizona, Department of soil, water, and environmental science, http://ag.arizona.edu/crop/irrigation/azdrip/SDI.htm
- EAIS, http://www.eais.net/soil/#1
- http://www.irrigationdirect.com/tutorial/irrigation/view/drip-irrigation-system-design-and-installation-guidelines/expert-advice/id/12
- http://ohioline.osu.edu/hyg-fact/1000/1603.html
- http://www.howtogardenadvice.com/vegetables/grow_asparagus.html#climate
- http://www.essentialgardenguide.com/garden-vegetables-problems/2/Asparagus/
- http://urbanext.illinois.edu/veggies/asparagus.cfm
- http://www.rain.org/global-garden/soil-types-and-testing.htm
- http://en.wikipedia.org/wiki/Leptosols
- http://www.bae.ncsu.edu/programs/extension/evans/ag452-2.html
- http://www.ars.usda.gov/SP2UserFiles/Place/53102000/pdf_pubs/P1647.pdf
- http://edis.ifas.ufl.edu/ss109
- http://en.wikipedia.org/wiki/Soil
- http://www.ext.colostate.edu/pubs/crops/04716.html

- http://www.statpac.com/research-papers/research-proposal.htm#chapter-3

Current articles

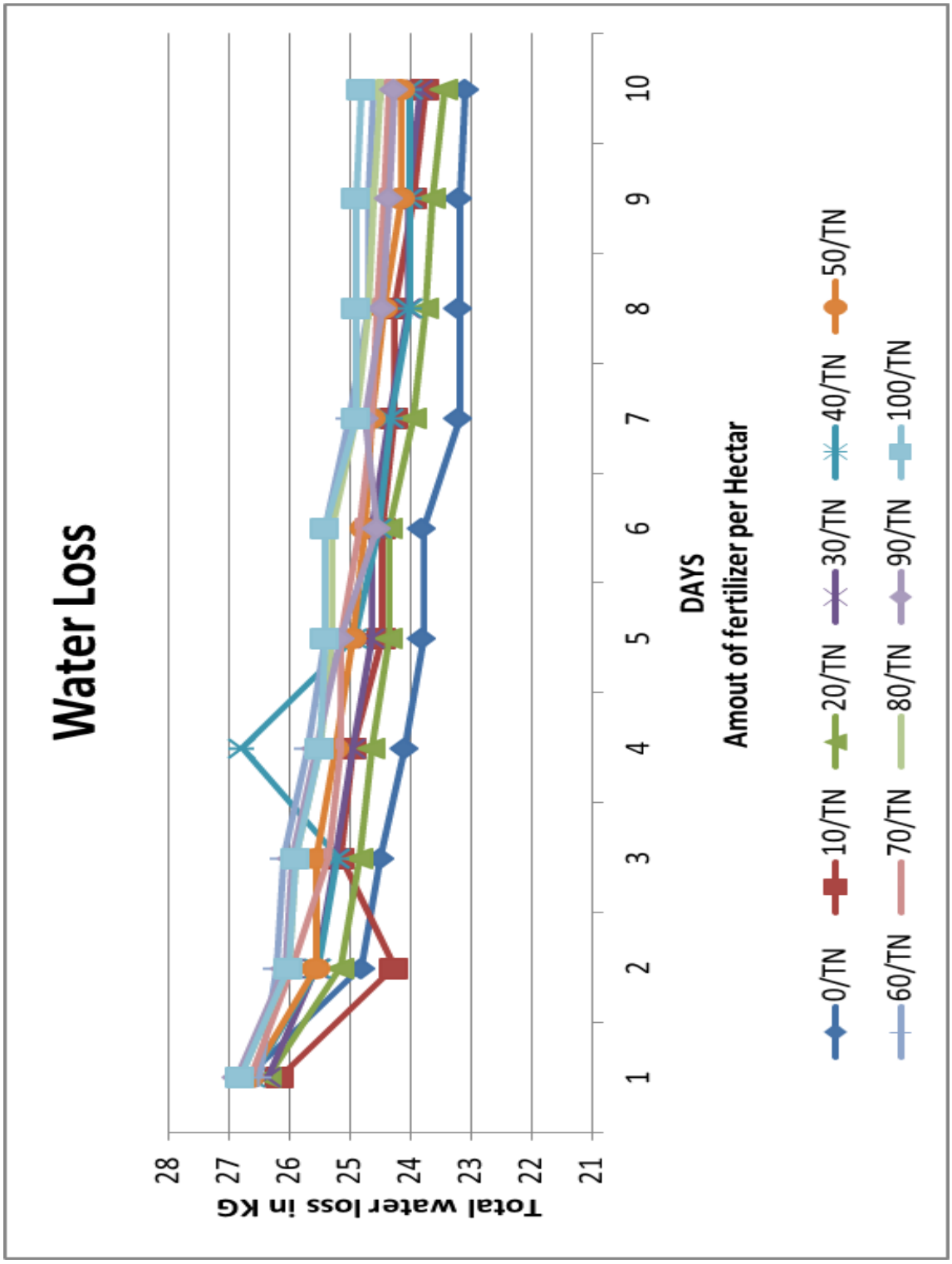
- To Water, or Not to Water?, by Steve Upson
- Benavides: Si no hacemos nada, Ica será sólo un desierto, http://www.expreso.com.pe/edicion/index.php?option=com_content&task=view&id=89615&Itemid=34, Aritcle, by PAOLA PLACIDO

