# LESSON C2
# CLIMATE CHANGE AND AGRICULTURE

**MAIN SUBJECTS**
Natural sciences / Geography

**DURATION**
~ Preparation: 5 min
~ Activity: 1h15

**AGE GROUP**
12-15 years

**LEARNING OUTCOMES**
In this activity, through documentary analysis students learn how modern agriculture is affected by climate change and how agriculture worldwide is influencing the climate.

Students learn that:
~ Modern agriculture is very diverse.
~ Agriculture is affected by climate change.
~ Extreme events affect the ability to grow crops or to farm animals.
~ Modern agriculture increases deforestation.
~ Modern agriculture impacts biodiversity.

**KEYWORDS**
Land, agriculture, deforestation, extreme events

**TEACHING METHOD**
Documentary analysis

## PREPARATION 10 MIN

**EQUIPMENT**

- Optional: computers with internet access, to use the multimedia animation Agriculture diversity.
- If no computers are available: **WORKSHEET C2.1.**
- **WORKSHEETS C2.2** and **C2.3** (one per student).
- **WORKSHEETS C2.4, C2.5, C2.6, C2.7** and **C2.8** (one or two copies, depending on the number of groups you have).

**LESSON PREPARATION**
The documents have two levels of difficulty – "curious", the most accessible level for students aged 11 to 12 years, and "experts", for students aged 12 and over. These levels are of course merely indicative. Print out the worksheets.

## INTRODUCTION 30 MIN

In the previous lesson, students worked on the link between eating habits and climate change. Ask them where their food comes from and how it is produced (from their garden? from the supermarket? from the farm?)

- *What is a farm? Why is it useful?*
- *How does a farm work?*

Possible answers: A dairy farm produces milk. The cows eat grass (or are fed in their cowshed with hay, and soya, corn, etc.) and are milked every morning and evening. The milk can be processed to make cheese, yoghurt or butter, which can be sold on the farm.
A famer grows vegetables in a greenhouse or in fields. They need to add nutrients to the soil, using manure or compost or fertilizers, and to water their plants.

- *Are all farms the same?*
- *How can these questions be answered?*

In order to answer them, students should suggest that they carry out research on how a farm operates. Then ask: *How can this be done? Take a tour? Have a farm in the school?* Initiate a discussion on this topic and then explain that you can see a farm from the air, using a website, or you can carry out a documentary analysis.

**1.** If you have access to the internet, your students can explore this topic using multimedia animation. Otherwise, distribute **WORKSHEET C2.1**.

**2.** Also hand out **WORKSHEET C2.2**; fill in the table with your students based on the information presented from a bird's eye view.

**3.** Lead a whole class discussion to compare their results, using the questions below. The idea here is to get them to see a link between agriculture and climate change:

## BACKGROUND FOR TEACHERS

**Agriculture is one of the biggest emitters of GHG in the atmosphere worldwide** (in 2014, it represented 24% of total emissions — source IPCC). Industrial agriculture is a major contributor for various reasons: fertilisers used for crop production emit large quantities of $N_2O$ into the atmosphere; cow, sheep and goat farming produces methane ($CH_4$).

In many cases, crop production — mainly cereals to feed cattle — encourages **deforestation**, resulting in the accumulation of $CO_2$ in the atmosphere.

**But agriculture is also directly impacted by climate change:** the increase in intensity and frequency of extreme events, such as flooding, heatwaves, bushfires, land erosion and drought, are already jeopardising food production and causing malnutrition in many regions.

You can learn more about these aspects and the link between climate change and food (lesson C1, page 137) by watching this video (in French but with English subtitles).

- *Which farm is bigger?*
- *For each farming system, how do you think this type of farming affects the environment (pollution, water, land use) or the climate?*
- *How do you think the climate may affect these farms?*
- *Do you think that some farms affect the environment more than others? What about climate change?*

## PROCEDURE 30 MIN

**4.** Explain to your students that they need to advise a farmer on the best way to set up a business (you can play the role of the farmer yourself). In teams, they must consider the problems that one can encounter as a farmer and the possible solutions.

- First of all, they will understand the role of one expert as a group (we advise groups of 3; there may be several groups working in the same role): they will have to analyse a portfolio, answer the questions, and fill in a short conclusion (one sentence) in the corresponding box on the summary sheet (**WORKSHEET C2.3**).
- Afterwards, each group of experts will mix together in larger groups of 5, which will have 1 expert from each category. This is the advisory board. Together, they will fill in the summary sheet, bringing together all their conclusions, and in this way they can help the farmer in his decision.

**5.** Hand out to each student the sheet summing up the conclusions of all the experts: **WORKSHEET C2.3**.

**6.** Divide the class into 5 groups (3 students per group):

- Meteorologists (expert level) – **WORKSHEET C2.4**
- Beekeepers (expert level) – **WORKSHEET C2.5**
- Veterinarians (expert level) – **WORKSHEET C2.6**
- Forest rangers (easy level) – **WORKSHEET C2.7**
- Journalists (easy level) – **WORKSHEET C2.8**

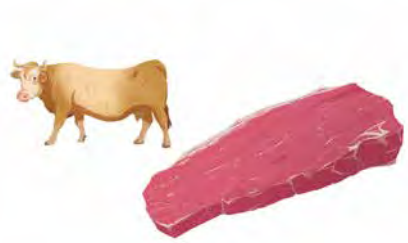
**7.** Each group answers the questions in their case study and puts down the conclusion of the study in one sentence on the summary sheet.

## WRAP-UP 10 MIN

Each group presents their conclusion to the rest of the class and the students can discuss. Give feedback to the whole class asking, for example, what can be done as a student, as a parent or even at school to encourage better farming. Encourage local agriculture – visit a farm, have a vegetable garden in the school, have vegetarian menus in the canteen, etc.

### TO GO FURTHER

You can take a trip to a local farm with your class.
You can propose to the class to work on a project on planting vegetables in the school or at home (see We Act, Project #5, page 245).



