ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

JANUARY 2024

What are the benefits of growing multiple crop species together?

Researchers:
Chunjie Li, Tjeerd-Jan Stomph, David Makowski, Wopke van der Werf and others
Associate Editors:
Allison Gamzon and Alexandra Appleton

Abstract

UPPER READING LEVEL

Did you know there are different ways to grow food? One way is sole cropping, which occurs when a field only has one species of crop. Another method is intercropping, which is when many species are grown together in the same field. We wanted to compare sole cropping and intercropping. We found that intercropping produces less of each type of crop on a field than sole cropping. But intercropping produces more diverse food choices. It also can save land space and reduce the amount of nitrogen fertilizer needed to grow food. That is why intercropping is an important agricultural technique to consider for the future.

Introduction

The goal of the current agricultural system is to meet the demand of an increasing world population in a **sustainable** way. How do farmers get high **yields** sustainably? There are different options, including **sole cropping** and **intercropping**. Sole cropping occurs when only one plant species grows in a field at a given time. Intercropping occurs when two or more plant species are grown in the same field at a given time. A common combination of species used in intercropping include grains and **legumes**.

Intercropping increases crop **diversity**, which can make crop production more stable. That is because when there is only one crop type, the field is **susceptible** to pests, diseases, and weeds. If one plant becomes infected with a pest or disease, this can spread to plants of the same species. With intercropping, the mixture of plants prevents the pests and diseases from spreading. Intercropping can also affect the amount of fertilizer used by a farm. Reducing fertilizer use is important because it can lessen costs for the farmer. It also reduces the amount of nitrogen reaching water systems through **runoff**.

Even though scientists and farmers know the benefits of intercropping, it is not a widespread practice. We wanted to do a comparison between sole cropping and intercropping to provide more information to farmers and policy makers. We used the results of field experiments to compare these two techniques.

Corn (maize) is the most widely cultivated grain in the world. People can eat it directly, but also use it for animal feed, corn starch, corn syrup, and biofuels.
Photo: Frank Meriño on Pexels.

Methods

We analyzed a global set of data. It included the results of over two hundred experiments. These experiments investigated intercrops that included a grain and another crop type, either a legume or **oilseed** crop. We focused on experiments that used the same or similar practices to grow the intercrop and the sole crop.

We used the results of these experiments to determine the amount of each crop that could grow on a piece of land together. Then we determined how much of each crop could grow on that same piece of land alone. We also figured out how much nitrogen fertilizer these crops needed if grown together and separately. Finally, we calculated different productivity measures. These included land use efficiency and protein content.

Results

Intercropping produces less grain compared to sole cropping (Fig. 1A). For example, if a farmer plants only corn (**maize**) on one **hectare** of land, they get 10 tons. If a farmer plants one hectare of land half with corn and half with soybeans, only 8 tons of corn grows.

However, intercropping is more land efficient because it produces a greater total output of food compared to sole cropping. For example, to grow corn and soybeans with sole cropping, a farmer needs two hectares of land. One hectare produces 10 tons of corn and the other produces 4 tons of soybeans, which is a total food output of 14 tons. If the farmer plants both hectares with half corn and half soybeans, they will produce 16 tons of corn and 4 tons of soybeans, which is a total output of 20 tons.

We also found that intercropping requires less nitrogen fertilizer (Fig. 1B). It also produces either the same amount or a higher amount of protein than the most protein-rich crop.

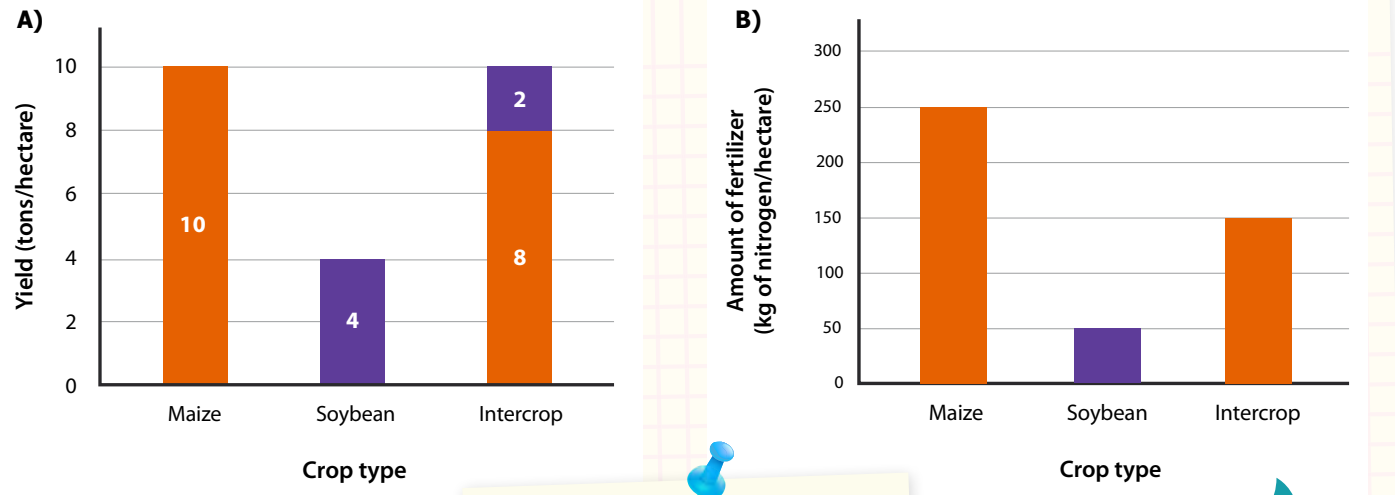

Figure 1:
A) The yields of corn (maize), soybeans, and an intercrop of corn and soybeans
B) The amount of fertilizer needed to grow corn, soybeans, and an intercrop of corn and soybeans