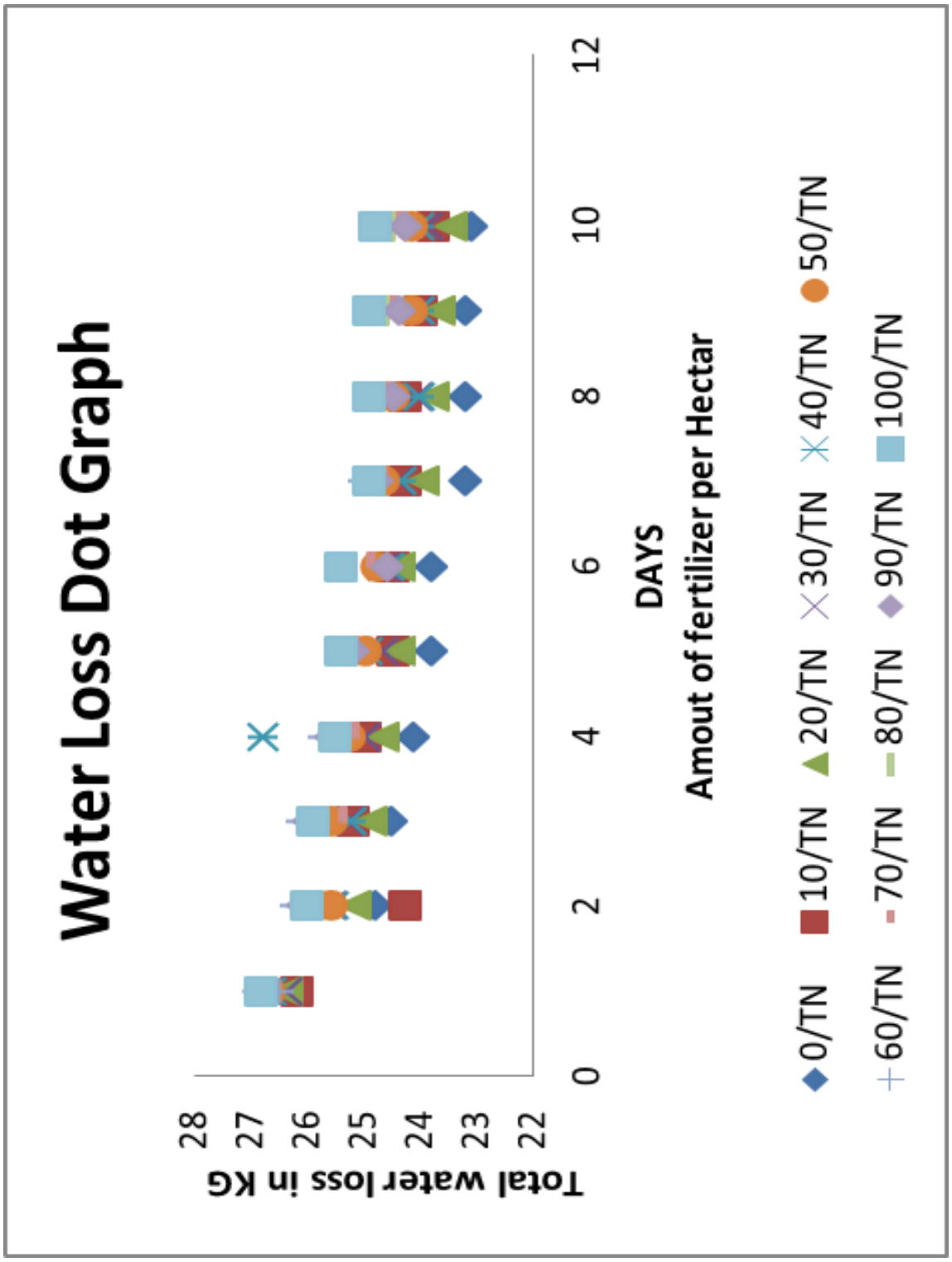
Documents a Reports

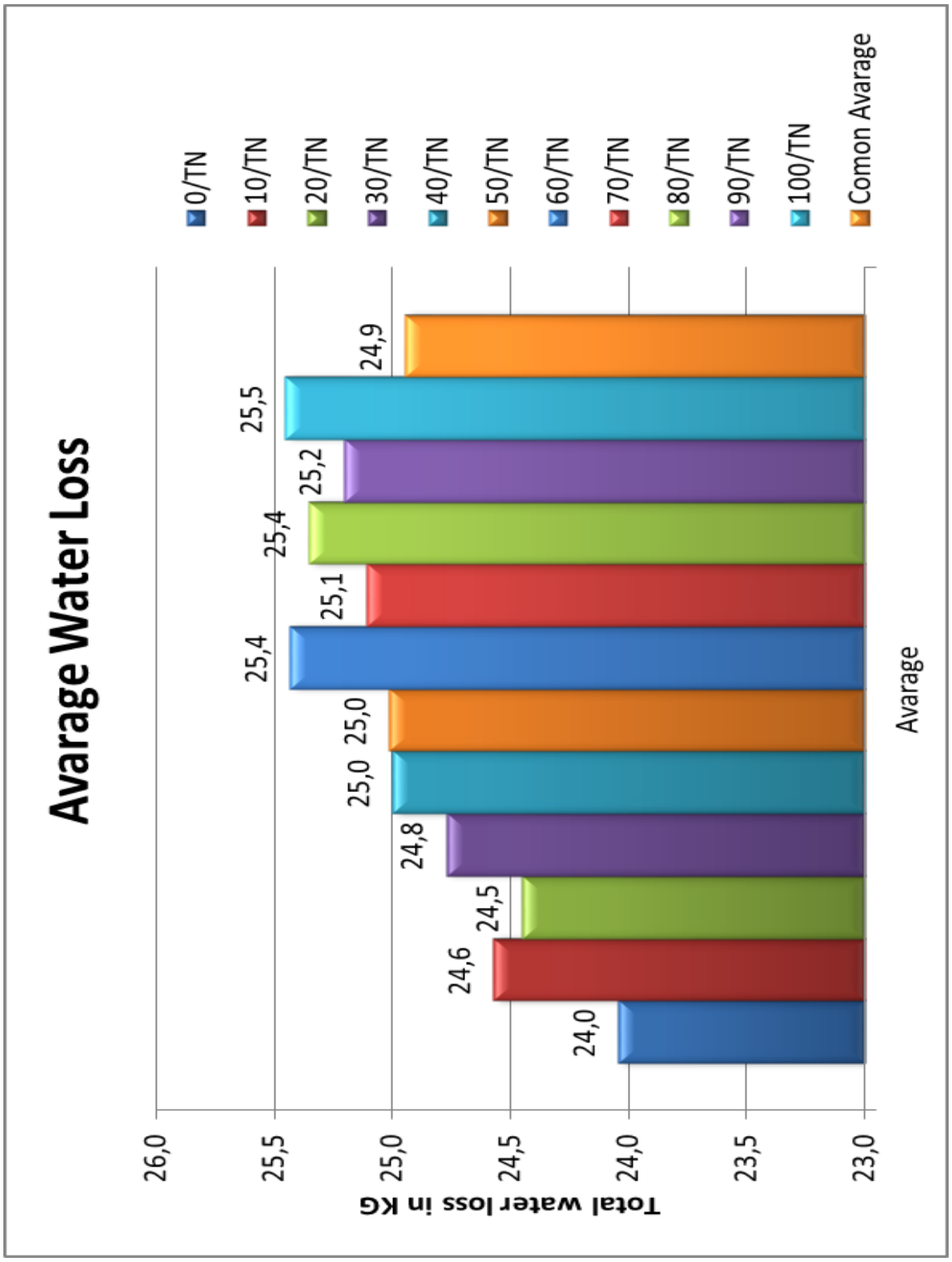
- Subsurface Drip Irrigation (SDI), by D. Reich, R. Godin, J.L. Chávez, I. Broner1 (3/09), doc no. 4.716, Colorado State University