# BEEF

## FRANCE: NORMANDY BOCAGE



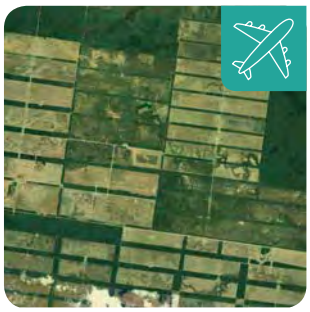
Normandy, in France, still has small-scale agriculture, with family-run farms. The meadows are small and delimited by hedges forming what is called the “bocage”. This contains a very rich biodiversity, especially in terms of insects and birds, which benefit from the many trees and shrubs. The traditional way of farming is to breed Normandy cows for milk (to make Camembert, for example), but also for meat. Cattle release methane into the atmosphere, which is a powerful greenhouse gas.

## BURKINA FASO: THE BEEF OF THE FULANI



The Fulani people have large herds of humped zebus, related to the cow. They mainly get milk from the females and use the males for draught power. In some cases, on special occasions, they eat the meat. Cattle release methane into the atmosphere, which is a powerful greenhouse gas. The animals graze on large, very arid areas and drink from big watering holes created by humans. Intense and increasingly frequent droughts linked to climate change are causing yield losses and herd mortality.

## PARAGUAY: CATTLE FARMS

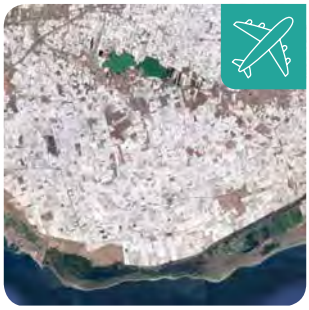


In Brazil and Paraguay, farmers cut down the forests to create space to raise cows. Cows live in dense groups in giant corrals to provide food for the local population and for export outside South America. Cows are the main emitters of methane, a major greenhouse gas. Deforestation also contributes to climate change.

Plane view  Drone view  Pedestrian view

# TOMATOES

## ALMERIA: THE SEA OF PLASTIC



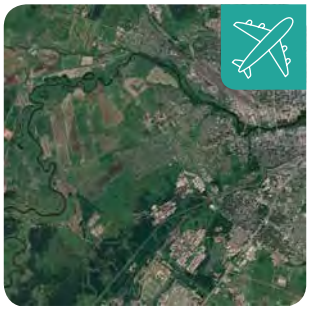
This large region in southern Spain was once a desert. Today, it is covered with greenhouses where tomatoes, amongst other products, are grown all year round to supply supermarkets throughout Europe. The fruit and vegetables grown here are often used in the preparation of industrial processed food. The highly intensive production requires a lot of water, fertilisers and pesticides. The greenhouses use a lot of plastic in their manufacture and frequent repair as the region is very windy. The use of so much fertiliser and plastic, and the transportation required to distribute the tomatoes all over Europe increases the emission of greenhouse gases into the atmosphere.

## TUNISIA: THE DRIED TOMATOES OF CAP BON



Close to the sea, in the north of Tunisia, traditional family tomato-growing enterprises remain. The tomatoes are grown in open fields and picked by hand by family members. They are then either dried on large racks in the sun, or made into tomato puree or concentrate. These small crops benefit from a favourable environment for tomato production that climate change and rising water levels could disrupt.

## RUSSIA: THE RUSSIAN GARDEN COLLECTIVE

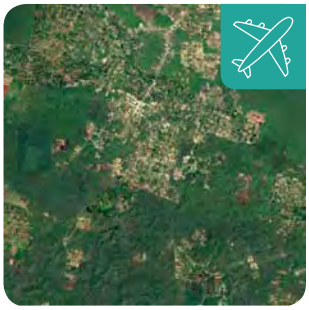


Russia offers an example of large-scale collective peri-urban agriculture. Many residents of Russia's large cities cultivate a garden for food purposes; they are called gardener-inhabitants (or datchniki). In these groupings of flower gardens, kitchen gardens, orchards and cottages, there are many crops grown such as fruit (strawberry and raspberry) or vegetables, such as cabbage, carrots, potatoes and tomatoes. In addition to making a significant contribution to the country's agricultural production, this "parallel circuit" makes it possible to be less affected by climate change.

Plane view  Drone view  Pedestrian view

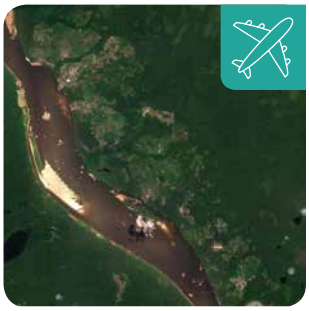
# MAIZE

## MEXICO: THE MAYAN TRADITIONS OF CORN CULTIVATION



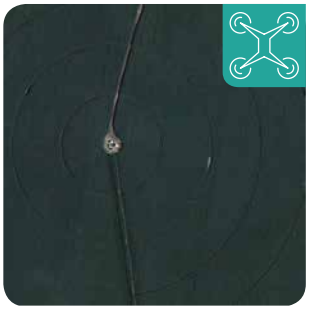
In the Yucatan region, there is a strong Mayan tradition. This translates into a very diversified diet and, in particular, the use of corn as a cereal base (as in the famous tortilla). In many villages, maize is grown by families on small plots of land, in divided farms that also grow fruit trees, fruit or vegetables. The land is often worked by hand. These farming practices have a low impact on the climate, as they require little transport and fertiliser.

## VENEZUELA: SLASH-AND-BURN



Along the Orinoco River, the Piaroa root people have practised traditional slash-and-burn agriculture for centuries. Farmers burn a part of the Amazonian forest, then cultivate successive assemblages of plants and trees for their consumption (maize gardens, then cassava gardens, fallow land, then a forest of palm trees and fruit trees). On a small plot of land, they burn, cultivate, and then plant a forest. This type of agriculture is very respectful of the environment and has a low impact on the climate and biodiversity.

