International Baccalaureate

Extended essay cover

SAMPLE A

Diploma Programme subject in which this extended essay is registered: Geography

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: To What Extent do Soil Characteristics Affect the Land Use On A Small Farm In Northern New South Wales, Australia

Candidate's declaration

If this declaration is not signed by the candidate the extended essay will not be assessed.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: _____ Date: 3/2/2009

IB Cardiff use only: A: [illegible] B: ✓

Supervisor's report

The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.

Name of supervisor (CAPITAL letters) _____

Comments

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

was fully engaged on this essay and found very clear on what he had to accomplish in the field. He clearly had a strong view on how the essay should develop.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [4] hours with the candidate discussing the progress of the extended essay.

Supervisor's signature: _____ Date: 11/2/09

To what extent do soil characteristics affect the land use on a small farm in northern New South Wales, Australia?

Name:
Candidate Number:
Supervisor:
Subject: Geography
May 2009 session
Word Count: Approximately 3960

Abstract

The aim of this extended essay is to investigate and attempt to answer the research question **"To what extent do soil characteristics affect the land use on two small farms in northern New South Wales, Australia?"** I investigated this question by testing the hypothesis "**There is a correlation between land use pattern and soil characteristics**". Soil is very important as it affects many essential aspects of our lives in some way. It is also a very important part of the farming system, which has many inputs, processes and outputs. Due to the scale of the farming system, I concentrated in particular on the input of soil into this system.

My approach to this essay was to collect a range of data regarding the soil characteristics being investigated. The investigation was carried out upon my uncle's farms in northern New South Wales in Australia. The data was collected from a range of paddocks. The characteristics observed were the soil pH, colour, texture, percentage cover and percolation, as well as what fertilizers were used on the paddocks. A range of secondary sources were also consulted in the writing of this essay.

To conclude this investigation, I accepted my hypothesis that "**There is a correlation between land use pattern and soil characteristics**". In answering my research question, I concluded that soil characteristics do, to a certain extent, affect the land use pattern on the two farms. My conclusions are supported by evidence from the analysis of my test results, as some paddocks clearly showed characteristics ideal for their particular use on a farm, such as optimum soil conditions for grazing. However, it appears that the biggest factor affecting land use was the convenience or physical characteristics of the paddock such as size, accessibility or the topography of the land.

Word Count: 296

Table of Contents

To what extent do soil characteristics affect the land use on two small farms in northern New South Wales, Australia?

Introduction

The aim of this essay is to investigate a pattern of soil characteristics on an Australian farm using the hypothesis "**There is a correlation between land use pattern and soil characteristics**". Ultimately this essay will attempt answer the research question: "to what extent do soil characteristics affect the type and extent of use on a farm"

Soil is often overlooked in terms of its importance in agriculture. Brian Knapp (1979) once said in *Soil Processes*, "To many people who do not live on the land, soil appears to be an inert, uniform, dark-brown coloured, uninteresting material in which plants happen to grow. In fact little could be farther from the truth."[1] Knapp is quite right in saying this as soil has many functions such as providing nutrients and support for plants to live and grow in, water storage and providing a habitat for many animals like earth worms. Soil is infinitely important and without soil there would be no life as "most life on earth depends upon the soil as a direct or indirect source of food".[2] There are clear differences between different types of soils in their characteristics "as well as in their ability to grow crops"[3]. This shows a direct link between soil pedology and agriculture, which is relevant to my essay. The Soils topic is not part of my IB Geography syllabus, however I grew up in a rural area in Australia and have many family members on farms in northern New South Wales. Since growing up in a rural area and visiting family on large farms, I have developed an interest in livestock and crop production and realise soil can play a large part in the success of farming. Therefore this topic is quite relevant and interesting to me and involves current geographical knowledge.

Farming is a system, with various processes inputs and outputs. These inputs include human and economic inputs such as labour, machinery, and money. The farming system also includes various physical inputs such as soil, water, climate, and geology. These inputs all go through processes together to eventually produce the outputs, which are animal products and crops. Farming is a large and complex system, so I will limit the scope of my essay by concentrating on one particular aspect of the system. This investigation effectively looks at the effect of the physical input of soils in the farming system, and on the land use pattern of a farm.

To approach and answer the research question of this essay, an investigation was carried out on the two small farms "Wyreema" and "Larrgahill". For this purpose primary data was collected, a range of sources was also consulted (see bibliography). The farms investigated are located in the Gwydir Shire of New England in New South Wales. This region of Australia, known as the Northern Tablelands is highly agricultural; towns in New England are very small with only four towns with populations over 10,000 and two over 20,000. There are also large open spaces and farms surrounding each town. The area is not entirely flat as shown in Figure 1, with a large proportion of undulating land, making it difficult to do any large-scale crop farming. Although it cannot be seen on this particular map, the land gets much flatter

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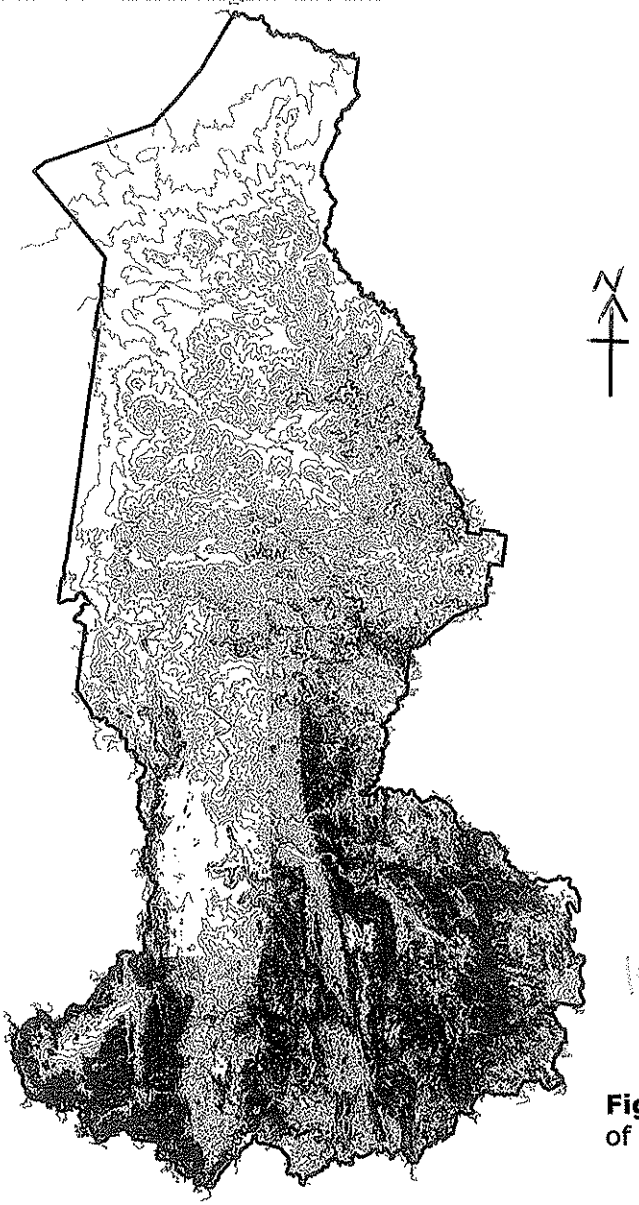
[1] Waugh, David. Geography: An Integrated Approach, Third Edition.
[2] "Soil". World Book 2008
[3] Whittow, John. The Penguin Dictionary of Physical Geography, Second Edition.

to the west and northwest of the region shown. Therefore a lot of the farming in the area is animal farming, mainly sheep and cattle.



No scale

Indistinct

Figure 1. – Contour map of Gwydir Shire

"Wyreema" and "Larrgahill" are situated 30km northwest of the small town of Warialda, which sits approximately 60km west of Inverell. The location of New England can be seen in Figure 2. Inverell can be seen in Figure 3. Warialda is a small town with a population of only 1,500. There are many people living in the surrounding area on farms so the region is highly agricultural. There are very few shops and businesses in Warialda, but there are large farm supply shops, stocking products ranging from tools to fertilizer and small machinery.

