

Agricultural Science

The Origins of Agriculture

The history of agriculture began with the Garden of Eden. As the Bible tells us in Genesis chapter 1, God created plants on the third day. On the fourth day He created the sun to give light and warmth for the plants to grow. The plants were watered by a large moist canopy which gave dew. The temperature was perfect for plant growth. There were no droughts and no temperature extremes.

On day six God created two human beings who would be friends with God, who would walk and talk with Him in the Garden. He told them that they must eat plants and seeds only. There was no killing and therefore no meat, since the creation was perfect, and no need for agriculture.

It wasn't long before Adam and Eve disobeyed God, and God's creation was no longer perfect.

Then the Lord God said, "Now these human beings have become like one of us and have knowledge of what is good and what is bad. They must not be allowed to take fruit from the tree that gives life, eat it, and live forever." So the Lord God sent them out of the Garden of Eden and made them cultivate the soil from which they had been formed. Gen 3:22-23

The plants would now not always have ideal growing conditions. The first animal was killed to provide clothing for Adam and Eve. From this point on, animals were killed for food.

The practice of agriculture is introduced in Genesis, where Cain is described as a "tiller of the ground" (Genesis 4:2). But because of the Fall, the ground was cursed, making agriculture a laborious task (Genesis 3:17-19).

Cain's offering to the Lord consisted of "some of the fruits of the soil" (Genesis 4:3), while his brother Abel offered "the firstborn of his flock and their fat portions" (Genesis 4:4).

Cain's killing of Abel brought a further curse on the land:

The Lord declared, "When you till the ground, it will no longer yield its produce for you. You will be a restless wanderer on the earth" (Genesis 4:12).

This curse highlights the broken relationship between humanity and creation due to sin, affecting the productivity.

Despite the negative aspects associated with Cain's account, agriculture remains a vital and honorable vocation throughout the Bible. It is a means by which humanity fulfills the divine command to "fill the earth and subdue it" (Genesis 1:28). The practice of agriculture is seen as a partnership with God, relying on His provision and blessing for a bountiful harvest.

The Effect of the Great Flood on Agriculture

The human race indulged in all kinds of evil. God was sorry to see His original perfect creation corrupted. He decided to send a Great Flood as judgment upon the sin in the world. He chose a man named Noah to be His servant. Noah followed God's instructions and built a boat called an ark so that his family could be saved from the flood. The human race, except for Noah and his family, would be destroyed. So would animals and plants. However, God had a plan to save some of the animals and plants.

When the boat was finished God sent two of each kind of animal to Noah to live on the ark for the duration of the Flood. Noah would also have collected plants and seeds. God sent seven of some animals - like sheep, goats and cattle - because these were going to be the food supply for Noah and his family when they came off the ark; for a while there would be no plants as they would have been destroyed by the flood.

It was at this time that God gave permission to eat meat, but not just any meat. God gave special instructions about the kind of meat to eat. God chose animals that were safe to eat. He did not choose animals that ate other animals, e.g. cats, dogs, vultures and shellfish. He did not choose animals that ate dead meat. These animals carried diseases. You can read God's instructions to His people in Leviticus 11: 1-23.

The Bible tells us clearly about the survival of animal species, but what about plants? Apart from the plants and seeds that Noah would have taken on board, there are other possibilities for their survival. How did plants survive in salt water? We don't know how salty the sea was after the Flood. It may have been less salty than today. Many terrestrial seeds can survive long periods of soaking in various concentrations of salt water. Others could have survived in floating masses.

During the Flood, air breathing terrestrial animals died (Genesis 7:22), but many other organisms—marine and aquatic animals, microbes, and plants must have survived, although many of these also perished. Not all land was flooded for the same length of time, nor did the Flood end everywhere at the same time. Highlands and mountains were pushed up, it appears, and ocean depths opened. Waters poured off the land. Animals in the ark were freed to reproduce and spread out.

After the Flood, the stage was set for a return to conditions where ecosystems could survive. These would not be exactly like those before the Flood, however, for there had been many changes due to extinctions and gene loss, mutations, as well as changes in the landscape (mountains and valleys) and climate. But agriculture would go on. Noah and his family would have been the first farmers in the post-Flood world.

About 100 years after the Great Flood, the earth's population had increased significantly. After the Ark landed on Mt. Ararat, in today's Eastern Turkey, the descendants of Noah migrated to the east and lived in the area of Mesopotamia called Babylon, (modern-day Iraq.). They settled in a land named Shinar. The population was growing, and they all spoke one language. The people decided to build a tall, proud symbol of how great they had made

their nation. The Babylonians wanted a tower that would "reach to the heavens" so they could be like God and would not need Him. They began to construct a great ziggurat.

God did not like the pride and arrogance in the people's hearts. God caused the people to suddenly speak different languages so they could not communicate and work together to build the tower. This caused the people to scatter across the land. The tower was named The Tower of Babel because the word Babel means confusion. This event is a powerful reminder of how important it is to obey God's Word and not think we can build a successful but godless life on our own!