Appendixes

Graphs




Water Loss Dot Graph
Total water loss in KG
28
27
26
25
24
23
22
0
2
4
6
8
10
12
DAYS
Amout of fertilizer per Hectar
0/TN
10/TN
20/TN
30/TN
40/TN
50/TN
60/TN
70/TN
80/TN
90/TN
100/TN


Avarage Water Loss
0/TN
10/TN
20/TN
30/TN
40/TN
50/TN
60/TN
70/TN
80/TN
90/TN
100/TN
Comon Avarage
24,0
24,6
24,5
24,8
25,0
25,0
25,4
25,1
25,4
25,2
25,5
24,9
Avarage
Total water loss in KG
26,0
25,5
25,0
24,5
24,0
23,5
23,0

Current Events

“Benavides: If we do nothing, Ica is just a desert

Agroexporters say that next to the Brescia Group financed project to bring water from the Rio Pisco various aquifers.

Ica, the Peruvian region that is known worldwide for the export boom,is literally "dying" of thirst, because of the scarcity of water, driven by their indiscriminate use of water ,and by the lack of a responsible management plan of groundwater recovery .

The situation begins to worsen, because there are business projects which rather to contribute to the development work of the aquifer reinjection, prefer to continue drilling wells to extract the little fresh water there is, despite the aquifer ban decreed by the National Water Authority (WNA).

So critical is the situation, which, for example, the 5000 inhabitants of Paracas have only water 10 minutes a day, and is supplied by a single shaft.

"If we do nothing Ica will only be a desert, agriculture will disappear again and poverty will dominate the region," said agricultural exporter and former Agriculture Minister Ismael Benavides Ferreyros.

Therefore questioned the attitude of the Metallurgical Company Aceros Arequipa SA, "that breaking the law and no respect for farmers insists the purposes of laying of 11.5 km of pipes in order to continue extracting groundwater at its plant, from its supposed fundo Benjamin (located 10 kilometers from the company). "

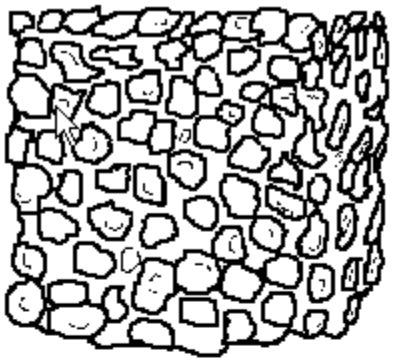
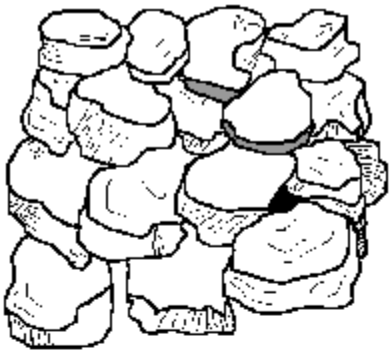
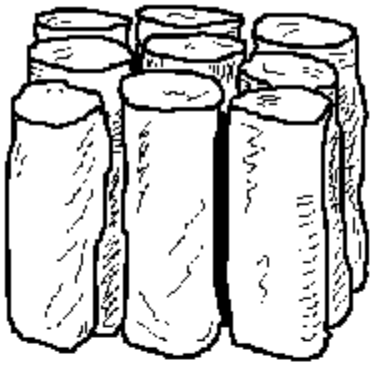
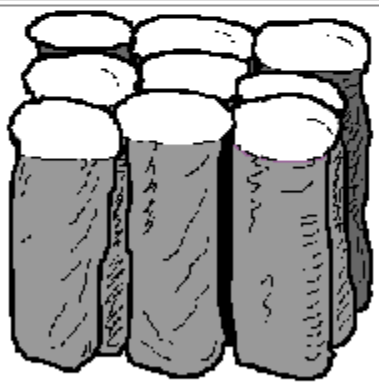
He recalled that on 15 January 2010, the WNA published the resolution directorial N º - 0015-2010-ANA-Darhan declaring automatically void the request for extension of validity of the Administrative Decision No. 025-2009-ANA-ALA-CH- P, filed by the company Aceros Arequipa, which gave them permit. "There is a ban established by the WNA wells in October 2009, which implies that one cannot draw the liquid component of the amount already established. Aceros Arequipa claims to have pre-ban licenses to operate two wells, but it is known that they were given in an irregular manner and that the WNA has revoked, the license “said Benavides.

saving plan

For Benavides an ultimate solution would be the project "Derivacion Pisco-Lanchas" which derives the Pisco river through a canal system and then re-inject water into wells (which are now empty) of the peoples of Motor Villacuri (Paracas .) He said that this work-investment of U.S. $ 4 billion, would be funded by Aceros Arequipa (33%), the agro-ters (33%) and group Brescia (33%). " however, Aceros Arequipa chose to abandon the project to lay pipes, and damage crops including grapes for export."”[20]