## UNITED STATES: CIRCULAR FIELDS OF CROPS

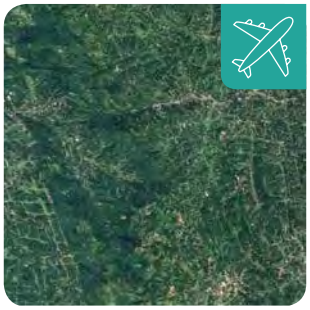

In semi-arid regions, to obtain fertile soil to grow crops such as maize (mainly used to feed animals), farmers use a watering system (irrigation) creating giant circular fields of crops. These crops use a lot of space and water. In addition, they are often linked to the use of fertilisers and pesticides (which have a very negative impact on the climate) as well as to the cultivation of GMOs. These structures are visible from space, giving the impression that the landscape is pixelated.

Plane view  Drone view  Pedestrian view

# PALM OIL

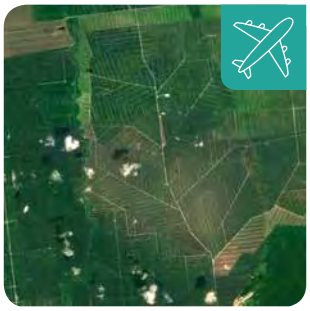
## SRI LANKA: AGROFORESTRY

Tea and palm oil plantations are combined with other plants to mimic the local ecosystem, and have more disease- and weather-resistant crops than monocultures. These family productions have a low impact on the climate and the local environment, and promote biodiversity.



## MALAYSIA: INTENSIVE PALM OIL PRODUCTION

In Sarawak, on the island of Borneo, the palm oil industry is very strong. Large tracts of rainforest are burnt down every year to make way for palm oil plantations. These endless palm groves are a disaster for the local ecosystems: the monoculture of these trees leads to a depletion of the previously rich local biodiversity (this is the land of the famous orangutans). In addition, deforestation contributes to climate change. Almost all the palm oil produced is exported from Malaysia.



## BENIN: TRADITIONAL PALM OIL PRODUCTION

In West Africa, farmers practice agroecology, harvesting the fruits of the palm tree in the wild or on small farms for local consumption, as they have done for generations. The traditional palm oil remains an essential part of the local culture, economy and diet. Its artisanal production is generally carried out by women farmers. These crops have a very low impact on the climate, as they do not require transport or the use of fertilisers.



Plane view  Drone view  Pedestrian view

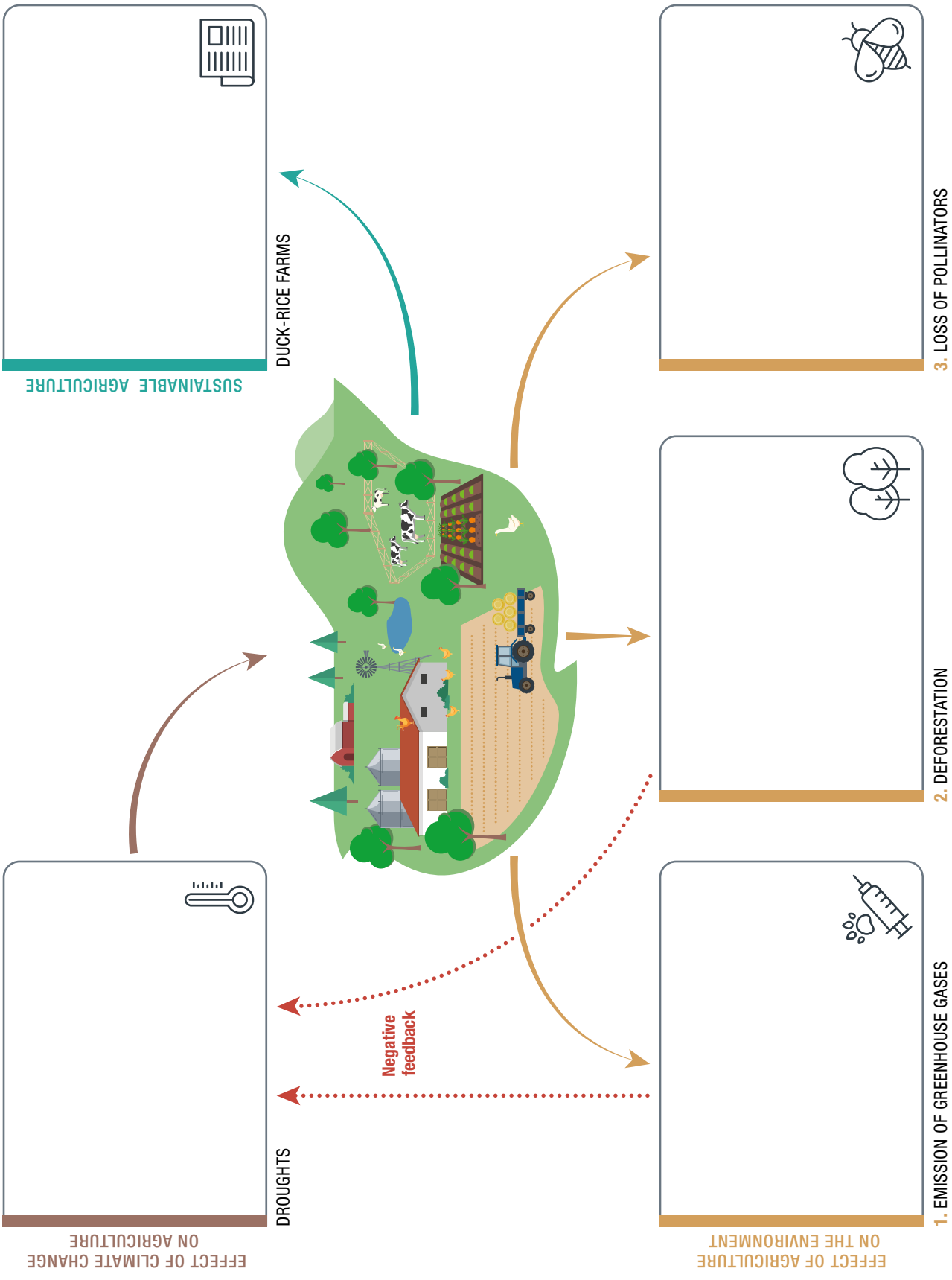
# WORKSHEET C2.2

## DIFFERENT TYPES OF FARMING IN THE WORLD

| | LOCATION / CLIMATE | TYPE OF FARMING AND PRODUCTION | APPROXIMATE SIZE |
|---|---|---|---|
| BEEF | | | |
| TOMATOES | | | |
| MAIZE | | | |
| PALM OIL | | | |

# WORKSHEET C2.3

## SUMMARY SHEET



## METEOROLOGISTS

You are a group of meteorologists (you study the temperature and rainfall at a given time). You are sent to Australia to discover what happened in 2015: animals were starving to death and it was very dry.

