

Precision agriculture: principles vs. practice



2.1.3



Dear student,

this chapter will introduce you to the principles of precision farming (also known as smart farming or Agriculture 4.0). It will show you how digital technologies (e.g. sensors, satellites, mobile apps) help improve efficiency, reduce costs, and at the same time be more considerate of soil, water, and animals.

You will learn:

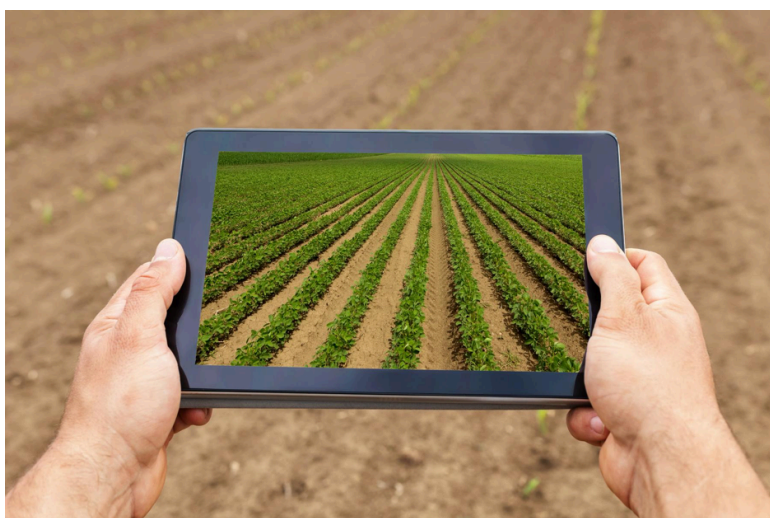
- **how data-driven decision-making works,**
- **what technologies can even a small farm use,**
- **how a precise approach contributes to sustainable management.**



Study text

Principles of precision agriculture

Precision farming, also known as SMART farming or Agriculture 4.0, relies on the consistent use of data to manage farming operations.



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The goal is to **optimize resources** — reducing labour, reducing the use of water, fertilizers, or pesticides, while maintaining or increasing yields. The fundamental principle is the use of technologies such as sensors, GPS, or satellite imagery that provide precise information about the condition of the soil, vegetation, or weather. Based on the data, the farmer can respond where it is really needed — not across the board. This reduces the amount of inputs used, limits erosion and chemical load on the landscape, and improves environmental sustainability (FAO, 2022; UNDESA, 2021).

The technical backbone of this approach is **yield maps** — a visual representation of the variability of fertility in a field — and **variable input applications** that enable targeted fertilization or irrigation. Sensor readings, GPS records, and data from drones or satellites are integrated into systems that advise farmers when, where, and for how long to intervene (ESA, 2023; CleverFarm, 2023). The result is **intelligent decision-making** based on real data, not guesswork.