20 http://www.expreso.com.pe/edicion/index.php?option=com_content&task=view&id=89615&Itemid=34, Aritcle, by **PAOLA PLACIDO**

Charts

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

(Chart 2)

	Day- Clouded				Day- Clouded		Day - Sunny	
	Weight Result		Weight Result		Weight Result		Weight Result	
	7:00 A.M.	1-9-2010	5:30 P.M.	1-9-2010	7:00 A.M.	2-9-2010	7:00 A.M.	3-9-2010
Doses	NET/W.	Measure.	NET/W.	Measure.	NET/W.	Measure.	NET/W.	Measure.
Amount/Ha	KGS.	Water/Volume	KGS.	Water/Volume	KGS.	Water/Volume	KGS.	Water/Volume
TN	KG	LT	KG	LT	KG	LT	KG	LT
0	**26,7**	1,5	**24,8**	0,8	**24,5**	0,17	**24,1**	0
10	**26,16**	1,3	**24,26**	0,5	**25,16**	0,1	**24,96**	0
20	**26,35**	1,4	**25,15**	0,6	**24,85**	0,1	**24,65**	0
30	**26,35**	1,2	**25,55**	0,4	**25,25**	0,25	**24,95**	0
40	**26,62**	1,3	**25,52**	0,5	**25,22**	0,2	**26,78**	0
50	**26,65**	1,3	**25,55**	0,3	**25,55**	0,12	**25,25**	0
60	**26,5**	1,1	**26,2**	0,1	**26,1**	0,06	**25,7**	0
70	**26,65**	1,3	**25,95**	0,25	**25,35**	0,25	**25,15**	0
80	**26,8**	0,7	**26**	0,4	**25,9**	0,1	**25,5**	0
90	**26,86**	0,9	**26,06**	0,45	**25,96**	0,12	**25,56**	0
100	**26,8**	0,9	**26**	0,65	**25,9**	0,02	**25,5**	0

	Day- Clouded		Day- Clouded		Day- Clouded		Day - Sunny	
	Weight Result		Weight Result		Weight Result		Weight Result	
	7:00 A.M.	04/0910	7:00 A.M.	5-9-2010	7:00 A.M.	6-9-2010	7:00 A.M.	7-9-2010
Doses	NET/W.	Measure.	NET/W.	Measure.	NET/W.	Measure.	NET/W.	Measure.
Amount/Ha	KGS.	Water/Volume	KGS.	Water/Volume	KGS.	Water/Volume	KGS.	Water/Volume
TN	KG	LT	KG	LT	KG	LT	KG	LT
0	**23,8**	0	**23,8**	0	**23,2**	0	**23,2**	0
10	**24,46**	0	**24,46**	0	**24,26**	0	**24,26**	0
20	**24,35**	0	**24,35**	0	**23,95**	0	**23,75**	0
30	**24,65**	0	**24,65**	0	**24,35**	0	**24,05**	0
40	**24,92**	0	**24,52**	0	**24,32**	0	**24,02**	0
50	**24,95**	0	**24,75**	0	**24,65**	0	**24,45**	0
60	**25,4**	0	**25,4**	0	**25**	0	**24,7**	0
70	**25,15**	0	**24,85**	0	**24,65**	0	**24,55**	0
80	**25,3**	0	**25,3**	0	**24,9**	0	**24,7**	0
90	**25,16**	0	**24,56**	0	**24,76**	0	**24,46**	0
100	**25,4**	0	**25,4**	0	**24,9**	0	**24,9**	0

	Day - Sunny		Day - Sunny	
	Weight Result		Weight Result	
	7:00 A.M.	8-9-2010	7:00 A.M.	9-9-2010
Doses	NET/W.	Measure.	NET/W.	Measure.
Amount/Ha	KGS.	Water/Volume	KGS.	Water/Volume
TN	KG	LT	KG	LT
0	**23,2**	0	**23,1**	0
10	**23,96**	0	**23,75**	0
20	**23,65**	0	**23,45**	0
30	**24,05**	0	**23,85**	0
40	**24,02**	0	**24,02**	0
50	**24,15**	0	**24,15**	0
60	**24,7**	0	**24,6**	0
70	**24,45**	0	**24,35**	0
80	**24,6**	0	**24,5**	0
90	**24,36**	0	**24,26**	0
100	**24,9**	0	**24,8**	0

(Charts 4)

CHART AMOUNT OF WATER LOST											
DAYS	0/TN	10/TN	20/TN	30/TN	40/TN	50/TN	60/TN	70/TN	80/TN	90/TN	100/TN
WEIGHT	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
1	**26,7**	**26,16**	**26,35**	**26,35**	**26,62**	**26,65**	**26,5**	**26,65**	**26,8**	**26,86**	**26,8**
2	**24,8**	**24,26**	**25,15**	**25,55**	**25,52**	**25,55**	**26,2**	**25,95**	**26**	**26,06**	**26**
3	**24,5**	**25,16**	**24,85**	**25,25**	**25,22**	**25,55**	**26,1**	**25,35**	**25,9**	**25,96**	**25,9**
4	**24,1**	**24,96**	**24,65**	**24,95**	**26,78**	**25,25**	**25,7**	**25,15**	**25,5**	**25,56**	**25,5**
5	**23,8**	**24,46**	**24,35**	**24,65**	**24,92**	**24,95**	**25,4**	**25,15**	**25,3**	**25,16**	**25,4**
6	**23,8**	**24,46**	**24,35**	**24,65**	**24,52**	**24,75**	**25,4**	**24,85**	**25,3**	**24,56**	**25,4**
7	**23,2**	**24,26**	**23,95**	**24,35**	**24,32**	**24,65**	**25**	**24,65**	**24,9**	**24,76**	**24,9**
8	**23,2**	**24,26**	**23,75**	**24,05**	**24,02**	**24,45**	**24,7**	**24,55**	**24,7**	**24,46**	**24,9**
9	**23,2**	**23,96**	**23,65**	**24,05**	**24,02**	**24,15**	**24,7**	**24,45**	**24,6**	**24,36**	**24,9**
10	**23,1**	**23,75**	**23,45**	**23,85**	**24,02**	**24,15**	**24,6**	**24,35**	**24,5**	**24,26**	**24,8**
Avarage	24,0	24,6	24,5	24,8	25,0	25,0	25,4	25,1	25,4	25,2	25,5
					Comon Avarage 24,9						

(Chart 5)

Asparagus Test Trial Log

PREPARATION OF SOIL BEFORE PLANTING.