- Where and when were the photos in **DOCUMENT 1** taken? Explain the differences between the "before" and "during" pictures. From the "before" picture, describe what you can see: humans, animals, plants, water? What does the sky look like? Cloudy or sunny? What aspects do you think are good for food production from what you see in the picture? Now look at the picture taken during the drought: what do you think is different?
- How does the weather influence agricultural activity? Can you explain in some detail (you can do some research online).
- Describe the two graphs in **DOCUMENTS 2** and **3**: in each case, what information is on the x and y axes? What type of data is represented here and how does it change over time? How does this relate to the images in **DOCUMENT 1**? Do you think this is related to climate change? Why do you think so? How do you think this will change over time?
- Answer in one sentence the following question (write your answer on the summary sheet): **What is the impact of climate change on agriculture in Australia? What are the resulting problems for the farm?**

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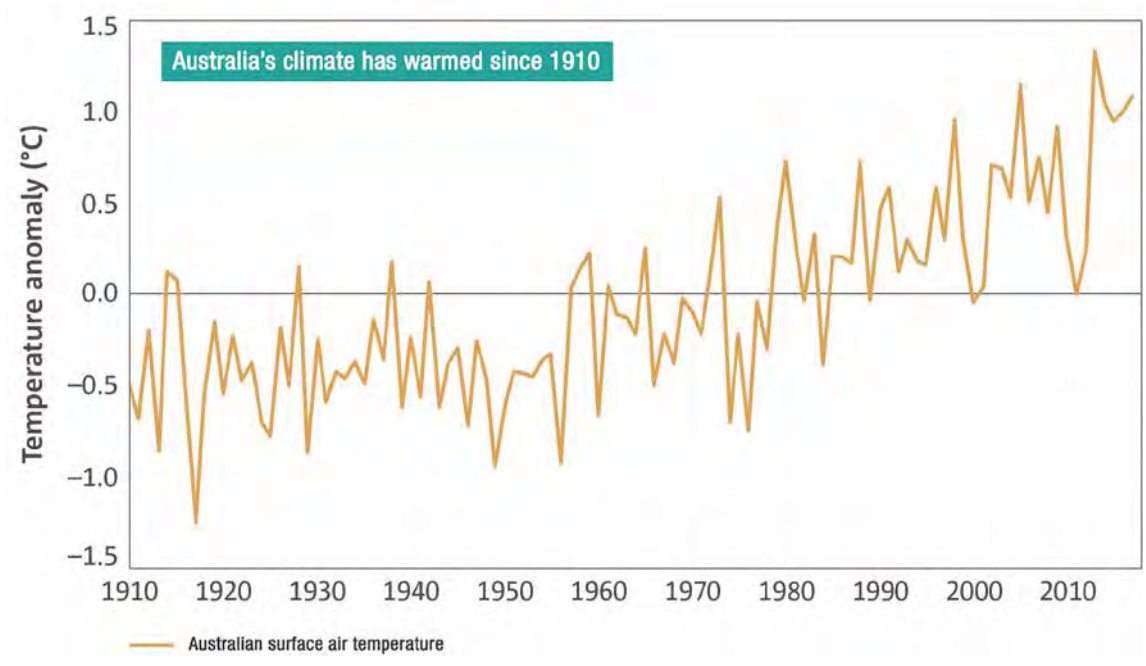
### DOCUMENT 1: BEFORE AND AFTER DROUGHT IN AUSTRALIA

If you have internet access, go to the following website and study the "before" and "after" pictures of drought on Australian farms.
https://www.abc.net.au/news/2015-12-17/queensland-drought-photos-before-after/7035610?nw=0

**2012**: Rearing healthy cattle at Catumnal Station.

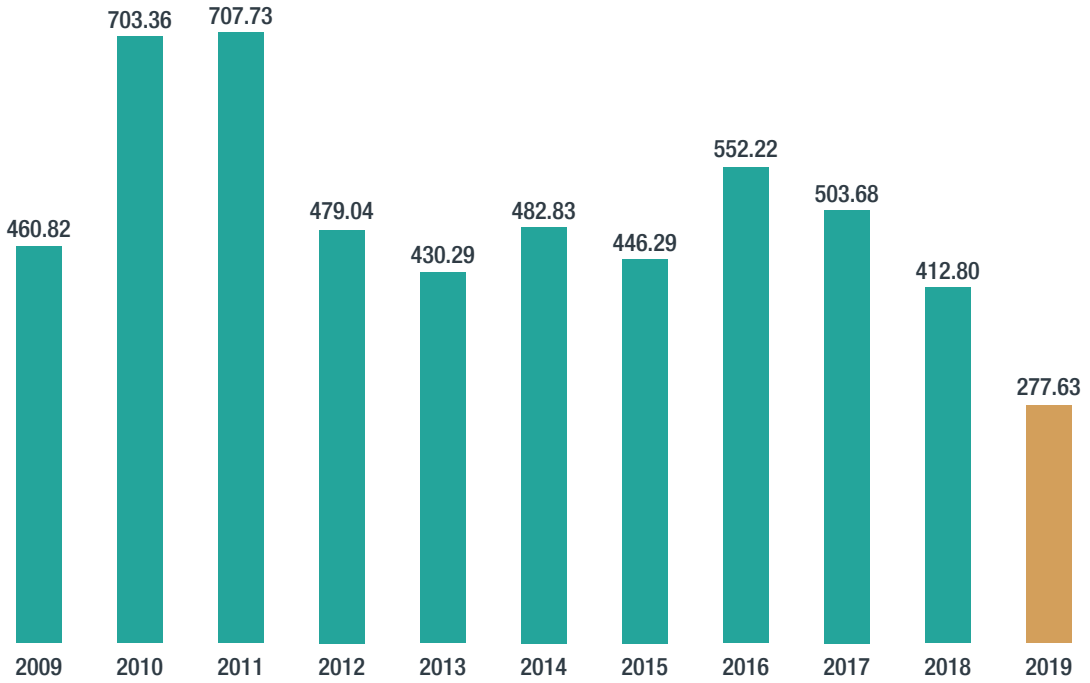
**2015**: This paddock at Catumnal Station can now only support about 20 cows.