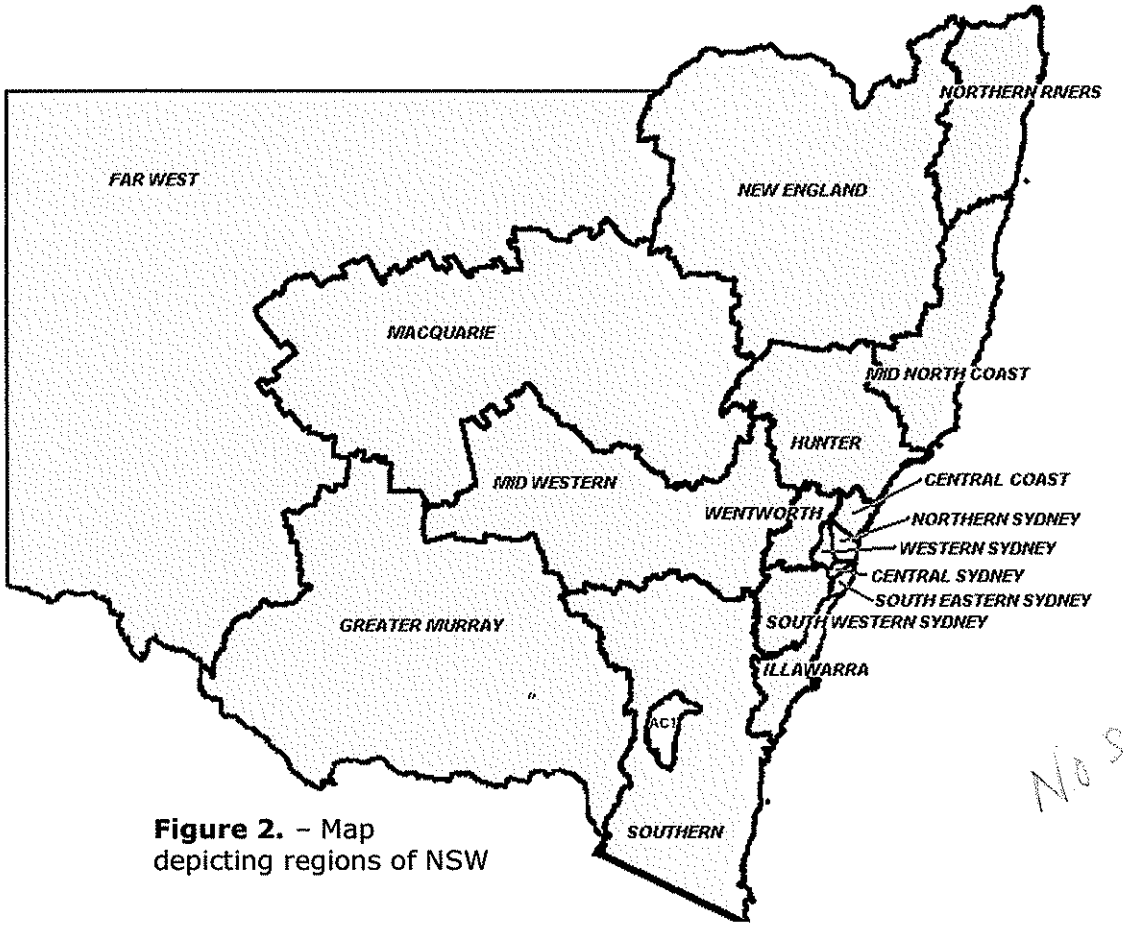


Figure 2. – Map depicting regions of NSW

http://www.dva.gov.au/health/homecare/regions/nsw/nswmap.htm

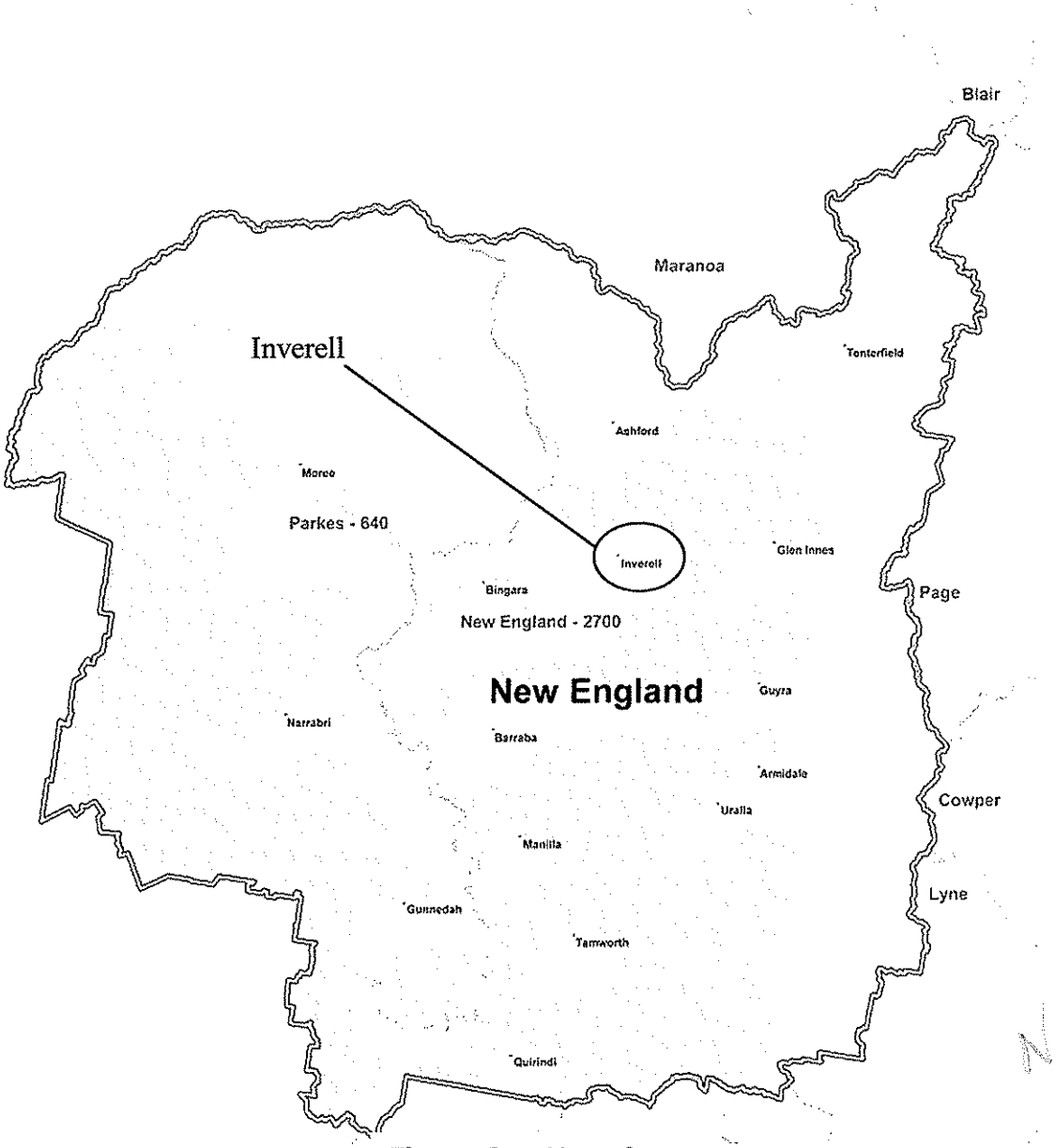


Figure 3. – Map of New England

http://www.dva.gov.au/health/homecare/regions/nsw/nswmap.htm

Australia is a country with a highly agricultural economy. Agriculture is responsible for $22.8 billion (3%) of its GDP (Purchasing Power Parity)[4] compared to 0.9% in the USA[5] and 0.9% in the UK[6]. There are numerous types of farms; the main types are sheep farms, crop farms, cattle farms, and then those who combine two or more of these types of farming. This is usually dependant on the landscape, for example in north western New South Wales in an area 80km west of Warialda, the land is very open and flat with dark rich silty soil, providing good conditions for cotton farming and as a result most farms in this area are cotton farms. These good conditions

[4] CIA World Fact Book: Australia.
[5] CIA World Fact Book: United States of America.
[6] CIA World Fact Book: United Kingdom.

involve large flat open spaces easily accessible to the large machinery required for cotton farming as well as the dark nutrient rich soil providing everything the plant needs to grow.