- Once installed underground drip irrigation system, we proceeded to make the soil washing "used 800 liters of pure water reaching humidity bulb a depth of 1.2 m and width 80 cm to the right and left, and 30 cm at the top from axis of the drip tape installed.
- Once the soil was washed, we proceeded to incorporate organic matter at a ratio of 70 TN / Ha then proceeded to disinfect the plant crowns with the following chemicals.
    - Mertec - (thiabendazole) - 400 cc / Ha
    - Roothor-(Auxin, Acid - Nucleic) - 400cc/Ha
    - Enziprom - (Bioactivator - Enzyme) - 400 cc / Ha

Date - 22/08/09

- Disinfected once, preceded to the planting of the crowns as the diagram was design for each particular test field.
- Then proceeded to perform the daily irrigation,
- The 22nd August 1st completed planting. We preceded to the 1st irrigation water volume of 200 liters, 2.0 liters of more Humic acid.

Date - 23/08/09

- Proceeded to water with 200 liters, 2.0 liters more Humic Acid

Date - 24/08/09

- Proceeded to water with 200 liters of water plus 2.0 liters of Humic acid.

Observations as follows (24th august):

- Test field - 01 - the humidity is 15 cm alive still does not reach the crown
- Test field - 02 - alive if moisture is coming to the crown
- Test field - 03 - the humidity is 15 cm and is coming to the crown.

Date - 25/08/09

- The 25th of August, with continuous irrigation volume of 200 liters of water, plus 2.0 liters of Humic Acid

Observations as follows (25th august):

- Test field -01-Issue humidity- has reached 22 cm, but still does not reach the crown in its entirety
- Test field -02 - Issue humidity - humidity has reached 25 cm. The crown with sufficient moisture.
- Test field -03 - Issue humidity - humidity has reached 24 cm, find the crown with sufficient moisture.

Date - 26/08/10

- Proceeded to irrigate with the same dose, but the dosification of water had been taken up, and we proceeded to review the tapes

Observations as follows (25th august):

- Test field -01, the humidity had dropped and was currently at 15 cm
- Test field -02, the humidity was kept at 25 cm normal functioning.
- Test field -03, , the humidity had dropped and was currently at 15 cm
- Checked the drippers found that Test field-01 and Test field-03, were clogged with the presence of silt, was cleaned and then continued with normal irrigation.

Date - 27/08/10

- Proceeded to water with 200 liters of water, with 2.0 liters of phosphoric acid.

Observations as follows (27th august):

- Test field -01, humidity at 25 cm total spread of 50cm. crown with sufficient moisture
- Test field -02, humidity at 25 cm total spread of 50cm. crown with sufficient moisture
- Test field -03, humidity at 25 cm total spread of 50cm. crown with sufficient moisture.

Date - 28/08/10

- Continuing with the same volume of water for irrigation

Observations as follows (28th august):

- Test Fields1,2,3, normal operation, there are the first shoots are seen in the Test fields 2,3

Date - 29/08/10

- Proceeded to water the same volume of water and SDI lines working perfectly.

Date - 30/08/10

- Proceeded to water the same volume of water and SDI lines working perfectly.

Date - 31/08/10

- Watered with 300 liters of water

Observations as follows (31th august):

- Test field -01 - number of sprouts 01
- Test field -02, -number of sprouts 05
- Test field -03, -number of sprouts 03
- Moisture gets up to 30 cm from the axis of the drip tape.

Date - 1/09/10

- Continued with normal irrigation

Date - 2/09/10

- Continued with normal irrigation

Observations as follows (2th September):

- Humidity up to 25 cm from the axis irrigation tape
- Test field -01 - number of sprouts 01
- Test field -02, -number of sprouts 08
- Test field -03, -number of sprouts 05
- Considering that Test field-01 did not show any humidity for the crown. We proceeded to install another drip tape at 22 cm deep, close to the crown.

Date - 20/09/10

- Continued with normal irrigation

Observations as follows (20th September):

- Test field -01- percentage of shoots reached a 75%
- Test field -02- percentage of shoots reached a 95%
- Test field -03- percentage of shoots reached a 95%

Date - 20/09/10

- The irrigation were normal 200 liters of water plus 2.0 kg of phosphoric acid and the plant achieved full maturity.
- Plant had shown signs of larval damage on the shoots (Copitarsia)
- The crop showed a good structure and we proceeded to plant nutrition program.