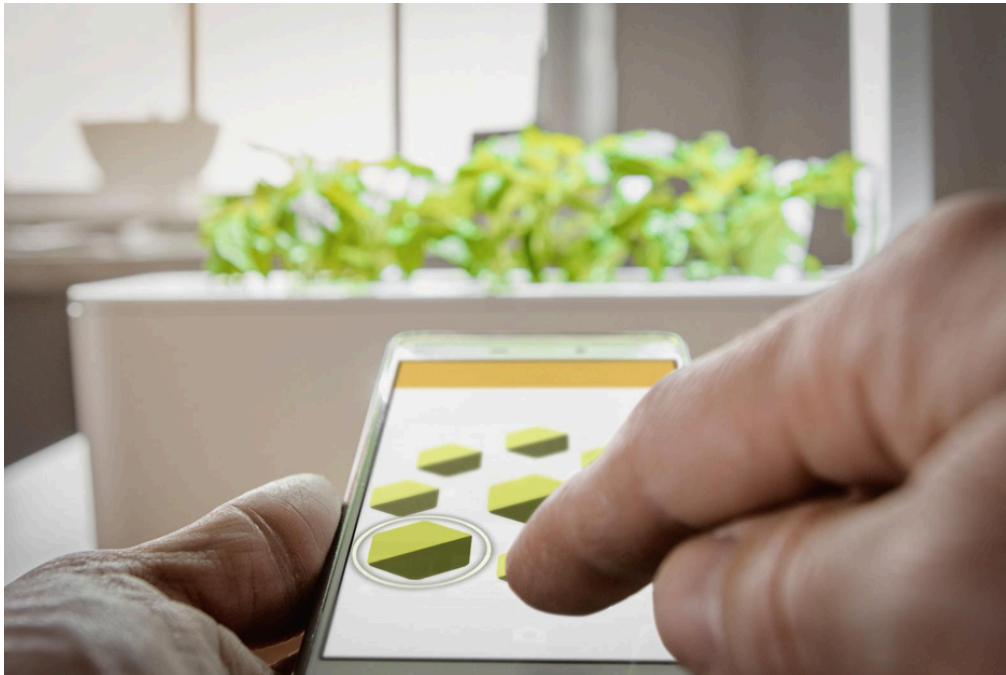
Real-world use on small farms

Although SMART farming sounds like a matter for large agroholdings, many examples show that **even small farmers can benefit from digital technologies**.

1. SMS Referrals in India

In India, farmers with limited internet access are receiving **SMS alerts** about planting dates. The FAO/ICRISAT program analysed long-term climate data and send simple messages based on predictions. Studies have shown that farmers who agreed to and shifted their plantings according to recommendations saw up to a **30% increase in yield** (UNDP, 2021; arxiv.org, 2021).





2. Weather stations on Czech organic farms

In the Czech Republic, small organic farms use **weather stations and soil sensors** (Farmonaut, 2024). These devices record humidity and temperature and allow farmers to plan or postpone irrigation wisely. The result is **water savings of up to 40%** and improved production quality without the need to invest in expensive technology.

3. Wearable sensors in the herd

In farms, the use of so-called **boluses** or collars with **sensors** that monitor the health status of animals (e.g. body temperature, movement or food intake) is expanding. These devices allow for the **early detection of disease or heat during herd operation**, thus preventing mortality or lower milk production.

4. Direct verification of principles vs. practice

"Precision farming leads to reduced input costs and higher productivity." – Real impact: **Indian small farmers have seen up to 30% higher yields, Czech organic farms save 40% water, and livestock monitoring has increased herd health.**

COMPARISON OF THE EFFECTS OF TECHNOLOGICAL INNOVATION

Area	Professional principle	Real impact on a small farm
Irrigation	Targeted irrigation based on soil moisture	– 40% water, more accurate planning
Fertilization and protection	Variable dosing based on yield maps	More efficient use of fertilizer, less waste
Animal health	Sensor-based monitoring	Early intervention, higher welfare
Analytical decision-making	Prediction using AI and statistics	Prediction using AI and statistics

These comparisons show that **the technological foundation works in practice** and that even simple data can bring significant benefits to farmers in a fair, sustainable and accessible way.

Benefits and opportunities for small farms

Small farms do not need to build complex systems. The following may be sufficient:

- **simple sensors,**
- **mobile application,**
- **services based on SMS or expensive telephone networks,**
- **sharing technology in communities or cooperatives.**



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These tools bring:

- **increased economic return,**
- **reduction of environmental burden,**
- **favourable return on investment,**
- **reasonable use of the farmer's labour and time.**



Summary

Precision farming is much more than a trendy term: it is a proven way for even a small farmer to farm smartly, efficiently and sustainably. Technological principles (sensors, GPS, AI, satellites) deliver concrete results that are measurable and practical. The transition to SMART farming is therefore accessible to everyone – regardless of the size of the farm – and offers a way to preserve soil, water and resources for future generations.