## DOCUMENT 2: CHANGE IN AUSTRALIA'S MEAN TEMPERATURE OVER A HUNDRED-YEAR PERIOD, FROM 1910 TO 2010




Source: © Copyright CSIRO Australia, data from Bureau of Meteorology.
https://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate/previous/state-of-the-climate-2018/australias-changing-climate

## DOCUMENT 3: AVERAGE RAINFALL IN AUSTRALIA BETWEEN 2009 AND 2019, IN MILLIMETRES




Source: Statista, data from Bureau of Meteorology.
https://www.statista.com/chart/20525/australia-wildfires-drought-rain/

## BEEKEEPERS

You are a group of beekeepers and your job is to look after hives, which contain bees that produce honey. You are experts on the environmental role of bees and you have been asked to study the following documents to find the link between the disappearance of bees and falling agricultural yields.

- With reference to the **DOCUMENT 1** and to the first paragraph of the article in **DOCUMENT 2**, explain why bees and other pollinators are important for food production.
- Read the whole article and explain, in your own words, what is happening to pollinators. What might this be due to? How is modern agriculture also a problem for bees?
- ***"Climate change interferes with the relationship between bees and the plants on which they feed."*** What do you understand from this sentence? What do you think is happening? You can do some research on the internet about how climate change affects flowers and bees.
- Write a one-sentence answer to this question on the summary sheet: **What is happening to pollinators around the world? Why is this a problem for farms?**

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### DOCUMENT 1: THE ROLE OF INSECT POLLINATION

LOSING OUR POLLINATORS MEANS LOSING OUR FRUIT AND VEGETABLES

# About a **third** of crops are **pollinated by bees**


INSECT POLLINATION VERSUS OTHER TYPES OF POLLINATION

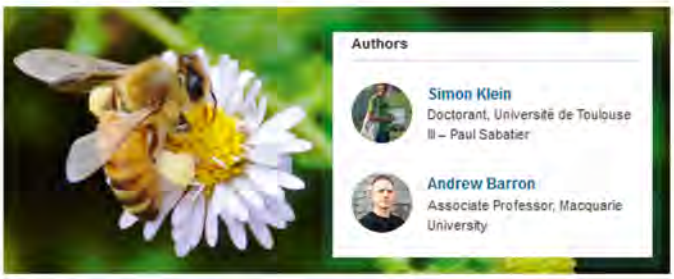
# Fruits can **vary greatly in size and quality** if insect pollination is taken out of the equation

## DOCUMENT 2: WHAT IS HAPPENING TO THE WORLD'S BEES?

If you have access to the internet you can read the entire article:
https://theconversation.com/ten-years-after-the-crisis-what-is-happening-to-the-worlds-bees-77164

THE CONVERSATION

Academic rigour, journalistic flair




### Ten years after the crisis, what is happening to the world's bees?

Ten years ago, beekeepers in the United States raised the alarm that housands of their hives were mysteriously empty of bees. What followed was global concern over a new phenomenon: Colony Collapse Disorder.

Since then we have realised that it was not just the US that was losing its honey bees; similar problems have manifested all over the world. To make things worse, we are also losing many of our populations of wild bees too.

Losing bees can have tragic consequences, for us as well as them. Bees are pollinators for about onethird of the plants we eat, a service that has been valued at €153 billion (US$168 billion) per year worldwide.

In a recently published review, we argue that modern agriculture and industry have created a host of sublethal stressors that damage bees' cognition. For example, diesel fumes and neonicotinoid pesticides both reduce bees' foraging efficiency by disturbing chemical communications in their brains. Modern intensive agriculture disturbs bee nutrition, which impairs their brain. Climate change interferes with the relationship between bees and the plants on which they feed.

### VOCABULARY

**HIVE** bee house.

**COLONY COLLAPSE DISORDER** the name given to a global phenomenon where honey bee populations are dramatically declining.

**SUBLETHAL STRESSORS** impacts from the direct environment that affect the behaviour or the health of an individual, without killing it directly (as opposed to a lethal stressor that kills the individual).

**COGNITION** functions of the brain, such as memory, choice, movement, senses, etc.

**DIESEL FUMES** air pollution coming from cars, trucks and tractors.

**NEONICOTINOID PESTICIDES** a type of chemical used on crops, and fruit and vegetable farms, to kill insects.

**FORAGING** pollinators, when they "forage", are collecting pollen and nectar from flowers to feed their larvae.

## VETERINARIANS

You are a group of veterinarians and you mainly take care of farm animals (cows, horses, pigs, chickens, etc.). You are experts on these animals and today you have been asked to describe their impact on the production of greenhouse gases.

- Using **DOCUMENT 1**, compare the amount of methane emitted in a year by a farm animal to what you (a human) emit over the same period. To estimate the amount produced by one kilogram of animal, divide methane emissions by animal weight. This will help you to find out which species emits the most $CH_4$ in relation to its weight.
- With your results, explain how farm animals have an impact on climate change.
- Take a look at the map (**DOCUMENT 2**), and compare the different regions. In your region, are there a lot of livestock? Do you think this affects the climate? What can you do about it?
- Write a one-sentence answer to this question on the summary sheet: **How do farm animals affect the climate? What solution(s) exist to limit the impact of agriculture on the climate?**

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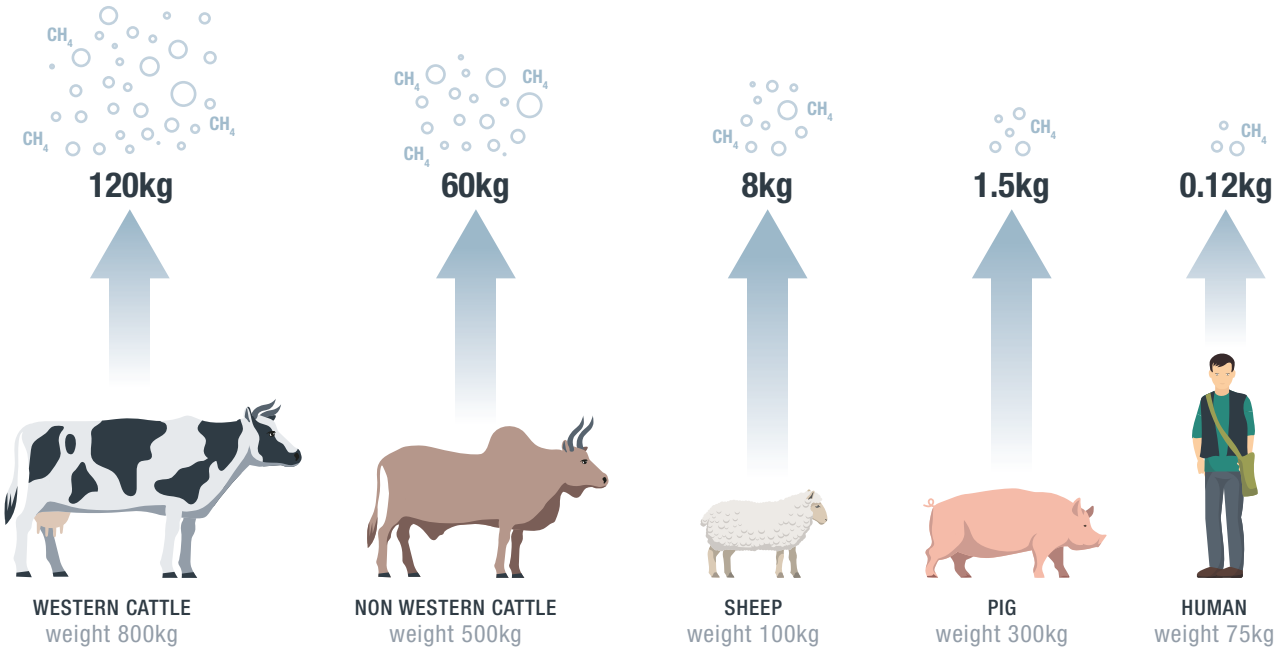
### DOCUMENT 1: FARM ANIMALS AND METHANE EMISSIONS (PER ANIMAL/HUMAN PER YEAR)

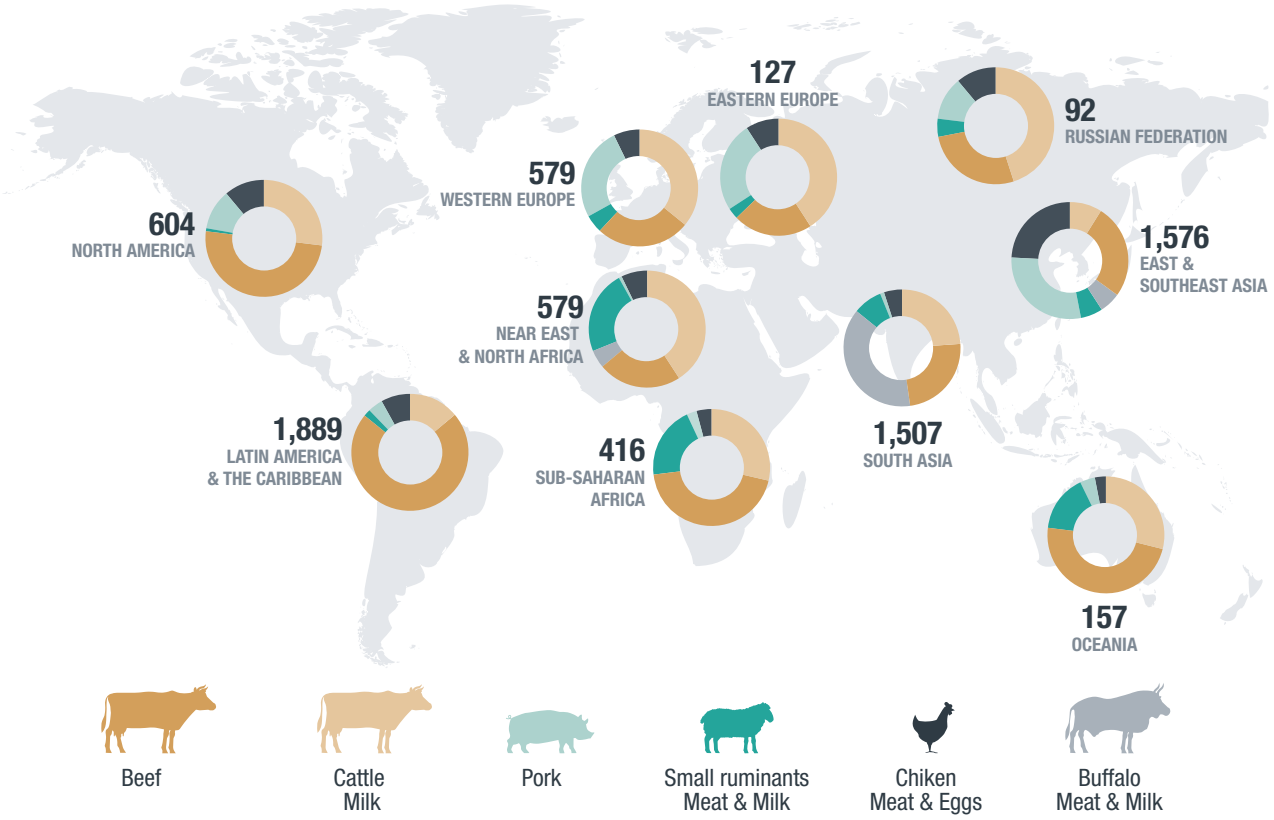
Cows – like other ruminants, such as buffalos or sheep – have a peculiar stomach: in fact, they have 4! Each "pocket" of the stomach contains millions of microbes that break down grasses into useable energy for the cow. During this process, they also produce methane, a greenhouse gas that contributes to global warming, which is released into the atmosphere through cows' burps, farts and dung.




Source: Adapted from Nasa's Goddard Institute for Space Science.

## DOCUMENT 2: REGIONAL EMISSIONS OF ALL GREENHOUSE GASES IN MILLION TONNES $CO_2$-EQ, BY SPECIES, IN 2010

"$CO_2$-eq" means "carbon dioxide equivalent". It is useful to compare the impact of different greenhouse gases, because they do not have the same "warming power": for instance, a given amount of methane heats the atmosphere 28 times more than the same amount of $CO_2$!




Source: Adapted from FAO (2017); Global Livestock Environmental Assessment Model (GLEAM).
http://www.fao.org/gleam/results/en/#c303617

## FOREST RANGERS

You are a group of forest rangers. You know the forest well and understand that trees capture $CO_2$ from the atmosphere, so the forest is good for fighting climate change. You are sent to Cambodia to study the link between forests, agriculture and climate change.

- **DOCUMENT 1:** When you look at the photographs, what do you see? What has happened to the forest over time?
- **DOCUMENT 2:** Why are vegetation, trees and forests important for the climate? Can you explain why it is important to conserve the forest?
- In this case, how does agriculture affect the climate? Is it a direct (affecting the temperature, or the rain) or indirect effect?
- Answer this question in one sentence and write it on the summary sheet: **Why are large farms / plantations problematic for forests? Why are they a problem for the climate?**

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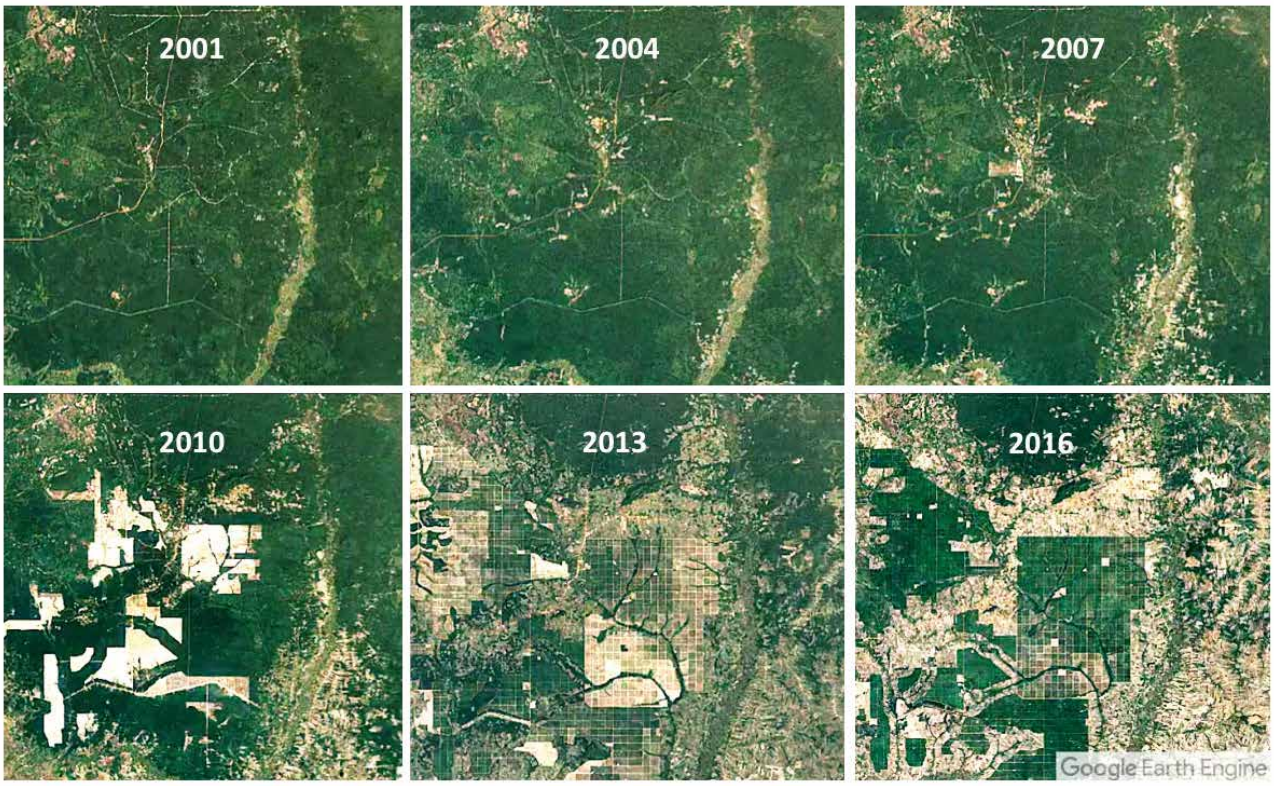
### DOCUMENT 1: DEFORESTATION IN BENG PER WILDLIFE SANCTUARY, CAMBODIA, FROM 2001 TO 2016