DOSE - KGS / Elements

N: 150Kgs

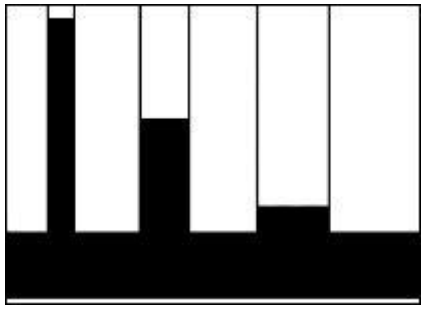
P: 100Kgs

K: 180Kgs

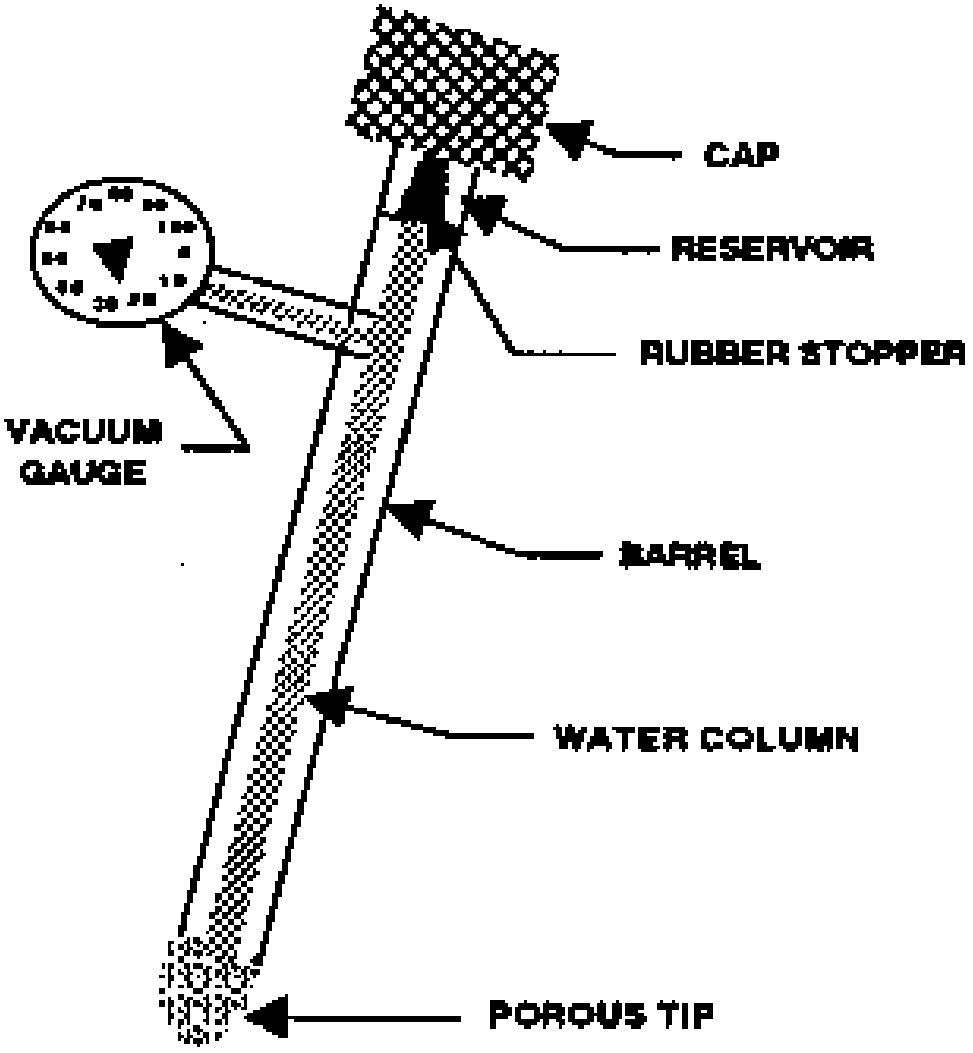
Ca: 80Kgs

MG: 60Kg

Photos



(Figure 1)



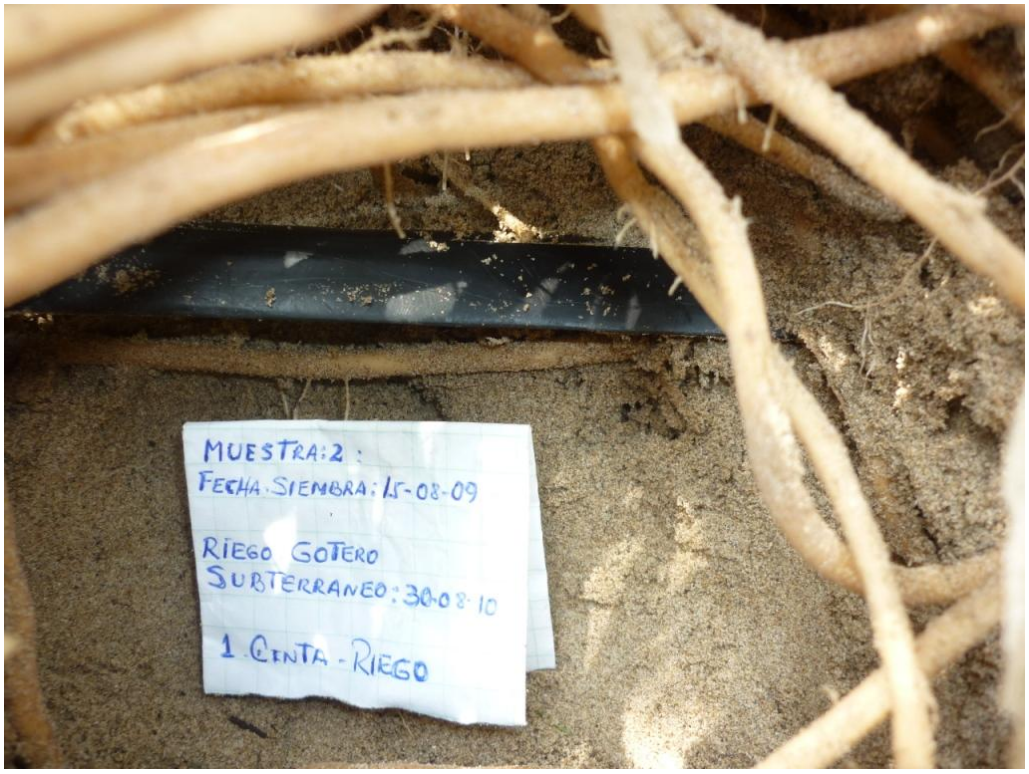
(Figure 2)

(Photo 1)