How does the amount of corn (maize) grown as a sole crop compare to the amount grown with intercropping?

How does the total amount of fertilizer needed to grow corn and soybeans separately compare to the amount of fertilizer needed to grow them as intercrops?

Discussion

The success of intercropping is dependent on the goal of the agricultural system. If the goal is to produce the largest crop yield of a single crop, then sole cropping is the better technique. If the goal of an agricultural system is a diversity of foods, then intercropping is the better technique. With intercropping, farmers cannot grow as much of each individual crop. But by growing two crops together, the land produces multiple food types.

Intercropping can also increase land **productivity**. If one hectare of land contains half corn and half soybeans, we expect half as much of each crop to grow compared to sole cropping. Based on the example above, that means 5 tons of corn and 2 tons of soybeans should grow. But 8 tons of corn and 2 tons of soybeans grew. Why? The corn and soybeans grow in alternating rows. Each species grows better because they compete less with individuals of a different species than from the same species. That is because they have different needs.

We also learned that intercropping often decreases nitrogen fertilizer use. That means intercropping is a more sustainable practice because it reduces the amount of resources needed to grow food. It also helps reduce the impact of farming on the environment. Nitrogen fertilizer is a common water pollutant that can negatively impact river systems and the ocean.

Our research showed that intercropping is a good alternative to sole cropping. We found that there are many benefits to intercropping, in addition to making areas more resistant to diseases, pests, and extreme weather. That is why this technique is an important consideration for the future.

Conclusion

Intercropping is an example of how important diversity is to an ecosystem. The more diverse an area, the more able it is to survive disease, pests, and extreme weather events. You can help keep your local ecosystem stable by planting a diverse set of plants in your yard or garden. This diversity can maintain the health of the soil and provide habitats to many organisms, such as insects and birds. Which plants are best to grow in your area? Do some research on native species or ask for guidance when purchasing plants to grow in your yard or garden.

REFERENCES

Chunjie Li, Tjeerd-Jan Stomph, David Makowski, Haigang Li, Chaochun Zhang, Fusuo Zhang, and Wopke van der Werf (2022) *The Productive Performance of Intercropping.* PNAS: Agricultural Science and Sustainability Science.
https://www.pnas.org/doi/10.1073/pnas.2201886120

United Nations Environment Programme (2021): A Beginner's Guide to Sustainable Farming.
https://www.unep.org/news-and-stories/story/beginners-guide-sustainable-farming

National Geographic: The Art and Science of Agriculture.
https://education.nationalgeographic.org/resource/agriculture/

Acknowledgment: This article's adaptation was supported by the Moderna Charitable Foundation.

Glossary of Key Terms

Diversity - the state of having variety or more than one type of something.

Hectare - a measurement of land area that is equal to 10,000 square meters or about 2.5 acres.

Intercropping - the agricultural practice of growing two or more crop species in a field at the same time.

Legumes - family of flowering plants that comprises species that produce protein-rich edible seeds. Legumes typically have a root relationship with bacteria that enables them to fix nitrogen from the atmosphere. Crop species include lentils, peas, broad beans, chickpeas, soybeans, common beans, lima beans, and peanuts.

Maize - the agricultural term used for corn.

Oilseed crop - a crop grown to produce oil. Examples include soybeans, cottonseed, sunflower seed, canola, rapeseed, and peanuts.

Runoff - when the water from heavy rainfall or excess irrigation doesn't sink into the soil, but instead washes into nearby streams, lakes, and other bodies of water.

Productivity - the ability of the land to grow crops.

Sole cropping - the agricultural practice of growing only one crop species in a field at the same time.

Susceptible - liable to be influenced or harmed by a particular thing.

Sustainable - avoiding an overuse of natural resources so that a practice can continue into the future.

Yield - a term in agriculture used to describe the amount of crop produced by a farm or piece of land.

Check your understanding

1. How does the amount of grain grown on a single field using sole cropping compare to the amount of grain grown using intercropping?

2. What are three benefits of intercropping?

3. How could this research impact the use of intercropping worldwide?

4. Intercropping requires farmers to select two or more crops that can grow together. With a partner, brainstorm at least two characteristics of crops that farmers need to consider when determining which plants to intercrop.

5. The increase in stability provided by intercropping is known as an ecosystem service. An ecosystem service is a benefit that humans obtain from an ecosystem. Make a list of other examples of ecosystem services you can think of.