Those who did obey God, the Hebrews, moved further to the south, to "the Promised Land", which is Israel today. The Bible describes it as "a land of hills and valleys . . . a land with streams and springs and fountains issuing from plain and hill; a land of wheat and barley, of vines, figs, and pomegranates, a land of olive trees and honey" (Deuteronomy 11:11; 8:7–8).

The central hills were the heartland of Israelite territory. Originally consisting of small, rural farms, probably settled by kinship groups, the central hill country eventually encompassed important cities such as Shechem, Bethel, Jerusalem, Bethlehem, Hebron, and Beersheba, which stood on its ridge. The rocky soil of the hills could be made to produce, but only with much effort. In order to increase the amount of flat land for planting, the Israelites built terraces on the hills. The primary crops were wheat and barley, grapes, and olives. Livestock, primarily sheep and goats, were herded in those fields that lay fallow. The river valleys of the Jordan River and the coastal plain proved to contain some of the most fertile land.

So we can see from this description that after the Flood, the practice of agriculture continued with the early Israelites. Knowledge of the farming practices was evident in nearby countries such as Egypt, Italy and Greece.

But what about the other nations, now who were on the move after the Tower of Babel, from Babylon to different parts of the world? People on the move to far-away locations, could not grow crops during this time or travelling. Think about how many generations it might have taken for people to move from Babylon to China. There is record however of the early Chinese growing crops on the fertile banks of the Yangtze River, so even if they had not brought seeds, they still had the knowledge of propagating the plants around them once they arrived. The early descendants of Noah did not lack intelligence as many would think.

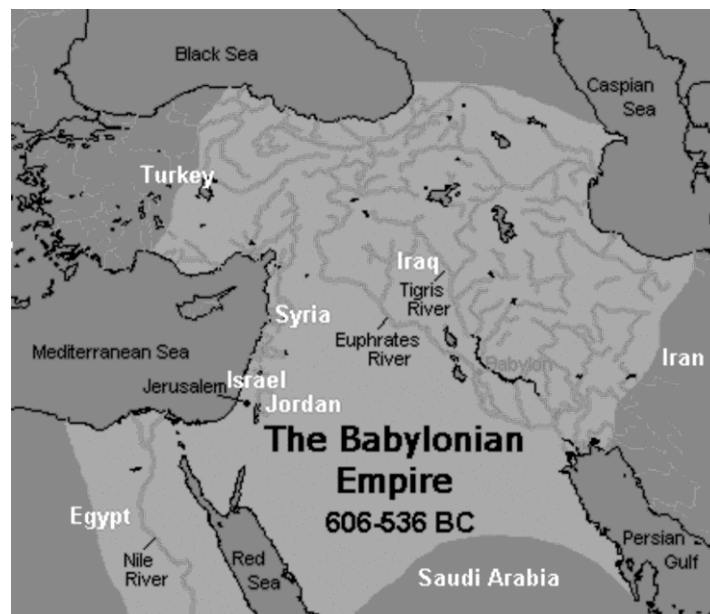
Many found themselves in new and hostile climates, making agriculture difficult. Some groups found it easier to live on the abundant food around them. Some had no choice but to become 'hunters and gatherers'. This was especially so in the Arctic regions. They killed wild animals for meat and foraged plant foods. Some lived in coastal regions and used the sea as a source of food.

The first inhabitants of Northern America, South America, parts of Africa, Northern Arctic regions, and Australia, were initially all hunters and gatherers until the age of exploration, beginning in 1428, when European ships sailed to these 'remote' parts of the world and brought resources for agricultural practice. In the case of Australia, Aboriginal people

traditionally moved from place to place, living off the land. In many places water was scarce and animals like kangaroos could not be farmed. Farming in Australia did not begin until the arrival of Captain Cook in 1770.

Timeline

4004 BC - The Creation	Adam was created.	His son Seth was born 3874 BC.
2348 BC- The Great Flood	Noah was born 2948 BC.	Noah's sons: Shem, Ham Japeth
2242 BC - The Tower of Babel	The population spread out from the Middle east	



References

https://biblehub.com/topical/naves/a/agriculture--practiced_by_cain.htm
www.creation.com Journal of Creation 14(2)
<https://www.posenlibrary.com/guide/geography-hebrew-bible-where-did-ancient-israelites-live>
<https://www.calendar-australia.com/faq/where-did-the-israelites-live-before-egypt>
<https://www.biblestudytools.com/bible-stories/the-tower-of-babel.html>

Questions

1. Why was there no need for agriculture in the Garden of Eden?
2. What were Adam and Eve NOT allowed to do?
3. What happened to plants and animals after the Fall?
4. Explain the differences in the types of agriculture practiced by Cain and Abel.
5. What added a further curse to the land?
6. Research some of the agricultural practices in Biblical times. Make a summary.
7. What is the relationship between agriculture and God's statement that He is a provider?
8. What thanksgiving festival was and is observed by Jewish people for provision of food?
9. How was animal farming made possible post-Flood?
10. How was the growing of crops made possible post-Flood?
11. What effect did the Tower of Babel have on agriculture?
12. Draw a map to show the migration of the Israelites from Mt. Ararat to the Promised Land.
13. Describe some of the farming practices of the Israelites once they reached the 'Promised Land'.

The development of agriculture in Fiji

The economic history of Fiji is closely linked to the development of agriculture. In the 18th century, explorers and traders began to visit Fiji. They bartered metal goods like fish hooks, axes and knives for water, fresh food and later for sandalwood and beach-de-mer. They released pigs on the main islands so that they could have another source of protein during later visits.

Missionaries also settled in Fiji. They introduced apiculture (bees), chickens and goats as a source of honey, eggs, meat and milk for themselves and their families.

Over time, farmers began to specialize in producing various commodities. They produced surplus which was bartered with other members of the community.

Commercial agriculture

The commercial production of sugar saw the introduction of the indentured labourers who brought cattle with them. The cattle provided milk, were used as draft animals and had religious significance too.

After the ceding of Fiji to Great Britain, money was introduced into trading.

To provide for the members of the population who were not self-sufficient in food production but could now buy food, farmers developed larger farms. They cleared the land, used animal drawn implements, fertilizing materials and agro-chemicals to increase the production of the commodities required by the population.

Farmers now have both local and export markets to cater for so they:

- use machines and metal implements to make the work lighter and quicker, produce more and to reduce the need for labour
- specialize in producing one or two commodities in large amounts

- sell their produce, either fresh or processed, on local and export markets.
- use farming techniques which have altered the environment, often resulting in pollution and the death of other plants and animals in the environment.

Activities

- 1 a) Identify who brought the first pigs to Fiji.
b) State one reason why they released the pigs in Fiji.
c) Discuss what happened to the pigs which were released.
- 2 a) Identify who brought the first chickens to Fiji.
b) List one reason why these chickens were raised.
- 3 a) Identify who brought the first goats to Fiji.
b) State one reason why these goats were brought o Fiji.
- 4 a) Identify who brought the first cattle to Fiji.
b) List three uses of these first cattle.

Hunters and gatherers

The first people to settle in Fiji were hunters and gatherers. They would have been hunters, gatherers and fishers when they first arrived while awaiting the growing of seeds and plants they brought with them. The principle of hunting and gathering for Fijians has always part of the way of life for providing complementary food even to this day. For examples, there was food for when a hurricane hit, having destroyed cultivated crops. There were wild yams and other food in the forest to be gathered to be eaten in these times of disaster. Tribal wars probably kept people from cultivating consistently because they would have to go into hiding or in some cases their gardens would have been destroyed by their enemies.

As the population of Fiji grew they began farming to overcome the problem of scarcity of food and land. They later began to specialize in producing certain commodities and bartered the surplus. Traders, European settlers, missionaries and indentured labourers introduced many animals that are now raised commercially.

Basic importance of agriculture

Vocabulary

Beef - the flesh of adult cattle.

Beverage - food taken in as a drink, besides water.

Bio-fuel - a fuel derived from living matter e.g. wood, ethanol.

Chevon - the flesh of goats.

Lamb - the flesh of sheep which are less than one year old.

Mutton - the flesh of mature sheep.

Poultry - domesticated fowl.

Pork - meat of pig.

Fiji is rich in resources including the land and sea. These resources are important in agriculture. This is why Fiji still has an agricultural-based economy. The list below illustrates the importance of agriculture.

Importance of agriculture in Fiji

GOODS

FRUIT: like watermelons, citrus, banana, mango etc

VEGETABLES: like beans, tomato, cabbages, carrots, bele, pumpkins, egg plants, peas, sea weeds, edible ferns

ROOT CROPS: like sweet potato, dalo, yams and cassava

CEREALS: like rice and maize

MEAT: poultry, mutton, chevon, beef, pork and fish

BEVERAGES: like cocoa, tea, coffee, green coconuts

LUMBER: for bridges, houses, boats, furniture

FUEL: like firewood, bio-fuel

OTHER PRODUCTS: like wood chips, paper, masi

EMPLOYMENT

Primary, secondary and tertiary sectors

HEALTH – foods from nature are most important in maintaining good health

Activities

Agriculture is important because it produces many of the basic necessities of life including food, medicines, materials, employment and leisure activities.

1. Prepare a chart to illustrate one way in which agriculture is important. Discuss your chart with members of the class.
2. List all the ways in which agriculture influenced your life today.

Challenges facing the development of agriculture in Fiji

Agriculture is a risky business. Farmers can never be 100% sure that the crop they plant or the livestock they raise will grow and produce the quantity and quality of commodities they hope for. Sometimes the crop may produce much more than the farmer expected while at other times the opposite may occur.

Agriculture faces many challenges. Farmers try to identify the challenges which may face the farming enterprises before they occur. In this way, they can put plans in place to help them avoid or cope with the challenges. This is one reason why planning is so important in farming.

Agriculture has developed over the years, despite many challenges.

Activities

1. State one likely reason why:
 - a) apples are not produced commercially in Fiji?
 - b) pine trees are grown in Seaqaqa?
 - c) commercial milking cattle are raised in Tailevu, Naitasiri and Serua?
 - d) sugarcane farmers use tractor drawn implements to cultivate soil and sugarcane harvesting machines on their farms?
 - e) some hotels grow vegetables using hydroponics?
2. List the main crops and livestock produced in each division: Northern, Western and Eastern.
3. Farming is a business which faces many challenges. However, farmers have used different solutions to help them overcome the challenges. Make a list of the challenges that farmers around your area face and ways in which they have dealt with the challenges.

Professions related to agriculture

- Agriculture teacher/lecturer – who facilitates the learning and teaching of agricultural theory and skills.
- Agro technician – who studies and develops ways of improving agricultural production.
- Extension officer – who takes research findings and advises farmers.
- Farmer – who uses research findings and available resources to produce agricultural goods.
- Pest controller – who advises and control pests like insects.
- Researcher – who identifies challenges and finds possible solutions to the challenges.
- Farmer- a professional who produces raw materials for food, fiber, buildings and energy.
- Agriculture teacher/lecturer – a person who facilitates the learning and teaching of careers in the agricultural field.
- Counselor – a person who gives advice and helps others to find solutions to challenges.

Farm Management - some related professions

- Engineer – a person who designs and builds structures like machines, drainage and irrigation facilities, waste disposal units etc.
- Mechanic – a person who repairs machines.
- Store man – a person who controls the physical capital on a farm e.g. tool, machines etc.
- Tool helver – a person who makes tool handles.
- Toolsmith – a person who designs and makes tools from metal.
- Machine operator – a person who uses farm machines
- Farm manager – a person plan, coordinate and analyse farming operations.
- Trader- a person who buys and sells agriculture goods and inputs: vendors, retailers, wholesalers, importers and exporters.
- Valuer – a person estimates the value of agricultural resources like land, buildings, machines etc.
- Agricultural economist – a person relates economic theory to agricultural production e.g. when is the best time to produce a crop and why.

Agronomy – some related professions

- Agronomy
- Explores issues related to producing crops while developing skills in crop production and soil conservation.
- Soil scientist – a person who studies the properties of soil and recommends ways to improve and conserve soil.
- Agronomist – a person who manages soil for crop production.
- Market gardener – a person who grows vegetables for sale.
- Entomologist – a person who studies insects.
- Floral designer – a person who makes floral designs like bouquets, wreaths, garlands
- Florist – a person who grows and/or sells ornamental plants like flowers and potted plants.
- Forester – a person who manages a forest.
- Grounds man – a person who maintains a sports field or park.
- Landscaper – a gardener who designs and constructs the environment e.g. parks, area around buildings like the office or homesteads.
- Plant pathologist – a person who studies plant diseases and ways to prevent or cure them.
- Livestock - some related professions
- Apiculturist – a person who raise honey bees.
- Aquaculturist – a person who farms aquatic organisms like fish.
- Poultry farmer – a person who raises birds like chickens and ducks for meat and/or eggs.

- Rancher – a person who owns or manages a large farm for raising cattle, horses, sheep and goats.
- Stockman – a person who looks after livestock like cattle, sheep and goats.
- Veterinarian – a person qualified to treat diseases and/or injured animals.

Jobs and professions that are closely related to conservation and sustainable agricultural practices are called green jobs.

Farm resources

Vocabulary

Aptitude - natural ability to do something.

Attitude - the way of thinking or feeling about something.

Entrepreneurship - the ability to turn an idea into an action.

Resource - inputs used to produce goods and services.

To be able to produce agricultural goods, a farmer needs resources. These resources are also called Factors of Production. They are essential for farming to occur.

There are many resources used in agricultural production and can be put into three categories:

1. Natural Resources - things found in the environment including land, soil, water, rainfall, temperature, sunshine, clouds, wind, topography and weather.
2. Human Resources - the people who make up the workforce. People bring talents, skills, qualifications, experience, aptitude and attitude with them. They also bring entrepreneurship and risk-taking ability too.
3. Capital Resources - man made items used to produce other goods and services. Capital resources are divided into two groups:
 - i) physical capital – equipment needed to produce goods and services which include tools, machines, drains and buildings.
 - ii) financial capital - money and financial services needed to produce goods and services which includes money, banking facilities, and loans.

Activities

1. List all the resources needed to produce tomatoes in a school garden.
2. Explain the importance of the human resource on a farm.
3. Discuss why farmers must use resources in a sustainable manner.

Farming systems in Fiji

All farming activities in Fiji can be divided into three systems: subsistence agriculture which is sometimes called hobby farming, semi-commercial agriculture and commercial agriculture.

SYSTEM	SUBSISTENCE	SEMI-COMMERCIAL	COMMERCIAL
Yield	small	larger	largest
Capital invested	low	more	most
Use of produce	No sales – food grown for the community	Some sales in local markets	All sold in local markets and exported
Number of these farms in Fiji	most	many	few

Activities

1. List the 3 systems of farming found in Fiji.
2. Identify and explain one disadvantage of commercial farms.
3. Discuss 3 reasons why semi-commercial farms are so important to the Fiji economy.

Basic skills in management

1. Planning – planning will allow the farmer to identify the challenge and make arrangements beforehand e.g., a farmer wants to plant rice but has no physical resources to prepare the land [tractor and plough]. The farmer can plan to hire the physical resource from the neighbour.

Planning is an important part of running a business because it deals with what resources:

- are needed and when
- are available and when
- where to get needed resources from and the cost

For example: A farmer may have all the natural and human resources that are needed for an enterprise but needs to plan for capital to be available when needed.

It is important for the farmer to record plans on paper so that the plans can be referred to and changed if need be.

2. Buying – the farmer will have to purchase many of the resources needed on the farm.

Buying means spending money. While buying the farmer must consider the:

- need for the item – does the farm really need the item or can the farmer borrow or use something else instead.
- quality – that the items paid for are of the quality needed.
- cost – farmers are advised to get three quotations for items if they can before deciding what to buy and from where.
- timing – can the items be bought during a sale and last until they are needed or not.
- storage – if the item is not all used up, has the farm got facilities to store the remaining item.

3. Producing – the farmer uses the resources to produce goods. The farmer must consider the customer who will buy the farm products and the other farms which will compete for the same customers.

Quality – the farmer must use methods to produce commodities which can compete with what other farmers produce. It is recommended that the farmer produce for niche markets so the items fetch a higher price.

Quantity – the farmer must produce the amount needed by the customers or the customers may go to another farm.

Method used – the farmer must make sure that the farm uses methods acceptable to the community i.e., sustainable and green.

When to produce – if many farmers are producing the same commodity, then there will be glut and the price of decrease. It is advisable for farmers to produce in the offseason as the price for the items will be higher.

4. Selling – farmers will receive an income if they sell the goods which have been produced. They must attract customers to choose their goods instead of the competitors. The farmer must consider:

The customer – what do they want, how much do they want, what price are they willing to pay, how do you inform them of your product [suitable advertising], when do they want your product, where are they willing to buy from, which competitors can they get the same product from, will they pay in cash or ask for credit.

The competitors – what are they producing, the quality and size of their products, how much are they producing, what price are they selling at, how will they advertise, how will they attract customers

5. Tracking – all businesses need records which are complete, up-to-date and reliable.

6. Managing – all resources must be managed efficiently.

- Natural Resources- are scarce and expensive so must be used sustainably.
- Pollution- must be minimized or avoided so the use of by-products is important.

Human Resources – the workers need a leader who motivates and treats them fairly. A happy and skilled workforce will achieve more if they feel that they are appreciated by the manager. Managers must also recognize the workers abilities and experience are appreciated and that the leaders listen to advice from them.

Capital Resources

- physical capital is expensive to replace. The manager must ensure that all tools, machines, fences, buildings etc. are in good working order so that work can be done well and on time.

- financial capital is also precious. The farmer will try to secure loans based on records and then try to repay the loans based on repayment schedules. All money coming into and going out of the business must be recorded so that the performance of the business can be analyzed.

Activities

The six basic skills above develop with experience and are all important in running a business.

1. List the six basic skills of management.
2. Explain why tracking is an important skill.
3. Discuss the importance of managing human resources wisely.

Role of the farm manager

The farm manager has many responsibilities on a farm including:

- 1) conducting research
- 2) running the farm
- 3) preparing plans
- 4) evaluating the progress of the farm
- 5) making decisions
- 6) taking responsibility for the successes and losses on the farm

These responsibilities all lead to the improvement of the farm in future

In this way, the farm is managed to ensure that the scarce resources are used to achieve sustainable production levels at a profit.

SOIL

The surface of the earth, which is the crust, is covered in a soft layer of material called soil. However, about 71% of the crust is covered in water. This leaves only 29% of the crust as land in the form of islands and continents.

The 29% of land is divided into

- a) Farm land – about 11%
- b) Land for other uses – about 18%

Soil is a mixture of materials including pieces of rock, minerals, organic matter, gases, liquids, and countless organisms that together support life on Earth.

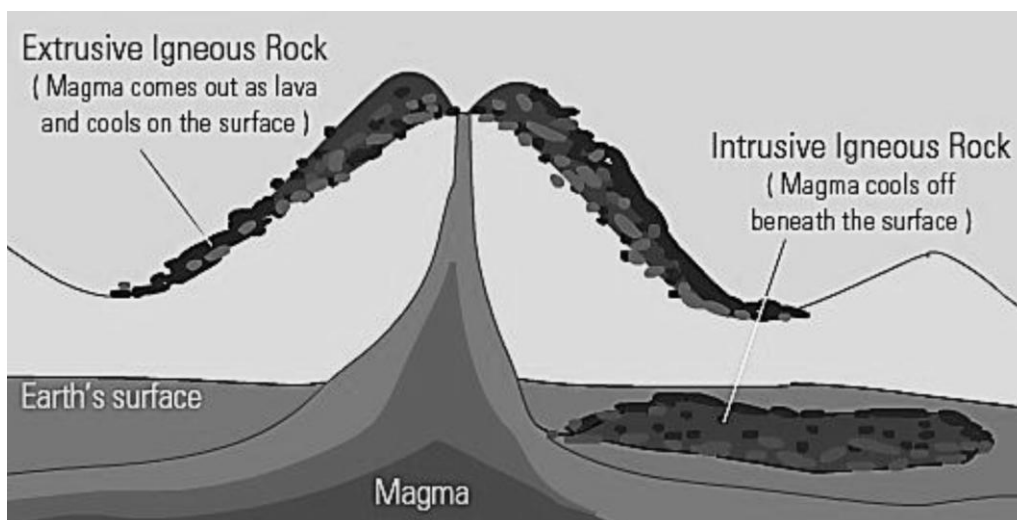
There are many types of soil in the world but the two main types are sand and clay. When sand and clay are combined in equal proportions, loam is formed. However, if individual sand grains are coated in clay, then silt is formed.

ROCKS

Rocks result when tiny grains of different minerals react and are compressed together. Rocks are a valuable which are continuously being made and weathered.

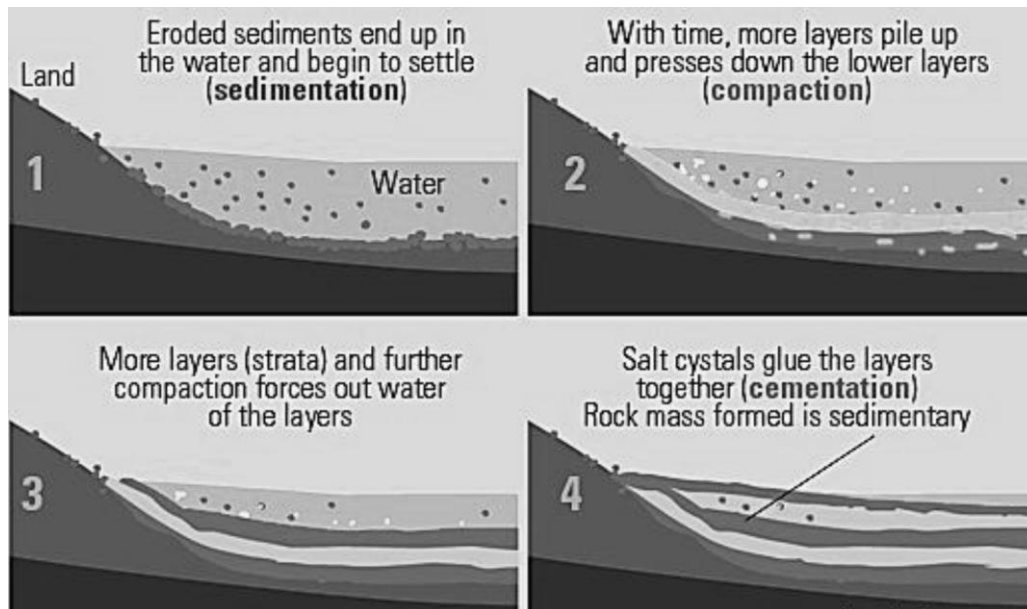
There are three types of rocks.

1. Igneous rocks – form when magma cools so do not contain fossils and organic matter. The diagram below illustrates how the two main groups of igneous rocks are formed.

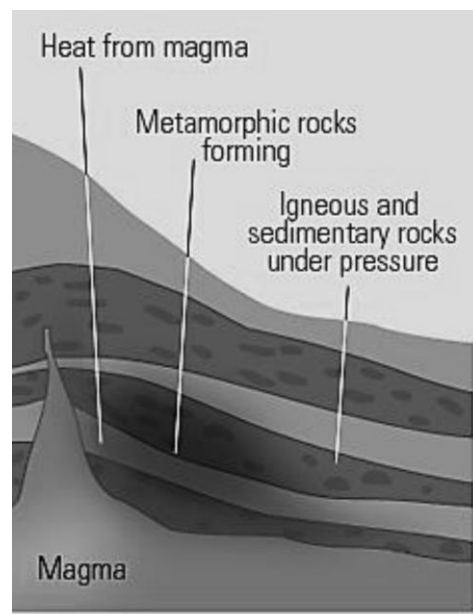


2. Sedimentary rocks – form when eroded particles of rock, wash down to the sea and settle out in layers, called strata, in a process called sedimentation. As more layers form, the weight causes compaction. Salt particles glue the layers together in a process called cementation. Over hundreds of years, the large amounts of plants and animals trapped between the strata for crude oil and gas.

The diagrams on the next page illustrate how sedimentary rocks are formed.



3. Metamorphic rocks – are formed when chemical changes occur in igneous and sedimentary rocks which are under extreme heat and pressure. The diagram below illustrates how metamorphic rocks are made.



Activities

1. List the three main types of rocks.
2. Differentiate between compaction and cementation in relation to rock formation.
3. Discuss how metamorphic rocks are formed.

Soil formation

Soil is a valuable resource which is continuously being made, used and lost from an area. There are five factors which work together to form soil.

1 Parent material

- Organic material, partially weathered rock, volcanic ash, deposited sediment and rock moved by glaciers are all part of the parent material of soil.
- Igneous, sedimentary and metamorphic rocks are broken into very small pieces during weathering. These pieces form the bulk of soil.

2 Climate

Precipitation, wind and changing temperature all cause rocks to weather.

Moving water pulverizes rocks as they crash into each other ☐ Strong wind causes wind blasting as particles of soil hit rocks ☐ Extreme heating and cooling causes exfoliation as rock surfaces peel off.

3 Topography

Soil is removed from steep slopes so the rocks which are exposed can be weathered. The eroded soil is deposited on the level land at the bottom of steep slopes resulting in deeper soil.

4 Biological activity

Plants and animals burrow into soil and soft rocks, so mix and aerate soil. They also remove minerals from the soil. Tree and plant roots can grow deep causing changes in the lower horizons (layers) of the soil. More organisms cause new soils to have a greater amount of organic material as these same organisms die and decompose and so return minerals to the soil. Human activity can aid or deter new soil production.

5 Time

New soil is always being formed as weathering is a very slow process. It sometimes takes two hundred years to form 1cm³ of soil. The more time each factor is given, the greater the influence on the soil.

Activities

1. List the five factors responsible for soil formation
2. Differentiate between pulverization and sandblasting in relation to soil formation.
3. Discuss the effect which each of the five factors listed in 1 above have on soil formation.

Components of soil

Soil is composed of equal proportions of solids and the spaces between them. The solids are divided into inorganic material and organic material.

The spaces between the solids are called pores. Pores are filled with air and water. In an ideal soil, the volume of:

- a) inorganic material is 45%.
- b) organic material is 5%.
- c) pore space is 50%.

This pore space should be filled with air (25%) and water (25%).

However, water displaces air so when more water is added to soil, air is pushed out of the pore spaces. This results in more water and less air in soil. When there is too much drainage and evaporation, there will be more air than water in pores.

Inorganic material in soil

Inorganic material which makes up the bulk of soil, originates from rock.

Activity

1. Conduct the following experiment in groups. You may begin the experiment on one day and observe the results on the next day:

You will:

- a) observe the solid components of soil.
- b) determine the type of soil in the bottle

Each group is to collect soil from a different location. Each group is to wash out an empty soft drink bottle or jar and then fill softened soil from their sample into it, up to the $\frac{1}{4}$ -full mark. Add tap water, close the lid and shake the bottle or jar vigorously. Leave the contents to settle, maybe overnight. Once the contents have settled, carefully observe the layers they have formed. Use a permanent marker to mark where each layer reaches on the side of the bottle or jar. Use a ruler to measure the height of each layer.

<http://www.howstuffworks.com>

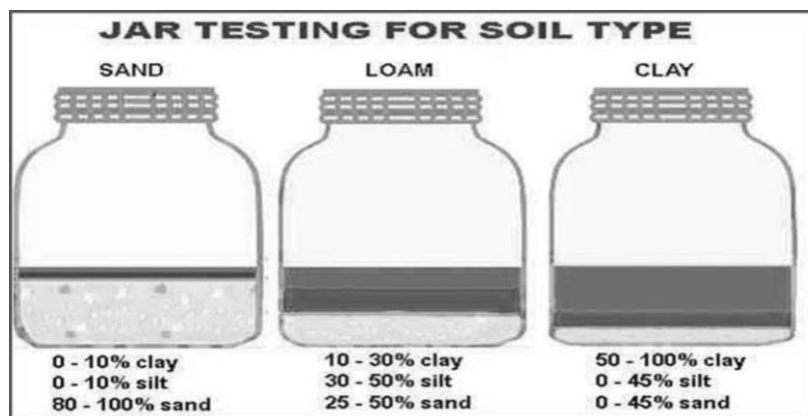
2. On a piece of paper, draw the bottle or jar showing each layer. Label each layer

Remember:

The inorganic material from the soil used in the experiment settles to the bottom of the bottle according to their various sizes. The finest particles are clay with silt, sand and gravel being the names of the particles as they get larger. Organic matter floats; often near the top of the water.

Write down the height of each layer of inorganic material and determine the percentage (%) of the content it makes.

4. Compare your results to the diagrams below and determine if your soil was sand, silt or clay.



5. Write the experiment using the science experiment format:

Title, Aim, Materials, Method, Results (with diagram), Discussion and Conclusion.

6. When you have finished your observations, shake the bottle or jar again and pour the contents into the garden where you got it from. Wash out the bottle or jar and place it in the appropriate recycle bin.

To ensure that the inorganic material in soil can provide benefits to plants, organic organisms and animals, farmers:

- soften the soil by tilling
- increase mineral content of soil by add fertilizing materials like fertilizer and manure
- control the water content by irrigating or draining soil
- minimize erosion
- encourage the growth of beneficial organisms in the soil

Summary

Inorganic matter in soil originates from rock and can be classified into silt, clay, sand and stones according to size. To ensure that plants and soil organisms can obtain what they need from inorganic matter, farmers practice tilling, water control and erosion control.

Organic material in soil

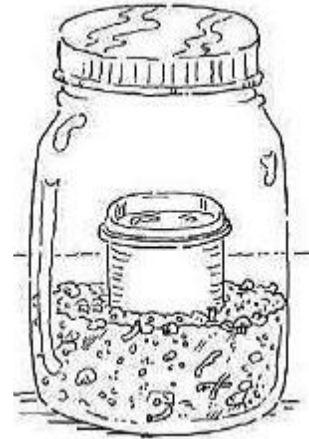
The organic materials found in soil include living, waste and dead parts of plants, animals and microorganisms.

Conduct the following experiment to observe the presence of microscopic organisms in soil.

Place soil in the bottom of the jar up to the $\frac{1}{4}$ - full mark.

Place an open container of limewater in the jar so that it rests on top of the soil. Close the jar lid tightly and leave the contents undisturbed for three days before observing the limewater.

NB: Do not let the lime water touch the soil.



2. Write the experiment using the science experiment format:

Title, Aim, Materials, Method, Results (with diagram), Discussion and Conclusion.

Remember: Carbon dioxide turns limewater milky.

Microscopic soil organisms like protozoan, bacteria and nematodes, take in oxygen and release carbon dioxide as a waste product.

To ensure that micro-organisms, plants and animals benefit from organic matter, farmers:

- minimize soil disturbance e.g. reduce soil tillage
- add minerals to soil e.g., add manure to soil like green manure, poultry
- manure and compost
- regulate the water content of soil e.g., irrigate or drain soil
- minimize changes in soil temperature e.g., covering the soil surface and avoid burning

Importance of soil organic matter:

1. provides food for soil organisms
2. controls soil temperature
3. recycles minerals
4. stores soil water
5. stores soil air

6. cementing agent which holds soil particles together so soil erosion is reduced

Activities

1. List 5 examples of soil organisms.
2. Differentiate between debris and organic matter.
3. Discuss 5 reasons why farmers should NOT clear fields by burning

FISHERIES

Pre-commercial fisheries

When the population was low, the ocean, streams, rivers and ponds were able to provide many different types of aquatic resources that were needed, so capture fisheries was practised. Aquatic organisms were available closer to shore so people used fishing gear made of local materials like bamboo rafts, canoes and traps made of stones or bamboo. They also gathered crabs, mussels, eels, prawns and sea weeds from the mangroves, rivers and inter-tidal areas.

Commercial fisheries

Over time larger catches were needed to feed the growing population. People began to specialize in harvesting more aquatic organisms for barter and then for sale. This resulted in the development of more efficient equipment and methods of capturing wild aquatic organisms and aquaculture.

Fisheries are important to Fiji for many reasons:

1. Source of food: there is a wide range of food which is harvested from aquatic environments.
2. Source of income: as well as selling raw and processed fisheries products, there are many professions and career opportunities and businesses associated with fisheries. These include:
 - a) equipment suppliers like boat builders, bait shops, fish and tackle shops.
 - b) fisher folk like captain and crew of fishing vessels, divers, fishermen.
 - c) value adding like canning factory workers.
 - d) tourism workers like tour guides.
 - e) traders like middlemen, salespersons, vendors.
3. Source of materials: there are many materials extracted from aquatic ecosystems including seawater, coral, sand, shells, pearls, sponge, gravel and limestone.
4. Source of leisure activities: nautical tourism, underwater photography, viewing, diving, surfing, rafting, aquariums, fish feeding and swimming are among the many leisure activities centred on aquatic environments.

5. Water: sea water is used for many purposes including saltwater pools for swimming in. Minerals are removed from seawater by the process of desalination so that fresh water can be obtained.

6. Important environmental functions including:

a) recycling nutrients – nutrients are dissolved in water and wash into aquatic ecosystems. Aquatic plants and animals absorb these minerals and return them to the food cycle.

b) purifying water – many microscopic organisms like bacteria and fungi remove impurities from water.

c) attenuating floods – water is channeled along streams and rivers to the sea so reducing flooding during heavy rain.

d) providing habitats for wildlife- a wide variety organisms live in water.

Activities

List all the ways in which your family benefit from the fisheries section of the economy.

Note: Apart from fish, shellfish, crabs and octopus are an important food source. Turtles are endangered species so are not to be caught and killed.

Aquatic plants

These grow in water and are called water plants, sea weeds or waterweeds. Aquatic plants are important because they:

a) oxygenate water – the aquatic plants produce oxygen during photosynthesis. This oxygen is released into water and is used by aquatic animals.

b) provide a habitat for other organisms including animals and micro-organisms.

c) provide a breeding ground for many aquatic organisms.

d) provide food for aquatic animals.

e) slow down the action of waves and reduce erosion.

People harvest and use aquatic plants:

a) as food for people e.g., sea grapes.

b) as feed for animals e.g., kelp.

c) to produce carrageen, a natural food gum used in food like salad dressing and sauces.

d) to produce agar which is used in laboratories for growing microorganisms and in foods like ice cream.

e) for making fertilizing material like compost.

f) for mulching material.

Aquatic plants range in size from microscopic algae which can only be seen under a microscope, to giant kelp which can grow to more than 50 meters in length.

One hundred of the 500 sea plants found in the Pacific region are edible.

Source: *Fiji Ministry of Education Agricultural Science text book, 2019*