

The basic principles of

# Vertical Farming

in 1,000 words



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# Vertical farming, a growing Interest

It has obvious benefits such as reduced use of water or crop protection products, and it is easier to steer production. It is these benefits and potential earning models that are attracting most attention globally for the practice of vertical farming. However, to make it a success, the range of supporting technology necessary for cultivation and processing, for example, is crucial. This white paper from Bosman Van Zaal details the key basic principles of vertical farming.

## INTRODUCTION

Vertical, or indoor, farming is a method of year-round crop production on two or multiple tiers or layers. This process requires less physical space for cultivation: the more layers, the greater the space savings.

But vertical farming offers other potential benefits, for example in terms of energy and water consumption. The scope of these benefits mainly depends on the crop, the chosen cultivation method, the scale and the degree to which growing takes place in a closed, controlled environment.



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# Vertical farming: Forms

There are many forms of vertical farming ranging from industrial-scale halls filled with immense racks or shelving systems to small climate chambers. The main difference is the focus. Generally speaking, the focus is either production or control, and there is a hybrid model.

## **FOCUS ON PRODUCTION**

When the focus is on production, the aim of the vertical farming unit is to produce a relatively high yield on a limited growing area, according to a strict delivery protocol. This is often done in halls or greenhouses covering up to 10,000 square metres. Important aspects here are efficiency and the ability to plan. For this reason, other automated systems used for sowing or seeding, transplanting seedlings, harvesting and packaging are located close to these units. Commonly grown produce in this form of vertical farming includes salad greens and herbs.

## **FOCUS ON CONTROL**

When the focus is on control, vertical farming generally involves small, closed cultivation chambers which are equipped with LED lighting and highly advanced climate control systems. The main aspect here is optimal steering and control of the climate conditions.

This form of vertical farming is frequently used by pharmaceutical companies (e.g. to produce active substances), research

institutes and R&D departments (e.g. to trial cultivation plans and strategies).

## **HYBRID MODEL**

In the hybrid model, the vertical farming component is only used for one part of cultivation, for example propagation or the final growing phase. An example of this is the cultivation of ornamental crops. Some of the benefits of the forms outlined above also apply in the hybrid model: products can be grown temporarily on a limited space under strictly controlled conditions before being transferred to a greenhouse, or even outdoors where growing can continue for substantially lower (energy) costs.



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# Vertical farming: Benefits

In a vertical farming unit, crops are cultivated in a (relatively) closed environment. This has immense advantages for production.

## YEAR-ROUND

Vertical farming units allow virtually identical and uniform climate conditions to be maintained all year round. This in turn enables year-round production.

## CONTROLLED PRODUCTION

In a vertical farming unit, extremely accurate control of the climate conditions is possible. This includes air handling and conditioning, cooling, humidification and dehumidification and CO<sub>2</sub> dosing. Regulating these parameters allows crop growth to be controlled down to the smallest detail. As a result, achieving higher and fully predictable yields is feasible, while fewer crops are lost, and fertiliser use is reduced.

## HYGIENE

As vertical farming takes place in a closed, or virtually closed, environment, a high level of hygiene is possible. Pests and diseases are practically eliminated. Vertical farming therefore guarantees higher levels of food safety. In fact, products grown in a closed unit such as a climate chamber do not even need post-harvest cleaning. One example is baby leaf lettuce.

## SCOPE OF APPLICATION

A vertical farming unit is more than simply a number of panels or gutters stacked in tiers or arranged in rows. The technology involved in vertical farming opens up a host of new applications.

## TRANSPARANCY

A vertical farming unit facilitates fully controllable production. This also serves to increase the transparency of the production process, both internally and toward customers. Vertical farming also allows targeted use of management data.

## SUSTAINABILITY

The importance of sustainability is still increasingly important in the production of vegetables and ornamental or other crops. Vertical farming enables huge advances in sustainability.

### *Water*

Water consumption is the aspect of sustainability where the greatest gains can be made in vertical farming systems. All the water used in vertical farming is collected and, if possible, recirculated in a closed irrigation system. As a result, the



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demand for water is significantly reduced, as is the volume of discharged water. In illustration, crops grown in a climate chamber use just 1% of the quantity of water used by the same crop grown outdoors in a field. Fertiliser and nutrient applications can also be controlled far better. Anything not absorbed by the plants is collected, replenished and reused during the next irrigation session.

#### *Energy*

As vertical farming involves growing on multiple layers, energy is used efficiently. Precisely how efficiently depends on how the unit is actually configured. Energy consumption is mainly determined by dehumidification, cooling and lighting. Unlike horticulture under glass, the source of energy in vertical farming is mainly electricity rather than gas or other primary energy carriers. Logically, the way this electricity is generated influences its sustainability credentials.

Dehumidification mainly determines how much energy is consumed. Reducing energy consumption becomes more feasible if dehumidification takes place efficiently. Significant savings can be achieved by zooming in on the topics below. This can sometimes make all the difference between the impossible and the possible.

Savings can be realised by;

- Optimising the recirculation of the airflow over the crop;
- Reducing the fan speed at night and halving the volume of air delivers an energy saving of 87.5%!
- If multi-level cooling is possible, it can be more efficient to cool compartments separately;
- Choice and application of correct refrigerant / refrigerant carrier;
- Using indirect free cooling - also called an economiser - where the climate conditions permit, can reduce energy use by around 80% in some cases!
- Application of heat recovery solutions in front of and behind the dehumidification coil can save up to 25% on the cooling capacity and up to 40% on total energy consumption!

#### *Crop protection*

A vertical farming unit is a closed production environment. As a result, pests and diseases are eliminated, or the infection risk is minimised, compared with traditional production methods. This allows a drastic reduction in the use of crop protection products, with the goal of zero use! If a treatment is necessary, the products used remain in the loop as the water is collected, purified and possibly recirculated.



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# Vertical farming: Considerations

Vertical farming is a sustainable, efficient, and reliable method of growing a wide diversity of crops: from herbs and salad greens to cannabis and medicinal crops.

## **OBJECTIVES CENTRAL**

There are different forms of vertical farming for all these crops and scopes. An advice to entrepreneurs is to focus on the business objectives and design the optimal vertical farming unit around that central principle.

## **TYPE OF ACTIVITY**

The authorities responsible for issuing zoning permits often consider vertical farming to be an industrial activity rather than an agricultural activity. This means that different planning permissions and regulations apply.

## **EXPERIENCED DEVELOPER**

In all cases, it is sensible to work with an experienced technical developer, who knows, for example, how to translate sustainable benefits into a feasible design, and is aware of the statutory requirements placed on buildings and the use of vertical farming units.



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