Those who mix crop and stock farming usually divide their land into pasture for their stock, and areas for growing crops as suggested by the *Managing land: within its capability* fact sheet from the Border Rivers-Gwydir Catchment Management Authority (CMA)[7]. This dividing of land can be done with the New South Wales land capability assessment system in which there are eight classes, classified according to the lie of the land, the risk of soil erosion and soil type. Areas can then be recommended for what types of farming they could be used best for. It could be said that if a particular paddock has better yields than others or has consistently good harvests the farmer may favour this paddock over others or plant a more valuable crop here. So farmers use different areas of a farm for different types of farming and some more frequently than others. This could be for various reasons such as pH, soil type, where the paddock is located and many others. Farmers also often rotate paddocks between stock and crop to "rest" the soil, or in the case of my uncle alternate between a cereal crop and a legume, as legumes return nitrogen, a much needed nutrient for plants, to the soil.

The topic for this essay was suggested to me as I noticed this different use of land while visiting the two farms which belong to my uncle, and even more so when looking at these overhead views from Google Earth shown in Figures 4 and 5. As one can see in the pictures below, there are separate areas of the farms, some are green, some brown and some have quite thick looking vegetation. This is a clear sign of differing frequency of use, and or different uses for the areas.

[7] Miller, W, (editor). Practical Guide to Soil Erosion: Managing Land: Within It's Capability.

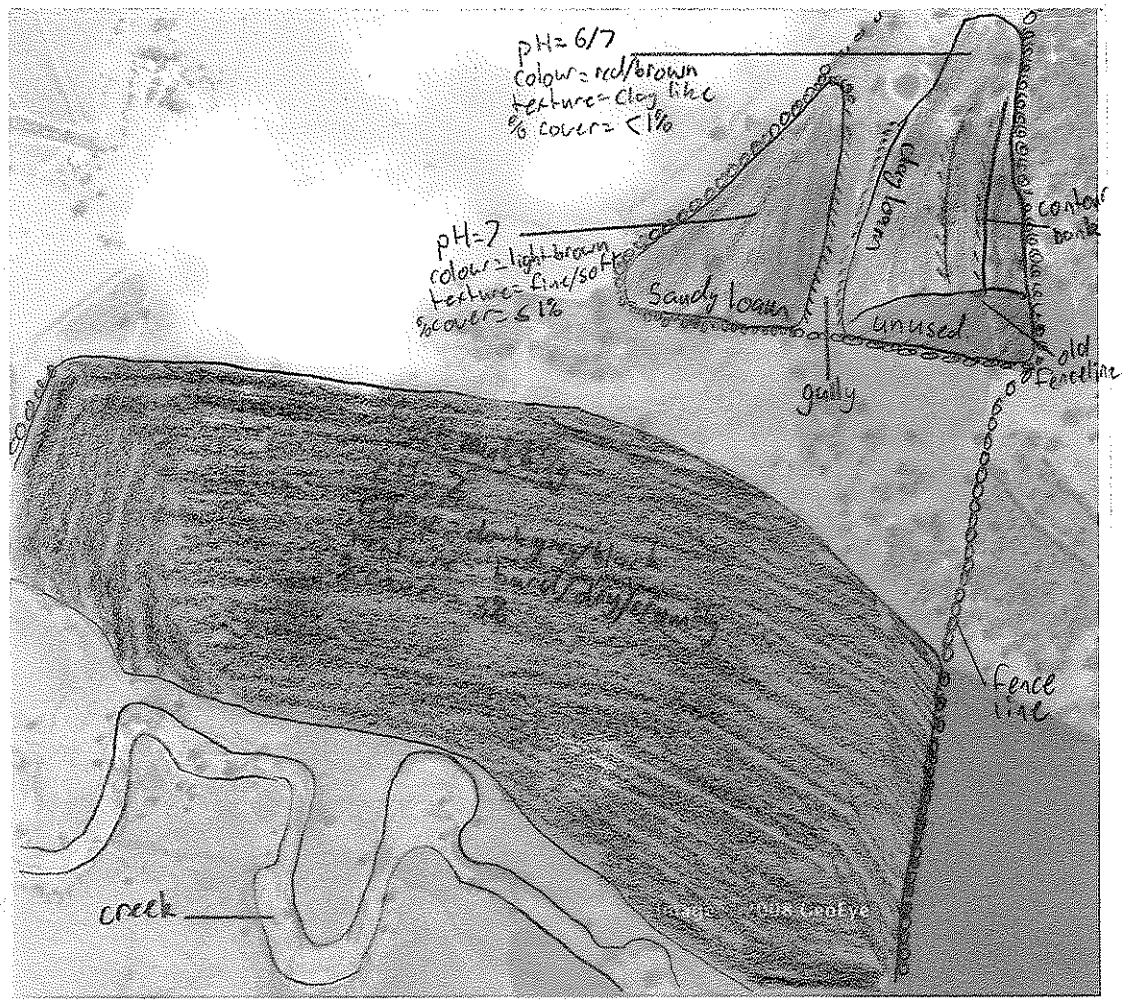


Figure 4. Larrgahill. From Google Earth

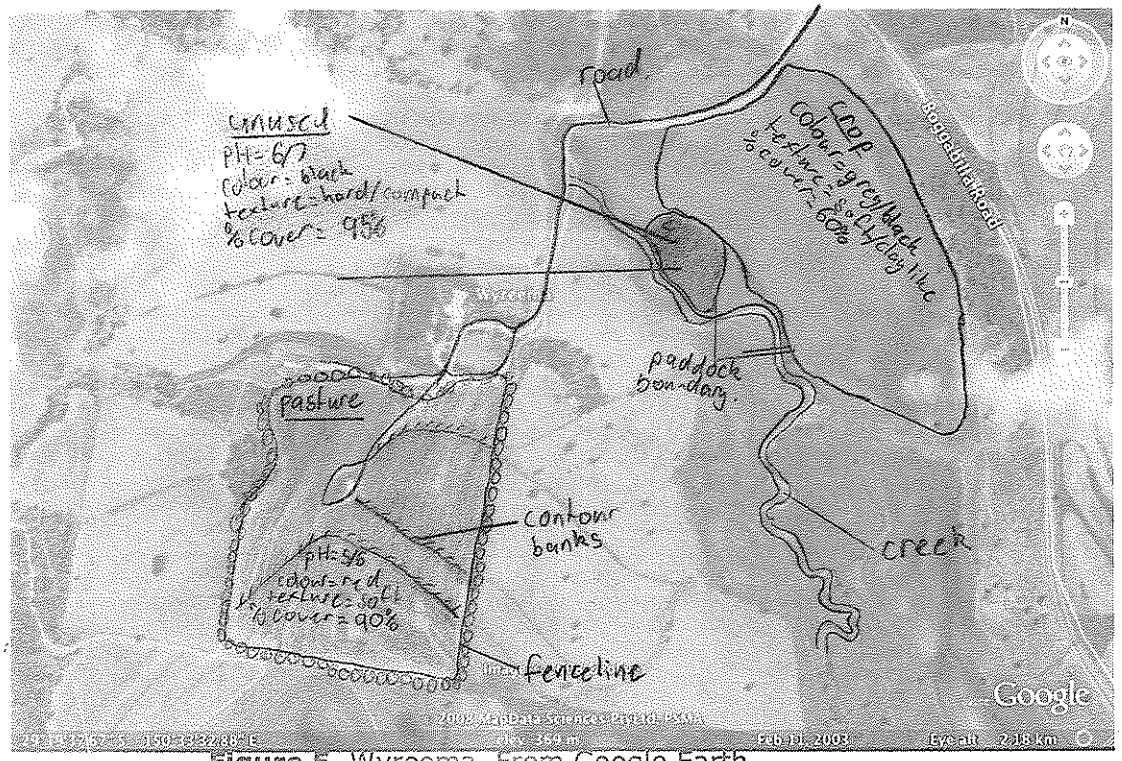


Figure 5. Wyreema. From Google Earth.