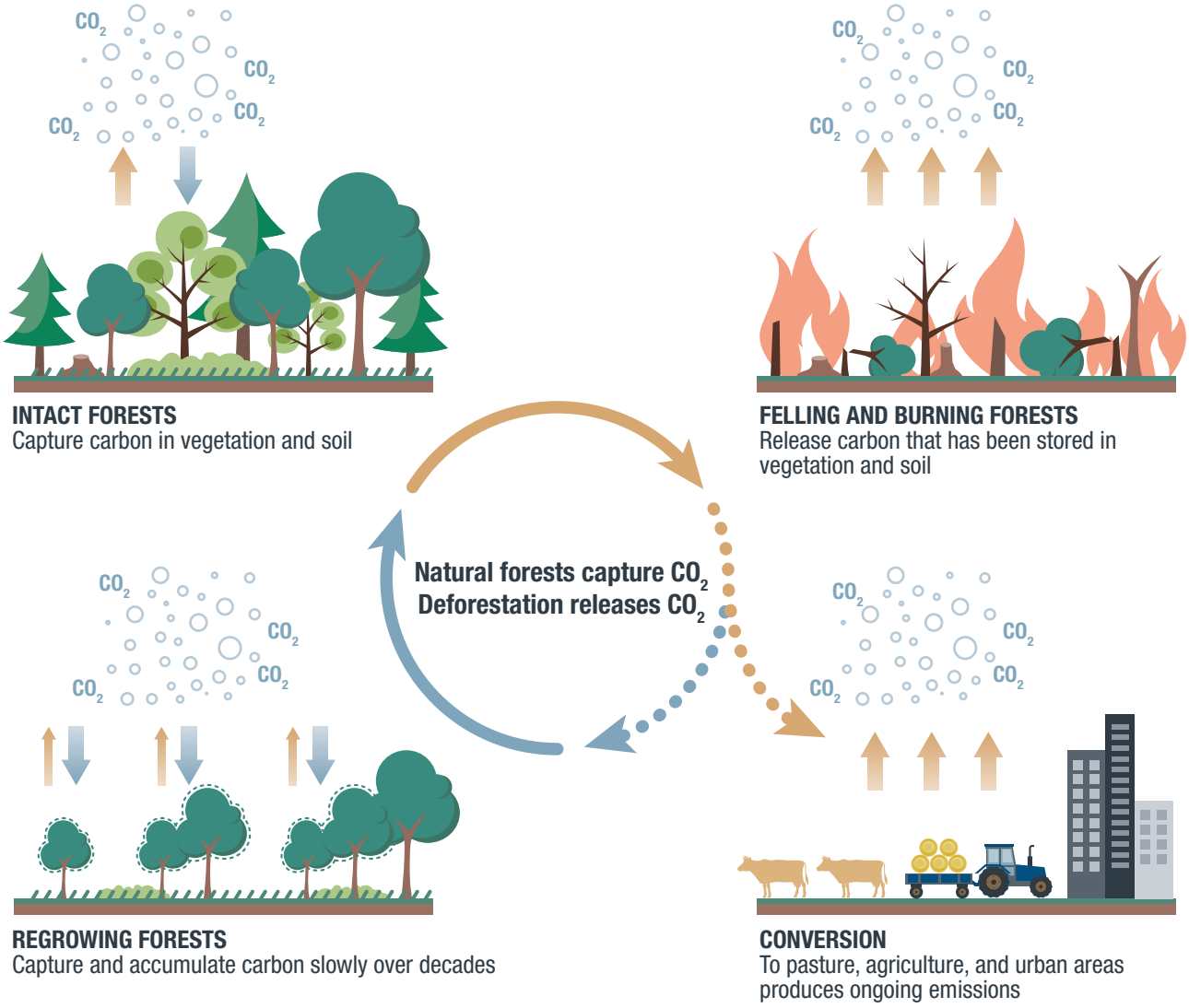
Trees have been cut down to make furniture, or to facilitate agricultural plantations producing products such as rubber, rice, bananas and cashew nuts, which are then exported all over the world. In these pictures, the forest has been replaced by rubber plantations.




Source: Google Earth Engine. https://earthengine.google.com/timelapse/

Note: if you have access to the internet, you can go on Google Earth and build up your own timeline looking at changes in land use in your own regions of interest.

## DOCUMENT 2: CARBON DIOXIDE CAPTURE AND RELEASE BY FORESTS




Source: Adapted from Center for Global Development
https://www.cgdev.org/page/infographics-why-forests-why-now

## JOURNALISTS

You are a group of journalists and you are interested in reporting on environmentally friendly agricultural methods. You go to visit a special farm in Japan, which has found an interesting way to ensure its methods have a very low impact on the climate.

- In your own words, can you describe this agricultural practice and where it comes from? Then make a diagram that summarises the text.
- From the short text and picture below, explain why this farming practice is good for the environment.
- Answer this question in one sentence and write it on the summary sheet: **How is this farming practice good for the environment and the climate?**

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### WHY RICE-DUCK FARMING IS GOOD FOR THE ENVIRONMENT [1]

Takao Furuno, a Japanese farmer, has developed a method for growing rice that mimics natural ecosystems. He puts ducks in his paddies (flooded parcels of land used to grow rice) to eat weeds and insects. The ducks' waste provides nutrients, which then nourish the crops, and allows the farmer to save money ordinarily used for pesticides and fertilisers. They earn extra money by selling duck meat and duck eggs. Furuno's system also uses fish in the paddies, which is another source of income. Industrial rice farmers have discontinued this latter practice because the pesticides they use in their system kill their fish. The Furuno system yields 20 percent more rice than conventional systems, which grow rice exclusively.

Note: Pesticides are chemicals used in fields (or rice paddies) to protect crops from being eaten by insects or to control diseases. Pesticides are dangerous for two reasons: they kill many insects that do not eat the crops; and they emit greenhouse gases when they are produced and when they are used in the fields. So pesticides make climate change worse.

1 Adapted from FoodSpan lesson plan, John Hopkins Center for a Livable Future. https://www.foodspan.org/lesson-plans/unit-2-farmers-factories-and-food-chains/