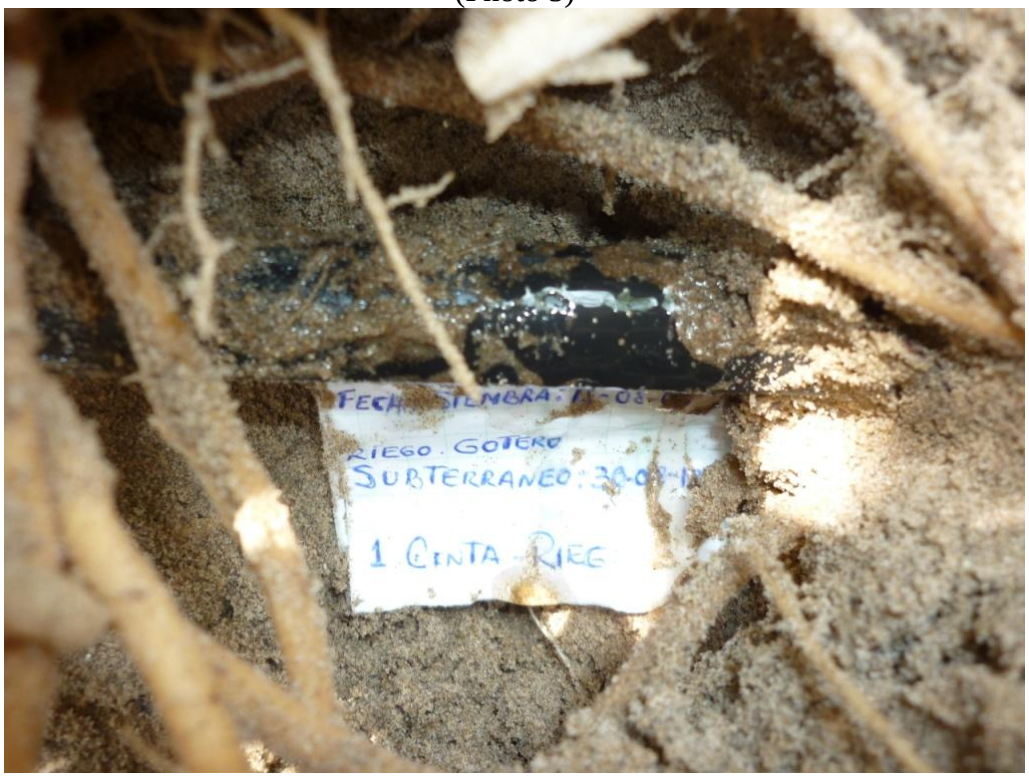
(Photo 2)

(Photo 3)

(Photo 4)

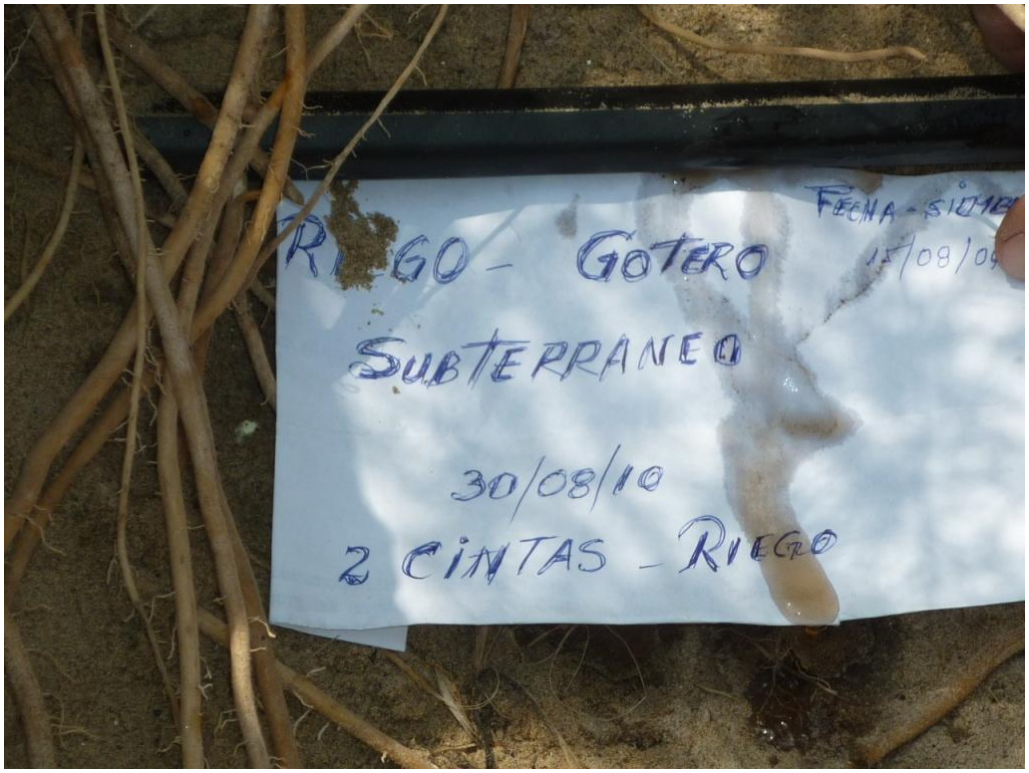


(Photo 5)



(Photo 6)

(Photo 7)



(Photo 8)

Lab Results

0 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA N º S-10/05283

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05283	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	TESTIGO/MUESTRA II-11	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	300,00	µS/cm a 20ºC	PEC-002
* Sulfato Disponible	98,85	mg/Kg	PEC-009
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Fósforo	22,66	mg/Kg	PEC-004
* Calcio Disponible	11,10	meq/100g	PEC-009
* Granulometría	11,00		PEC-018
* pH (Extracto 1/1)	8,78		PEC-001
* Boro Asimilable	0,77	mg/Kg	PEC-005
* Sodio Disponible	0,60	meq/100g	PEC-009
* Magnesio Disponible	0,48	meq/100g	PEC-009
* Potasio Disponible	0,37	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

10 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05273

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05273	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-01	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	300,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Sulfato Disponible	122,70	mg/Kg	PEC-009
* Fósforo	23,62	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	10,07	meq/100g	PEC-009
* pH (Extracto 1/1)	8,63		PEC-001
* Boro Asimilable	0,72	mg/Kg	PEC-005
* Sodio Disponible	0,47	meq/100g	PEC-009
* Potasio Disponible	0,45	meq/100g	PEC-009
* Magnesio Disponible	0,37	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