Investigation

An investigation was set up to determine reasons for these differences in the type and frequency of use of soil. The planned investigation will be carried out by measuring and analysing various soil characteristics on the two farms. These include the pH, soil colour, texture, percentage cover and percolation. My uncle was also asked what chemicals or fertilizers (if any) he used on the soils. These characteristics will be measured using the following method.

After selecting paddocks to do my test in according to the map, I decided how best to sample the site to obtain the best results for representing the field. It is also highly time consuming to get results from every section of a paddock, therefore it would be far more desirable to sample. After looking at various sampling techniques it was decided that the random quadrat technique using quadrats that are 1m x 1m in size would be most suitable for these large paddocks. The way I did this was pick a point near to the centre of the paddock and then I used the random number sheet to see how far from this point the quadrat should be, in any random direction. I collected 4 sets of data in each of the seven areas.

The first characteristic measured was the soil pH. To measure this an approximately 20-gram sample of soil was taken from the quadrat and put in a container with approximately 50 ml of water and left it to dissolve. Then a small sample of this water was taken and put on some litmus paper and compared the colour with the scale provided with the litmus paper, shown below in Figure 6.

Figure 6. – Chart provided with litmus paper to compare pH

The pH was then compared with values from Figures 7 and 8 to determine the significance of the pH detected.

Soil acidity	pH value	
Strongly alkaline	8.5	
Most plants suffer from alkalinity	8.0	
Mildly alkaline	7.5	Barley, Sugar beet Lucerne
Neutral	7.0	Wheat
Optimum for most plants	6.5	Red clover, Turnips Swedes
Slightly acid	6.0	Cabbage, Potatoes
Moderately acid	5.5	Kale, White clover Oats/Rye
Most plants suffer from acidity	5.0	
Extremely acid	4.5	Types of grass
	4.0	
	3.5	
	3.0	

Figure 7. – Table showing significance of soil pH values

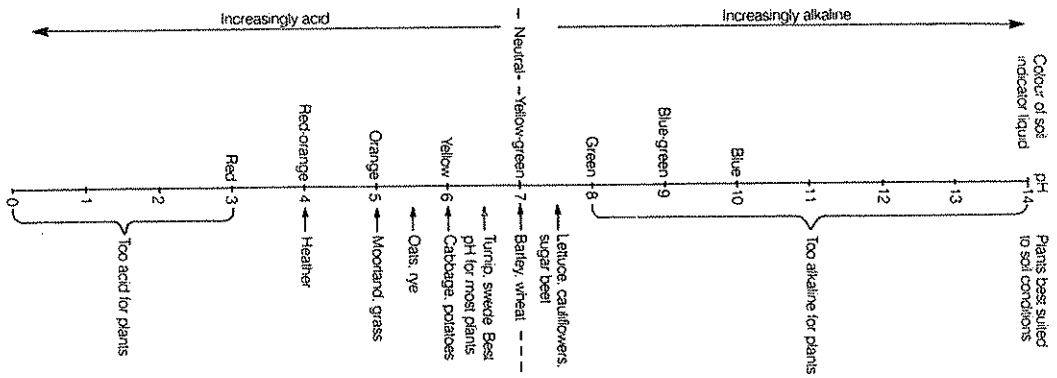


Figure 8. Diagram showing significance of soil pH values

Next was to collect a sample looking at the colour of the soil and to compare this with the table in Figure 9 below to indicate what this soil type means in terms of nutrient content and drainage.

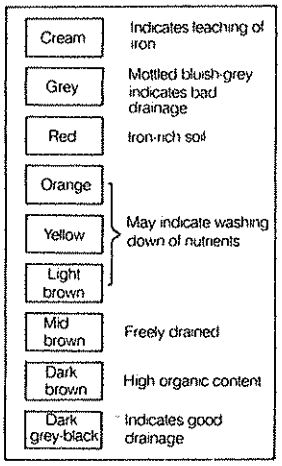


Figure 9. – Chart explaining significance of soil colour

With the same sample of soil, the texture of the soil can be analysed by moulding it around in the hand to see how easily it breaks up, and also the make up of the soil. I also examined the soil to see how fine the sediment particles were. From this, conclusions can be drawn as to the paddock's susceptibility to surface run off etc. The next characteristic to measure will be the percolation of the soil. Percolation is how easily water filters through the soil. This method involves cutting the bottom off a bottle, removing the lid, and pushing the lid end of the bottle into the soil. Then a certain amount of water was poured into the bottle, I used 300mL and the time taken for the water to infiltrate the soil. The amount of water does not matter as long as it is the same each time. This method of measuring percolation does not give an exact figure for the percolation of soil, but it will give a good indication of which soils percolate better than others.

Another characteristic to be measured is to estimate the percentage of ground covered by vegetation in each quadrat, this will help to show differences between the varying types of paddocks.

Finally my uncle was asked what chemicals he has applied to the area, if any, which may affect the soil. Photos were taken of each site for possible further reference.

Analysis

Unfortunately for each paddock the method of measuring percolation rates did not work and I was therefore unable to collect data for percolation. I attribute this to the neck of the bottle not being wide enough and the soil being compacted, not allowing water to percolate. However, when tipping water out from the bottle, I noticed that in some paddocks that water did infiltrate faster than other paddocks, though this is not an entirely accurate measure of percolation because the water may have spread over different areas thus affecting its percolation rate. Although this does not give an accurate representation of the percolation rates, it does allow a basic analysis to be carried out.

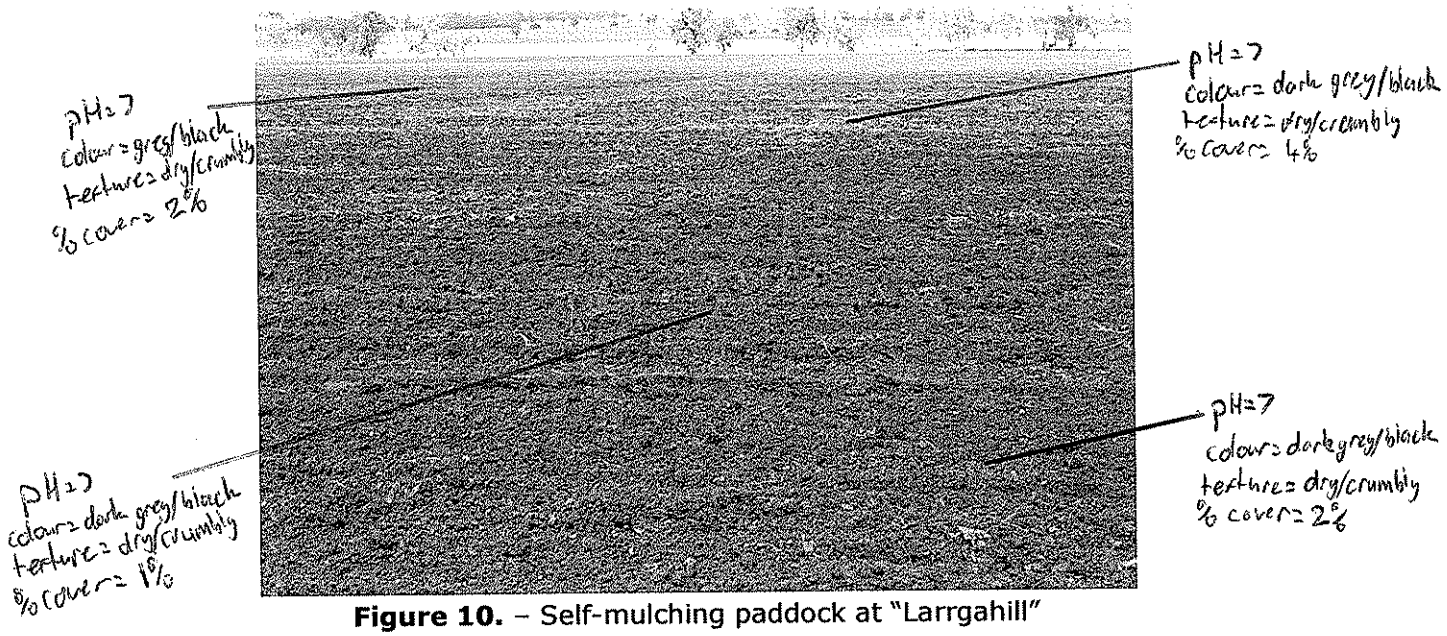


Figure 10. – Self-mulching paddock at "Larrgahill"

The first paddock investigated was a large flat paddock in "Larrgahill" shown above in Figure 10 and in red on Figure 4. It was a very flat paddock, which is good, as it decreases surface runoff. The soil was quite hard and dry, which can be attributed to the lack of recent rain, however underneath this top layer it was quite fine, when wet the soil became sticky and coagulated. The soil is what my uncle called a self-mulching soil, and is very fertile and nutrient rich. Self-mulching soil is a basalt/clay based soil and when wet swells and then crumbles, this swelling also means the soil is has a very large field capacity. Due to the fact that it is self-mulching and fertile, this means that my uncle needs to do very little work when planting a new crop, and uses a technique called "minimum till", meaning the soil is only worked close to the surface and not much then. The colour is a dark grey/black, which indicates that the soil has a high organic content and is well drained. This means that the soil provides very good conditions for growing plants, and with a neutral pH of 7, the soil is ideal for growing the crop it has, wheat. The little ground cover there is, is made up of old stubble from the previous crop, chickpeas. My uncle says that chickpeas are a classified as a legume, which are good for the soil as they replace nitrogen. Therefore we can assume that the soil has a good nitrogen content.

Figure 11. – Sandy loam paddock at "Larrgahill"

The second paddock was a sandy loam paddock in "Larrgahill" quite close to the first shown in Figure 11 and in blue in Figure 4 above. Sandy loam refers to the soil type of the paddock being predominantly made up of sand, silt and clay, with a predominance of sand. Loam soils have a good field capacity and often have high nutrient content. The paddock was on quite a slope, which means it is more susceptible to surface runoff, which will decrease the amount of water the plants get. This could be a very significant factor as the region receives very little rainfall. However the soil is quite fine, powdery and soft underfoot which makes the water easier to absorb and this can combat surface runoff, as it promotes infiltration. This is proven with the soil colour, as at mid-light brown the soil is well drained, however this may have washed away some important nutrients.

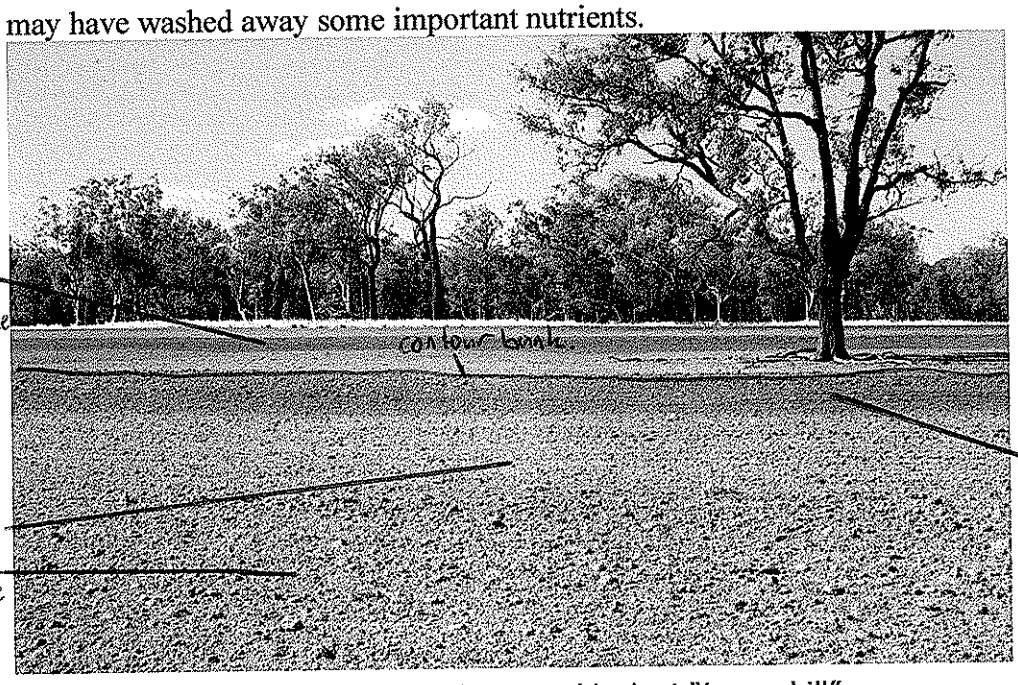


Figure 12. – Clay loam paddock at "Larrgahill"

The third paddock was a clay loam paddock on a similar slope to the sandy loam paddock and is shown in Figure 12 and in orange in Figure 4 above. This slope combined with the slightly more impermeable clay based loam soil of sand, silt and clay, makes the paddock even more susceptible to surface runoff so my uncle has built small contour banks across the paddock to help retain the precious water. The colour of the paddock varies from a reddish colour, light reddish brown and a darker reddish brown. The redness of the soil indicates that the soil is very iron rich, and the brownness indicates good drainage. The pH of the soil in the paddock was between 6 and 7; this provides good conditions for growing cereals like wheat.

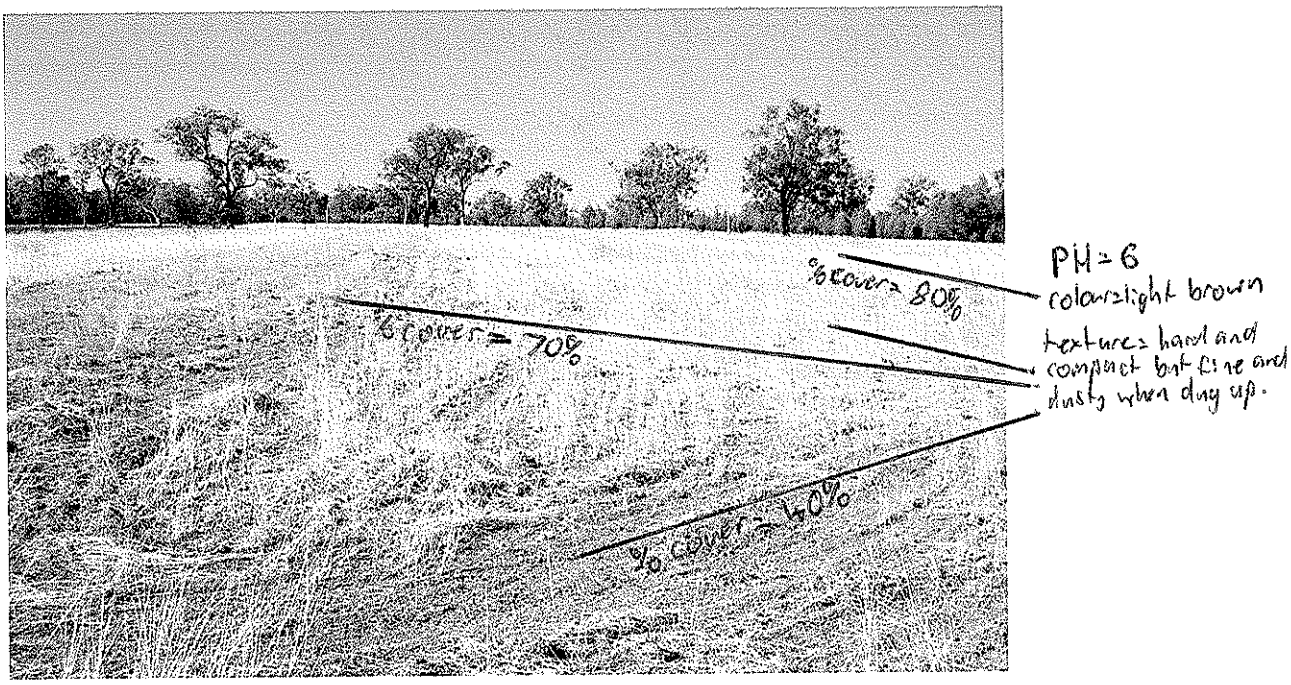


Figure 13. – Paddock that has never been farmed at "Larrgahill"

The final test paddock in "Larrgahill" was an area that had never ever been farmed, as opposed to the other 3 paddocks, which have been farmed for approximately 80 years according to my uncle. The paddock is shown above in Figure 13 and in green in Figure 4. This paddock is directly adjacent to the clay loam paddock and has the same gradient. This gradient combined with the compact soil due to not farming, makes for a lot of surface runoff and very little infiltration. The soil, when it was dug up was light brown, which indicates possible washing away of nutrients, and the soil has a pH of 6. When the soil is dug up it has a fine and light when mixed up which after being worked and tilled for a while as my uncle intends to do, could produce nice soil for crops in the future. This can be seen by the high percentage ground cover, because good ground cover can help to prevent soil loss[8]. Protection against soil erosion is particularly important in sloping areas such as this. Ground cover is also an indicator of soil condition as well as developing soil health and stability. The reason that this soil had not previously been cropped is that in the past few decades, the soil may not have been suitable for cultivation, but now after 80 years of decaying plant matter as well as sheep and cattle faeces fertilizing the soil and occasional light grazing the soil is now arable. My uncle has also moved the fence line to make cultivation easier.

[8] CMA Fact Sheet 3

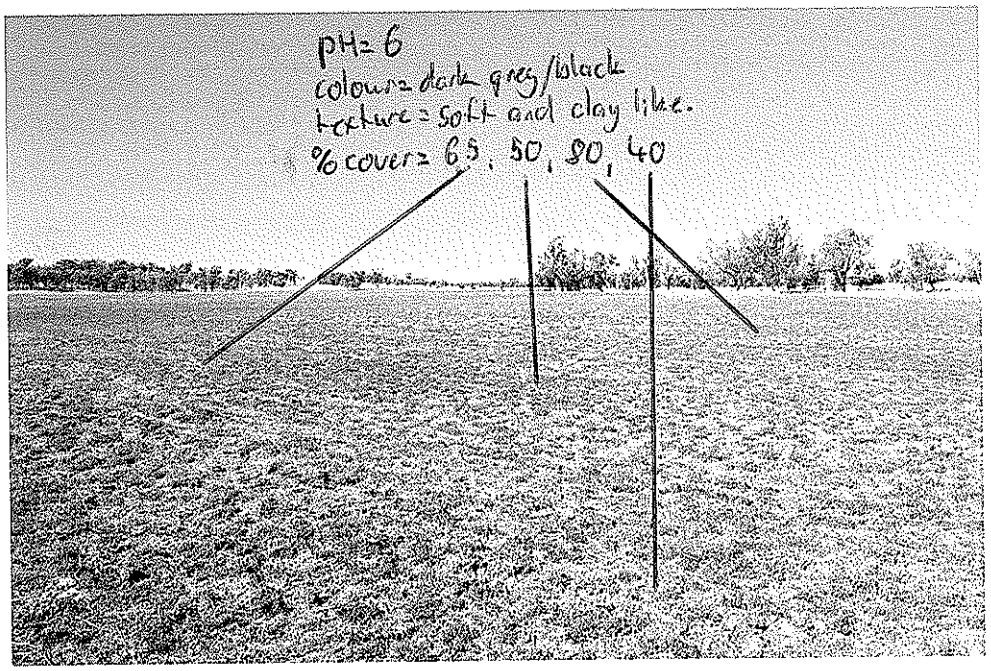


Figure 14. – Crop paddock at "Wyreema"

The first paddock tested in "Wyreema" was a paddock used for crops as shown in Figure 14 and as green in Figure 5 above. The soil at this site was similar to the self-mulching soil at Larrgahill. This means it has a high organic content and is very fertile, the paddock is also flat meaning it maximises infiltration and minimises surface runoff to absorb as much water as possible, making it very suitable for growing crops, as well as having a pH of 6 which is slightly acidic, but is close to the ideal range for crops. This paddock also had a higher percentage cover than the others tested, although this can be attributed to the fact that this was tested later, and crops here were planted slightly earlier.

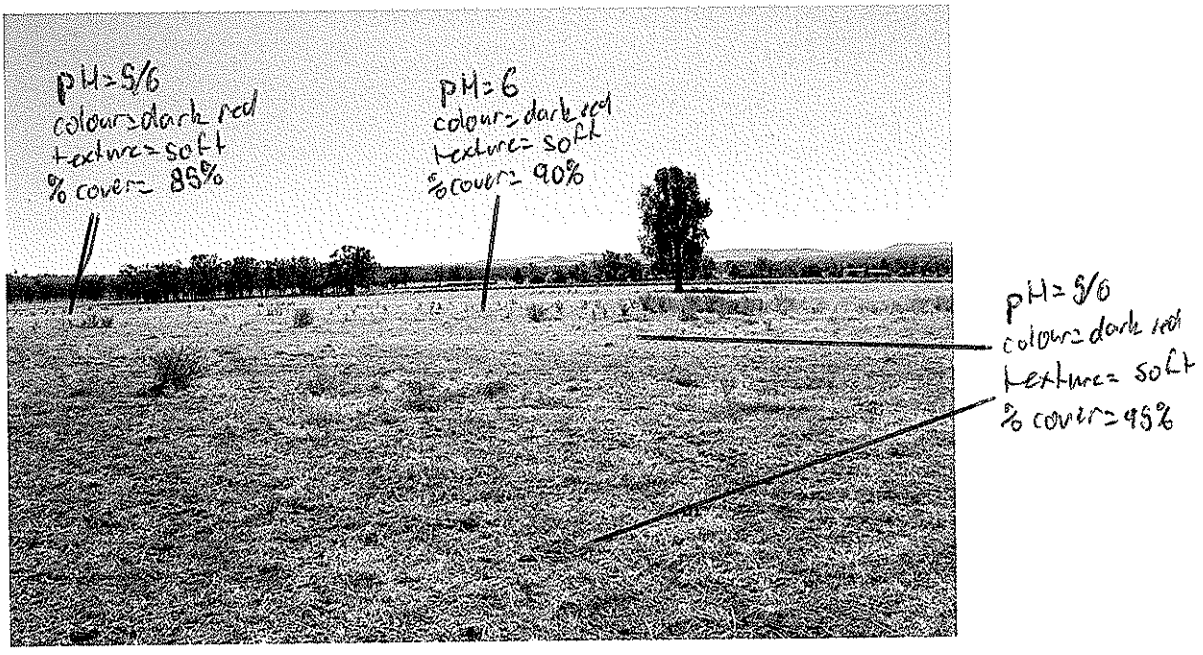


Figure 15. – Grazing paddock at "Wyreema"

The next paddock tested at "Wyreema" was a grazing paddock, shown above in Figure 15 and as orange in Figure 5, and seemed to be well suited for this. It was a very large paddock and had varying topography, with flat areas and sloped areas. To retain water contour banks were built along the bottom of the sloped section, also preventing water from running off and flooding the flat area. The soil was a dark red colour indicating it is very iron rich and was soft and easily separated. This allows for easier infiltration of rainwater and less surface runoff, it also makes it easier for grass to grow here, and if it wasn't for the high percentage cover, this paddock due to its soft soil texture, would be susceptible to soil erosion. This good ground cover indicates good soil health and nutrient content, and is also important as a source of food for the cattle. As a more acidic paddock than the others with a pH of 5.5 – 6 it is more suited to grasses, hence being used for pasture, however oats do grow well in soils of this pH and my uncle has used this paddock for oats before, for the cattle to eat.

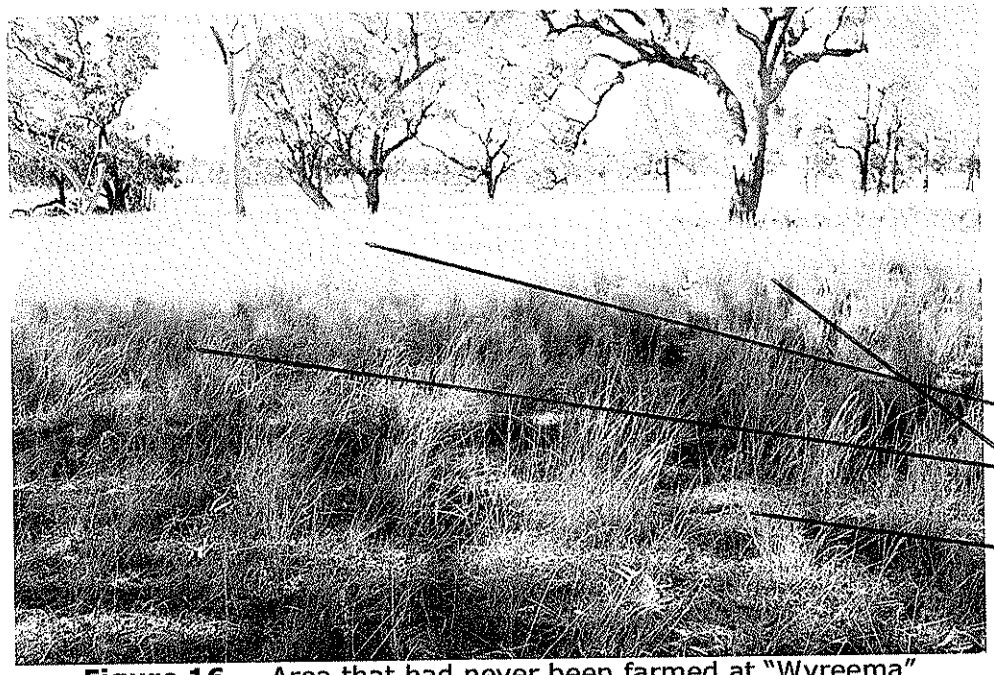


Figure 16. – Area that had never been farmed at "Wyreema"

The final area tested was a small section of land sitting in between the cropping paddock and the creek in "Wyreema". This area is shown above in Figure 16 as well as in blue in Figure 5. This land was never farmed due to the trees in and around it and its proximity to the creek. The land is also impossible for farming as it is very uneven, making it impossible for any vehicles to gain access. However according to the data collected, this soil could be very suitable for farming if in a better location. The soil is a black colour like the self-mulching soil and the cropping paddock, which indicates a high content of organic matter, this could be because of the decades worth of dead plant and leaf matter decaying, when they die or fall off. The area is most likely well drained too as it is right next to the creek and has easy access to water. The pH of the soil ranges from 6 to a neutral 7, which is optimum for most plants. All of this can be seen clearly by the very high percentage of ground cover in the area, showing the soils fertility and good health.

Conclusion

The aim of this essay was to provide an answer to the question: "**To what extent do soil characteristics affect the land use on two small farms in northern New South Wales, Australia?**" With the hypothesis: "**There is a correlation between land use pattern and soil characteristics**". The pH values collected during the investigation did not vary a great deal between the paddocks, however all the cropping paddocks, with the exception of the crop paddock at "Wyreema", had pH's of around 7, ideal for growing most plants, for example crops like barley and wheat, these farms' main crop. The land used for grazing in "Wyreema" had pHs of 6 or 5/6 making it slightly acidic, according to Figures 6 and 7 this provides best growing pH for grasses, making these paddocks ideal to use for grazing. There was no pattern in where the fertilizer was used however there was a pattern in the method in which the fertilizer was administered. In grazing paddocks the fertilizer, in a granular form, was spread over the area, to allow rainwater to wash the nutrients into the soil. In crop paddocks the granular phosphate fertilizer was sown with the crop to ensure an immediate, more reliable effect. The colour of the soil is a good indicator of the drainage and nutrient content of the soil, and seems to have an effect on my uncles decision regarding land use, as the highest yielding paddock and my uncles favourite, was the flat self-mulching paddock. This paddock was shown by the soil colour to have a high organic compound content. The texture did not seem to have an affect on my uncle's decisions on what to use particular paddocks for because apart from the paddocks that had never been farmed, all paddocks had a relatively similar soft texture, allowing for good absorption and minimal soil erosion and surface runoff.

I can therefore, according to the evidence given above, conclude that my hypothesis that "there is a correlation between land use pattern and soil characteristics", is true, to a certain extent. I can then answer my research question "To what extent do soil characteristics affect the land use on two small farms in northern New South Wales, Australia?" The answer to this question is that to a certain degree some soil characteristics do affect the land use. However, many other factors also have an impact on the type and extent of land use in certain paddocks on these two farms. The main soil characteristic that appears to have an effect on land use is pH, as my uncle has used more acidic paddocks for pasture and more neutral paddocks for crop, providing the plants in each with the ideal growing conditions. The texture and colour also have a small effect on the frequency of land use, as the blacker soil types are rested less often and are my uncle's favourite paddocks. It seems to me from observations of the farm and talking to my uncle that the biggest factor affecting land use may simply be convenience or physical characteristics of the paddock such as size, accessibility or the topography of the land.

To get a bigger range of results and possibly therefore a more distinct answer to the question of soil characteristics affecting land use I would need to investigate a larger number of paddocks on each of the two farms, as well as possibly investigating more farms in the shire. This would only serve to consolidate my results from "Wyreema" and "Larrgahill" because according to my uncle, these two farms a "very typical of the area". The methodology for investigating the paddocks was quite appropriate, however as mentioned above in the analysis, the method of recording percolation

rates was flawed, however this can be corrected by using a container that enables a larger area of water to be in contact with the soil.

I think additional investigations that would further my understanding of this topic could be investigations into the actual nutrient content of the soils of these two farms and how this affects the land use pattern, however this is a much more time consuming and high tech investigation which requires specialist equipment. As well as the nutrient content, various other soil characteristics could be investigated such as the organic matter in the soil, organisms in the soil. The air and moisture in the soil could also have effects on the land use patterns in farms and would therefore be suitable to investigate. This would also have given me more quantitative data in order to perform statistical tests upon, as the data I had acquired did not allow for this to be done.

Bibliography:

Australian Government Department of Veterans' Affairs: Health. URLs:
<http://www.dva.gov.au/health/homecare/regions/nsw/nswmap.htm>
<http://www.dva.gov.au/images/health/vhc/nsw/new_england.gif>
Border Rivers-Gwydir Catchment Management Authority. "Fact Sheet 3: Good Ground Cover Improves Soil Health" URL:
<http://brg.cma.nsw.gov.au/uploads/File/GC3.pdf>
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Appendices

Appendix 1: Results from fieldwork conducted on the farms "Wyreema" (Figure 5.) and "Larrgahill" (Figure 4.)

Larrgahill – Self Mulching soil				
Quadrat	1	2	3	4
pH	7	7	7	7
Chemicals used	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser
Colour	Dark Grey/Black	Dark Grey/Black	Dark Grey/Black	Dark Grey/Black
Texture	Hard and dry on top, fine underneath and sticky when moist	Hard and dry on top, fine underneath and sticky when moist	Hard and dry on top, fine underneath and sticky when moist	Hard and dry on top, fine underneath and sticky when moist
% Cover	2%	2%	4%	1%
Percolation	-	-	-	-

Larrgahill – Sandy Loam				
Quadrat	1	2	3	4
pH	7	7	7	7
Chemicals used	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser
Colour	Very light brown	Very light brown	Very light brown	Very light brown
Texture	Very fine, powdery, soft underfoot	Very fine, powdery, soft underfoot	Very fine, powdery, soft underfoot	Very fine, powdery, soft underfoot
% Cover	<1%	<1%	<1%	<1%
Percolation	-	-	-	-

Larrgahill – Clay Loam				
Quadrat	1	2	3	4
pH	6/7	6/7	6/7	6/7
Chemicals used	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser
Colour	Reddish	Darker red, a bit brown	Lighter reddish brown	Lighter reddish brown
Texture	Clay like (can be made into a ball)	Stickier more clay like	More clay like that 1st, less than 2nd	More clay like that 1st, less than 2nd
% Cover	<1%	<1%	<1%	<1%
Percolation	-	-	-	-

Larrgahill – Never been farmed				
Quadrat	1	2	3	4
pH	6	6	6	6
Chemicals used	-	-	-	-
Colour	Light brown	Light brown	Light brown	Light brown
Texture	Very compact, but fine and dusty when dug up	Very compact, but fine and dusty when dug up	Very compact, but fine and dusty when dug up	Very compact, but fine and dusty when dug up
% Cover	80%	70%	40%	80%
Percolation	-	-	-	-

Wyreema – Crop				
Quadrat	1	2	3	4
pH	6	6	6	6
Chemicals used	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser
Colour	Dark grey/black	Dark grey/black	Dark grey/black	Dark grey/black
Texture	Soft and clay like	Soft and clay like	Soft and clay like	Soft and clay like
% Cover	65%	50%	80%	40%
Percolation	-	-	-	-

Wyreema – Pasture				
Quadrat	1	2	3	4
pH	5/6	6	5/6	6
Chemicals used	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser	Phosphate Fertiliser
Colour	Dark red	Dark red	Dark red	Dark red
Texture	Soft and easily separated	Soft and easily separated	Soft and easily separated	Soft and easily separated
% Cover	85%	90%	95%	95%
Percolation	-	-	-	-

Wyreema – Never been farmed				
Quadrat	1	2	3	4
pH	6/7	6/7	6/7	6/7
Chemicals used	-	-	-	-
Colour	Black	Black	Black	Black
Texture	Hard and compact, but clay like when dug up	Hard and compact, but clay like when dug up	Hard and compact, but clay like when dug up	Hard and compact, but clay like when dug up
% Cover	99%	99%	90%	85%
Percolation	-	-	-	-

Appendix 2: Random sampling numbers

A1 Random sampling numbers

20	17	42	28	23	17	59	66	38	61	02	10	86	10	51	55	92	52
74	49	04	49	03	04	10	33	53	70	11	54	48	63	94	60	94	49
94	70	49	31	38	67	23	42	29	65	40	88	78	71	37	18	48	64
22	15	78	15	69	84	32	52	32	54	15	12	54	02	01	37	38	37
93	29	12	18	27	30	30	55	91	87	50	57	58	51	49	36	12	53
45	04	77	97	36	14	99	45	52	95	69	85	03	83	51	87	85	56
44	91	99	49	89	39	94	60	48	49	06	77	64	72	59	26	08	51
16	23	91	02	19	96	47	59	89	65	27	84	30	92	63	37	26	24
04	50	65	04	65	65	82	42	70	51	55	04	61	47	88	83	99	34
32	70	17	72	03	61	66	26	24	71	22	77	88	33	17	78	08	92
03	64	59	07	42	95	81	39	06	41	20	81	92	34	51	90	39	08
62	49	00	90	67	86	83	48	31	83	19	07	67	68	49	03	27	47
61	00	95	86	98	36	14	03	48	88	51	07	33	40	06	86	33	76
89	03	90	49	28	74	21	04	09	96	60	45	22	03	52	80	01	79
01	72	33	85	52	40	60	07	06	71	89	27	14	29	55	24	85	79
27	56	49	79	34	34	32	22	60	53	91	17	33	26	44	70	93	14
49	05	74	48	10	55	35	25	24	28	20	22	35	66	66	34	26	35
49	74	37	25	97	26	33	94	42	23	01	28	59	58	92	69	03	66
20	26	22	43	88	08	19	85	08	12	47	65	65	63	56	07	97	85
48	87	77	96	43	39	76	93	08	79	22	18	54	55	93	75	97	26
08	72	87	46	75	73	00	11	27	07	05	20	30	85	22	21	04	67
95	97	98	62	17	27	31	42	64	71	46	22	32	75	19	32	20	99
37	99	57	31	70	40	46	55	46	12	24	32	36	74	69	20	72	10
05	79	58	37	85	33	75	18	88	71	23	44	54	28	00	48	96	23
55	85	63	42	00	79	91	22	29	01	41	39	51	50	36	65	26	11
67	28	96	25	68	36	24	72	03	85	49	24	05	69	64	86	08	19
85	86	94	78	32	59	51	82	86	43	73	84	45	60	89	57	06	87
40	10	60	09	05	88	78	44	63	13	58	25	37	11	18	47	75	62
94	55	89	48	90	80	77	80	26	89	87	44	23	74	66	20	20	19
11	63	77	77	23	20	33	62	62	19	29	03	94	15	56	37	14	09
64	00	26	04	54	55	38	57	94	62	68	40	26	04	24	25	03	61
50	94	13	23	78	41	60	58	10	60	88	46	30	21	45	98	70	96
66	98	37	96	44	13	45	05	34	59	75	85	48	97	27	19	17	85
66	91	42	83	60	77	90	91	60	90	79	62	57	66	72	28	08	70
33	58	12	18	02	07	19	40	21	29	39	45	90	42	58	84	85	43
52	49	70	16	72	40	73	05	50	90	02	04	98	24	05	30	27	25
74	98	93	99	78	30	79	47	96	62	45	58	40	37	89	76	84	41
50	26	54	30	01	88	69	57	54	45	69	88	23	21	05	69	93	44
49	46	61	89	33	79	96	84	28	34	19	35	28	73	39	59	56	34
19	64	13	44	78	39	73	88	62	03	36	00	25	96	86	76	67	90
64	17	47	67	87	59	81	40	72	61	14	00	28	28	55	86	23	38
18	43	97	37	68	97	56	56	57	95	01	88	11	89	48	07	42	07
65	58	60	87	51	09	96	61	15	53	66	81	66	88	44	75	37	01
79	90	31	00	91	14	85	65	31	75	43	15	45	93	64	78	34	53
07	23	00	15	59	05	16	09	94	42	20	40	63	76	65	67	34	11
90	98	14	24	01	51	95	46	30	32	33	19	00	14	19	28	40	51
53	82	62	02	21	82	34	13	41	03	12	85	65	30	00	97	56	30
98	17	26	15	04	50	76	25	20	33	54	84	39	31	23	33	59	64
08	91	12	44	82	40	30	62	45	50	64	54	65	17	89	25	59	44
37	21	46	77	84	87	67	39	85	54	97	37	33	41	11	74	90	50

After Lindley and Miller (1953)

Rules

1 You can start reading from any point and move in any direction *as long as you are consistent*, i.e. if you start top left and read along rows, you must continue working along the rows.

2 Numbers can be read singly, in pairs (as printed), or multiples of 3, 4, etc. Thus in the first row you can read 2, or 20, or 201, etc. Decide which you want and *be consistent*.

Assessment form (for examiner use only)

Candidate session number	0	0							

		Achievement level: First examiner	maximum	Second examiner
Assessment criteria	**A** research question	2	2	
	B introduction	2	2	
	C investigation	3	4	
	D knowledge and understanding	3	4	
	E reasoned argument	3	4	
	F analysis and evaluation	3	4	
	G use of subject language	2	4	
	H conclusion	2	2	
	I formal presentation	2	4	
	J abstract	2	2	
	K holistic judgment	2	4	
	Total out of 36	26		

ame of first examiner: _____ Examiner number: _____
CAPITAL letters)

ame of second examiner: _____ Examiner number: _____
CAPITAL letters)