20 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05274

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05274	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-02	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	280,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Sulfato Disponible	87,35	mg/Kg	PEC-009
* Fósforo	20,74	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	9,61	meq/100g	PEC-009
* pH (Extracto 1/1)	8,72		PEC-001
* Boro Asimilable	0,83	mg/Kg	PEC-005
* Potasio Disponible	0,55	meq/100g	PEC-009
* Sodio Disponible	0,47	meq/100g	PEC-009
* Magnesio Disponible	0,35	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

30 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05275

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05275	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-03	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	320,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	170,80	mg/Kg	PEC-034
* Sulfato Disponible	90,95	mg/Kg	PEC-009
* Fósforo	28,68	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	9,54	meq/100g	PEC-009
* pH (Extracto 1/1)	8,74		PEC-001
* Boro Asimilable	0,82	mg/Kg	PEC-005
* Potasio Disponible	0,61	meq/100g	PEC-009
* Sodio Disponible	0,47	meq/100g	PEC-009
* Magnesio Disponible	0,46	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

40 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05276

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05276	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-04	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	400,00	µS/cm a 20ºC	PEC-002
* Sulfato Disponible	131,90	mg/Kg	PEC-009
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Fósforo	30,70	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	9,09	meq/100g	PEC-009
* pH (Extracto 1/1)	8,22		PEC-001
* Boro Asimilable	1,03	mg/Kg	PEC-005
* Potasio Disponible	0,66	meq/100g	PEC-009
* Sodio Disponible	0,59	meq/100g	PEC-009
* Magnesio Disponible	0,45	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

50 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05277

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05277	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-05	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	460,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	158,80	mg/Kg	PEC-034
* Sulfato Disponible	121,40	mg/Kg	PEC-009
* Fósforo	42,10	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	9,01	meq/100g	PEC-009
* pH (Extracto 1/1)	8,33		PEC-001
* Boro Asimilable	2,14	mg/Kg	PEC-005
* Potasio Disponible	0,75	meq/100g	PEC-009
* Sodio Disponible	0,54	meq/100g	PEC-009
* Magnesio Disponible	0,44	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

60 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05278

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05278	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-06	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	500,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Sulfato Disponible	106,70	mg/Kg	PEC-009
* Fósforo	37,99	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	8,56	meq/100g	PEC-009
* pH (Extracto 1/1)	8,54		PEC-001
* Boro Asimilable	1,11	mg/Kg	PEC-005
* Potasio Disponible	0,89	meq/100g	PEC-009
* Sodio Disponible	0,54	meq/100g	PEC-009
* Magnesio Disponible	0,50	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

70 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05279

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05279	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-07	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	580,00	µS/cm a 20ºC	PEC-002
* Sulfato Disponible	129,30	mg/Kg	PEC-009
* Nitrógeno Dumas	< 155,00	mg/Kg	PEC-034
* Fósforo	34,58	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	8,95	meq/100g	PEC-009
* pH (Extracto 1/1)	8,65		PEC-001
* Boro Asimilable	1,05	mg/Kg	PEC-005
* Potasio Disponible	0,92	meq/100g	PEC-009
* Sodio Disponible	0,61	meq/100g	PEC-009
* Magnesio Disponible	0,57	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

80 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA N º S-10/05280

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05280	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-08	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	480,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	216,70	mg/Kg	PEC-034
* Sulfato Disponible	103,15	mg/Kg	PEC-009
* Fósforo	33,91	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* Calcio Disponible	8,78	meq/100g	PEC-009
* pH (Extracto 1/1)	8,71		PEC-001
* Boro Asimilable	1,07	mg/Kg	PEC-005
* Potasio Disponible	0,92	meq/100g	PEC-009
* Magnesio Disponible	0,53	meq/100g	PEC-009
* Sodio Disponible	0,49	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

90 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05281

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05281	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-09	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	600,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	218,80	mg/Kg	PEC-034
* Sulfato Disponible	131,15	mg/Kg	PEC-009
* Fósforo	31,42	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* pH (Extracto 1/1)	8,74		PEC-001
* Calcio Disponible	8,56	meq/100g	PEC-009
* Boro Asimilable	1,56	mg/Kg	PEC-005
* Potasio Disponible	1,01	meq/100g	PEC-009
* Sodio Disponible	0,64	meq/100g	PEC-009
* Magnesio Disponible	0,51	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones:

100 Tons

ADELANTO DE RESULTADOS ANALITICOS DE LA MUESTRA Nº S-10/05282

CLIENTE: FUNDO FANGELICA S.A.C
Cal. los Almendros Nro. 221 -LA MOLINA

Nº de Muestra:	S-10/05282	**Fecha de Muestreo:**	16-sep-10
Tipo de Muestra:	SUELO AGRICOLA	**Fecha de Recepción:**	17-sep-10
Finca:		**Fecha de Inicio:**	23-sep-10
Parcela:			
Descripcion:	MUESTRA II-10	**Muestreo:**	CLIENTE
Código de análisis:	S-0678-CH (AGQPerú_2)		

ANÁLISIS QUÍMICO

Parámetros	*Resultado*	*Unidades*	*Procedimiento de Análisis*
* Conductividad Electrica (E	800,00	µS/cm a 20ºC	PEC-002
* Nitrógeno Dumas	223,40	mg/Kg	PEC-034
* Sulfato Disponible	188,50	mg/Kg	PEC-009
* Fósforo	47,75	mg/Kg	PEC-004
* Granulometría	11,00		PEC-018
* pH (Extracto 1/1)	8,61		PEC-001
* Calcio Disponible	8,59	meq/100g	PEC-009
* Boro Asimilable	1,55	mg/Kg	PEC-005
* Potasio Disponible	1,10	meq/100g	PEC-009
* Sodio Disponible	0,69	meq/100g	PEC-009
* Magnesio Disponible	0,65	meq/100g	PEC-009
* Caliza Activa	< 0,50	% CaCO3	PEC-014
* Capacidad de Intercambio C		meq/100g	PEC-019
* Calcio Cambio		meq/100g	PEC-009
* Aluminio		meq/100g	PC-214
* Cobre		mg/Kg	PEC-009
* Hierro		mg/Kg	PEC-009

Observaciones: