The Road to Higher Yields

Precision in All Work Operations
Aeration and Functional Water Regime
Plant Nutrition – PROFIle Fertilisation
Sustainable Development

JOY
OF FARMING

CONTENTS

MODERN FARMING PYRAMID

DESIRE TO MOVE FORWARD...

Farms all over the world show such big differences in their results in spite of farming in the same localities with the same soil quality and the same precipitation.

“Copying” the method of set rules definitely has an effect. The competitiveness between the farmers is also a huge motivation factor. PROFIt is the main factor but the competitiveness between farms is increased by the desire to be better than others and to move forward, just like in sports. If the fastest time for 100m sprint is 9 seconds, it is a goal that is hard to achieve, but it is possible to get close to it.

Achieved yields is the goal in agriculture. Agriculture works with external non-controllable factors but there are many procedures and systems for working with soil that can constantly increase the yields, such as:

- Precision in all operations that enter the plant production.
- Aeration and functional water regime is the road to increase the yields.
- Effective and targeted nutrition of plants so that the yields and the investment show the best ratio.
- Sustainable development so that all we do does not degrade the basic production factor – soil. Soil stays healthy for the following generations.

The farmer has almost no influence on the purchase prices of commodities but he or she can become more competitive by influencing the yields.

PRECISION

source: wikipedia.org

The term ‘precision’ means a sense for detail, which almost transforms into perfectionism. It is not possible to perform operations in plant production only halfway or partially. The result is a higher profit that is generated by increasing yields, sometimes at the cost of partially increased expenses. The growth of the yields is higher than the growth of the input costs.

source: wikipedia.org

Precision starts after the harvest by proper crop residue management. The crop residue management is often underestimated. When the post-harvest residues of the previous crop is not incorporated in the soil properly, a whole array of problems results, such as diseases (see the photo at the top) or gradation of pests (see the photo on the left).

Clumps of straw complicate stubble cultivation.

Clumps of straw are an ideal environment for proliferation of slugs and similar pests.

Soil blockage caused by large clumps of residue. An impermeable layer of plant residue is created in the soil.

Unsuitable seedbed for the following crop etc.

POST-HARVEST RESIDUE MANAGEMENT

YIELD < 8 T/HA

– yield is lower than 8 t/ha, it is possible to use the SWIFTERDISC short disc cultivators with 520mm discs. Such a fast stubble cultivation reduces the risk of losing moisture in soil, the rear packer of the machine presses seeds of the second growth to soil which starts regulated second growth that can be destroyed mechanically by another stubble cultivation, or chemically by using glyphosates.

It is necessary to check the regularity of the distribution of post-harvest residue after the crasher of the harvest combiner. If the distribution is uneven, it is necessary to use Striegel-Pro straw harrows before stubble cultivation.

YIELD > 8 T/HA MEANS AT LEAST 6.4T OF POST-HARVEST RESIDUE PER HECTARE

– yield is higher than 8 t/ha. In this case, it is recommended to do the following:

1. Crushing and regular distribution of residue on the plot.
2. Incorporation and even mixing of plant residue with soil.

Modern effective agricultural crop technology provides high yields of harvesting products, which is also related to the increased production of side products, such as straw or higher corn stubble field for silage. This type of leftover product has a high content of carbon and a low content of nitrogen and sulphur. The carbon and nitrogen ratio is often more than 1:80 and sulphur more than 1:200, which usually leads undesirable immobilisation of these nutrients in soil after the incorporation into the soil profile using a regular stubble cultivator, i.e. without the addition of N (or S) from fertilisers. It also slows down the process of decomposition of the straw stalks in soil due to the reduced soil microbial activity. The impact on the agricultural production is visible after sowing plants that follow the previous crop producing a lot of post-harvest residue (straw). The next crop shows a nitrogen deficit due to the consumption of mineral forms of nitrogen from soil by soil microorganisms that use it for their own nutrition, while performing energetically demanding breakdown of carbon substrates. The slow decomposition of straw leads to accumulation of post-harvest residue in the soil profile and this condition disturbs the moisture regime in soil, blocks capillary pores distributing moisture from the bottom layers to the germinating seeds in soil and this undesirable condition slows down the growth of roots of the plants in the vertical direction.

POST-HARVEST CEREAL RESIDUE MANAGEMENT

The post-harvest cereal residue management differs based on the potential utilisation of the straw. The post-harvest residue management is much easier when the straw is pressed. It is important to quickly press the straw and remove it from the land so that stubble cultivation can be done as fast as possible using the SWIFTERDISC stubble cultivator with 520mm discs. Fast and shallow stubble cultivation:

– reduces the risk of drying out and maintains moisture for the following crops,
– starts controlled second growth.

The second growth can be then eliminated mechanically by repeated stubble cultivation, or chemically by applying glyphosates.

If the post-harvest cereal residue stays on the plot, it is required to apply one of the following operations according to the yields.

1. Crushing and regular distribution of plant residue on the plot provides two options

First option: use of MULCHER with a vertical rotation axis that will crush the residue and distributes it regularly on the plot.

Second option: use of STRIEGEL-PRO straw harrows that evenly spread straw on the plot and also create conditions for the second growth.

2. Incorporation and even mixing of plant residues with soil

It is necessary to use ATLAS disc cultivators with 620mm or 660mm discs for 6.4t and more. The size of the discs and the weight of the machine guarantee quality mixing and incorporation of plant residue in a single pass.
When the yield is above 10t, it is recommended to treat the stubble field with STRIEGEL-PRO one more time.

POST-HARVEST
WINTER RAPE RESIDUE MANAGEMENT

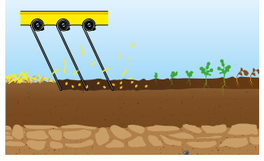
A mulcher has to be applied to a rape stubble field after non-desiccated growth to crush any resistant post-harvest residue and evenly spread it on the plot.

Why and what mulcher to use on the rape field?

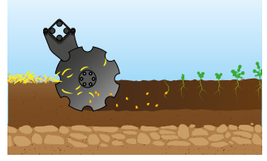
- A mulcher that will crush and shorten rape stalks and spread them evenly.
- A mulcher that has a high capacity given by the working width.
- A mulcher that does not require a high pulling force and has a low fuel consumption of the tractor.

Rape creates a large quantity of above-ground biomass that can be very resistant (non-desiccated growth) and thus difficult to incorporate into the soil profile. Farmers have quite a short between-crops period after harvesting winter rape, not enough time for destroying the second growth and for decomposition of plant residues so that it is possible to establish new crop on the plots after rape, usually cereals, as rape is an excellent pre-crop for cereals and a desired interrupter of cereal succession. To be able to process the plot, it is important to evenly spread and disrupt/cut post-harvest rape residue.
The accumulation and subsequent decomposition of plant residues creates phytotoxic substances, the increased concentration of which has a negative effect on germinating plants. A fast and cheap management of rape residue depends on the use, or non-use of desiccants.

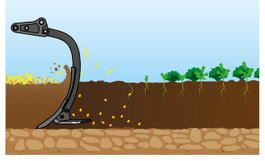
- It is ideal to use STRIEGEL-PRO straw harrows for a rape stubble field after desiccated growth. STRIEGEL-PRO straw harrows: the front coulters cut the dry post-harvest rape residue, the straws spread the residue evenly on the plot. The land is prepared well for stubble cultivation. Moreover, it immediately starts the second growth – the coulters crumble the soil, the straws mix the small rape seeds with soil on the surface, the seeds start to germinate. Their elimination is effective, cheap and fast, on the entire lot.



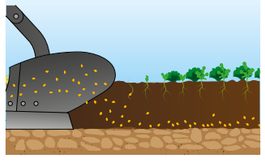
STRIEGEL-PRO straw harrows mix the rape second growth with soil in a shallow layer (2–4cm). The seeds quickly germinate and it can be destroyed chemically fast.



By mixing the second growth into the top parts of the soil profile, e.g. using a disc cultivator, it is possible to control the second growth very well. The germination of the second growth is slower when compared with the straw harrows.



When using share cultivators or chisel ploughs directly without a prior check of the second growth, the second growth is mixed deep in the soil profile and can be found in the newly established crop.



The use of plough places the second growth on the bottom of the furrow. The risk of secondary germination in newly establish crops, even in the following years, is high.

Zero crop residue management after harvesting rape has a very negative effect on the germination of the crop that follows the harvested rape.

Mulched post-harvest winter rape residue after a single pass by BEDNAR MULCHER.

The resistant stalks of the rape have to be crushed before soil preparation.

POST-HARVEST
CORN RESIDUE MANAGEMENT

Corn is a crop that creates a large quantity of mass above the ground and very strong and extensive root barriers with proper soil processing and nutrition. Establishing a new crop after corn means dealing with a large amount of organic material and incorporating this material into soil so that the decomposition processes can be started and the transfer of pests and diseases can be eliminated.

Mulching as an important part of crop residue management**:**

1. Mulching post-harvest residue is an important field operation. Mulching reduces the post-harvest, resistant parts of corn to smaller parts. The smaller parts are easier incorporated in the soil. Soil transforms them better and faster into an important organic part of the soil structure by biological processes.

2. Mulching reduces the transfer of pests and diseases, such as the European corn borer.

BEDNAR MULCHER is a heat-galvanised machine that can crush a large quantity of post-harvest residue to 3–5cm pieces thanks to the well-tested structural elements (a system of mulching knives for corn, front counter-blades, anti-line screen, protective armour plating, stepping axles etc.

source: entomart.be

The worms of the European corn borer eat out extensive passages in the plant and they even get to the cob and grain where they cause the worst damage. At the end of their development, they migrate to the bottom part of the corn where they survive winter – and this is when the stalks need to be mulched. If you do not mulch the stalk residue and only incorporate it into soil, the borer hibernates successfully and you will have the same problem in the following year, either in the form of reduced yield or increased costs of chemical elimination.

Therefore mulching is important – it mechanically destroys some of the larvae and also significantly reduces the ability of the borer to survive winter in the crushed stalks, which decreases its occurrence in the following years.

source: entomart.be

The European corn borer is a pest that causes significant economic damage. The damage affects both quantity and quality of the harvested products.

source: entomart.be

A growth affected by the European corn borer. Due to the fattening of the warms, the plants break down or are uprooted. Also, fungi pathogens, namely Fusarium species, are also spread. The fungi produces toxic metabolites – mycotoxins that have an adverse affect on the health of livestock.

PRECISE SEEDBED PREPARATION

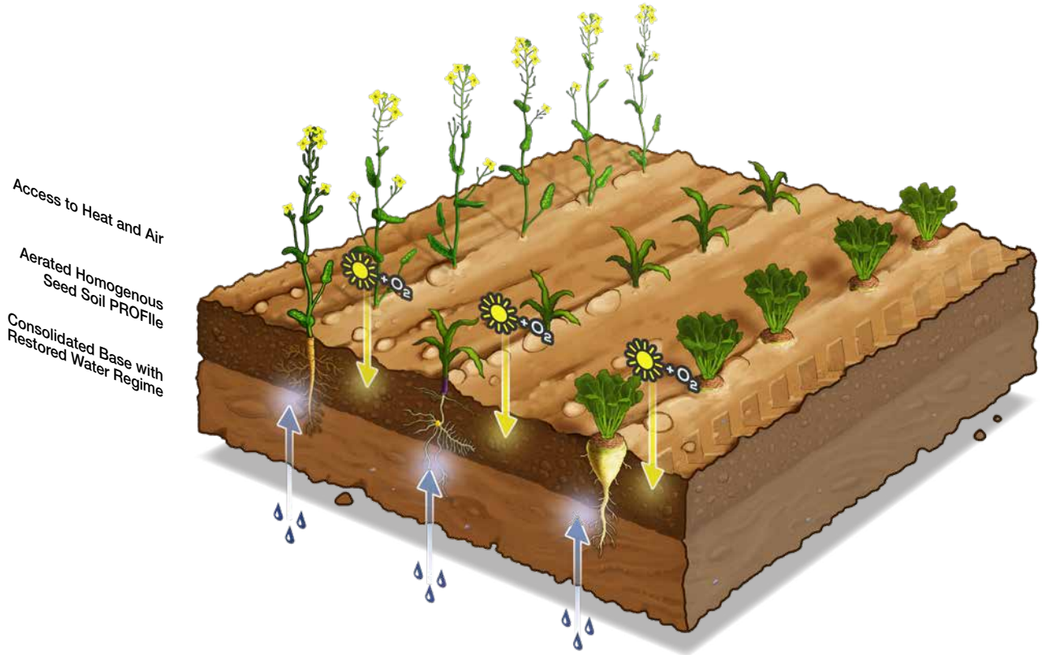
Precise farming is distinguished by increased intensity that includes quality seedbed preparation.

SWIFTER seedbed cultivators are designed in a way that makes it possible to prepare the seedbed for crop establishment in a single pass. A single pass is important not only for lower operating costs, but also to slow down drying of the plot. Such established crop germinates evenly and plants have a very fast development because soil is deeply cultivated by the chisel plough and has enough nutrients supplied in the form of profile fertilisation.

Risk related to the seedbed preparation**:**

- Seedbed preparation of immature soil –> risk of clod formation
- Loss of loosened soil due to a large number of work operations
- Low sowing depth + clotted soil increase the risk of uneven germination of plants
- Sowing into immature soil – pressing out V groove –> seeds not covered, uneven germination
- The seedbed preparation can also be performed when using minimising technology due to warming up and loosening of the soil.

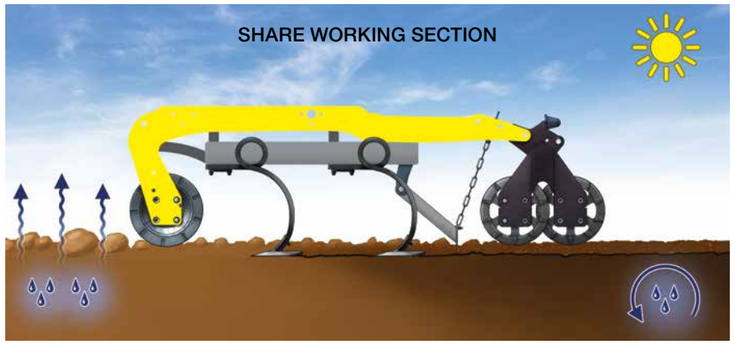
UNIFORM GERMINATION IN IDEAL CONDITIONS



An uneven seedbed, a large number of passes during seedbed preparation, a coarse structure of the seedbed and insufficient mixing of industrial fertilisers with the soil have a negative impact on germination of seeds.

An even seedbed and a flat surface for precise seed drill, all prepared in a single pass, means a good foundation for a fast and uniform germination on the entire established lot.

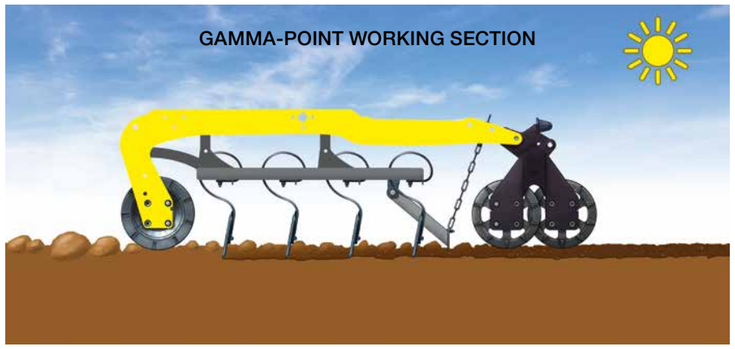
SWIFTER, REPLACEABLE WORKING SECTIONS FOR VARIOUS CROPS



270mm sweeps in two rows with overlapping guarantee undercut of the soil profile along the entire width of the machine which creates a firm bottom. At the same time, soil is aggressively processed thanks to the working angle of the sweeps, which creates a loosened top layer.

Each sweep is attached to a flexible tine which allows for the “3D effect” (horizontal and vertical movement) that protects the sweep from damage.

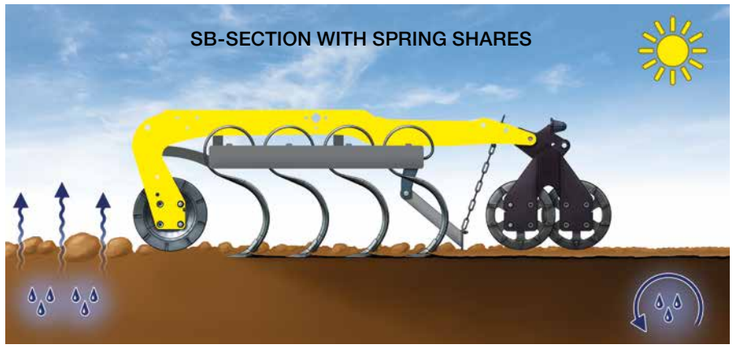
Use it for – summer and autumn preparation when the soil needs loosening and mixing after the previous harvest.



Four rows of gamma-points at negative angle safely loosen, aerate and warm up soil without bringing wet particles to the surface, which keeps the winter moisture in soil, important for a fast start of the growth of spring crop.

Spring loading of each tine allows working at high speeds of up to 15 km/h. That means time saving and time is what you need in spring.

Use for – spring seedbed preparation, with maintaining winter moisture in soil.



The spring shares located in four rows on S-tines provide quality soil processing in spring. The share angle does not cause vertical mixing of soil, which preserves its spring moisture, important for the quality and speed of plant germination. Moreover, the requirement for the pulling vehicle is reduced.

S-tines can be used with overlapping shares 150 × 4mm or shares Duck foot 70 × 6mm.

Use it for – spring seedbed preparation with maintaining moisture. Suitable mainly for sugar beet.

CROP ESTABLISHMENT IN WET AND DRY CONDITIONS

If you farm on medium-heavy and heavy soils and your seeding process includes spring crops, then you will definitely appreciate the additional equipment of the seed drill including a coulter section. Thanks to this accessory, based on the experience of leading farmers, you will achieve optimal soil structure even in heavier types of soil without creating sticky clumps and tongues, created by the disc section. Use only the coulters and lift the disc section to achieve aerated top soil structure without the formation and bringing out of wet particles.

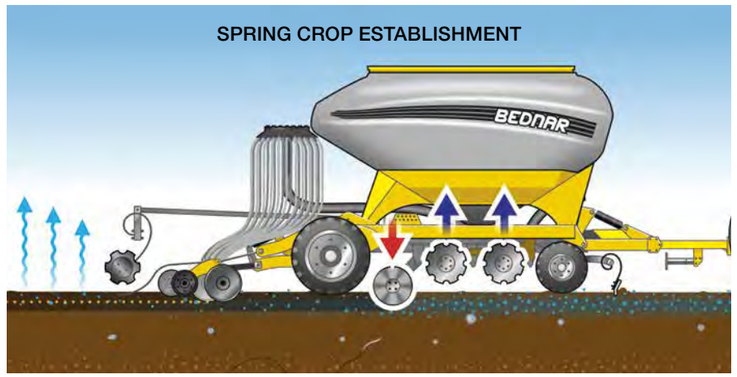
COULTERS AFTER THE DISC SECTION

Independently mounted coulters with a self-cleaning effect

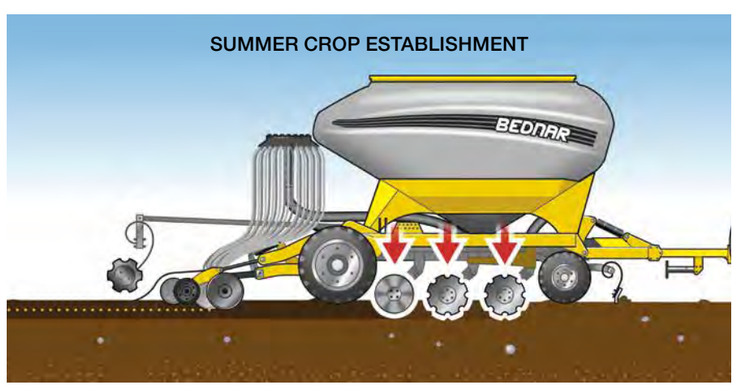
The coulters are controlled hydraulically. The operator can respond faster to local conditions.

Important equipment of seed drills for heavier types of soil.

THE COULTER WORKING SECTION SOLVES THE PROBLEM OF LARGE SOIL PARTICLES



The OMEGA OO seed drill can work completely without the discs in spring. The discs create undesirable soil parts in the heavier type of soil in spring. The work of the discs, i.e. warming up and aerating the top soil profile, can be done by coulters. The result is a well-established crop with excellent even germination within the plot.



In the summer, the intense work of front working discs is very important. Discs aerate soil, cut post-harvest residue and mix it with soil. Coulters increase the intensity of discs! They process the clods after discs, cut and push down remaining crop residue back into the ground. The result is well-established crop with excellent even germination within the plot.

Sticky clods created in spring by the front discs in heavier types of soil cannot be processed by the pneumatic packer. The drill coulters cannot place seeds well. That has a very negative effect on germination of spring crop!

It results in uneven germination. Clods (clumps, soil tongues) created by the front rows of discs in heavier types of soil make it impossible to place the seeds in the seed profile well and aggravate germination.

ROLLING

Rolling is an important operation that is usually omitted. Rolling is not as important in wet years, but recently we have had less precipitation than usual and in this case rolling solves how to maintain moisture in soil and start germination of the crop.

SPRING ROLLING

When the spring is extremely dry, it is suitable to close the field prior to seeding by the PRESSPACK rollers that prevent vaporisation of water from the top soil layer. The starting moisture remains preserved for the seeds. PRESSPACK can be used after seeding for better germination of the seeds.

AUTUMN ROLLING

In the dry autumn season from September to October, when the winter rape and winter wheat crop has been established, there may be significantly slower and worse germination of crops. Rolling the growth by the PRESSPACK rollers solves this issue. The rollers press the seeds/plants to the ground, support germination and lower the vaporisation from the top layers of soil. The seed/plant is protected and does not lose its vitality as when the rolling operation is omitted.

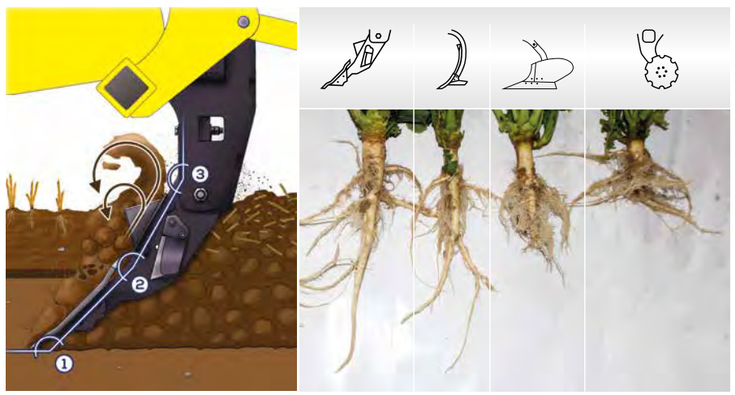
Also, it is important to close the soil after “terralanding” in summer. TERRALANDing enriches the soil with air and starts the water regime, usually deformed by the heavy harvesting technology. TERRALANDing can cause fast drying out of the top soil layer, therefore it is recommended to close soil using PRESSPACK packers after using TERRALAND.

AIR IN SOIL AND FUNCTIONAL WATER REGIME

AIR IN SOIL DETERMINES YIELD

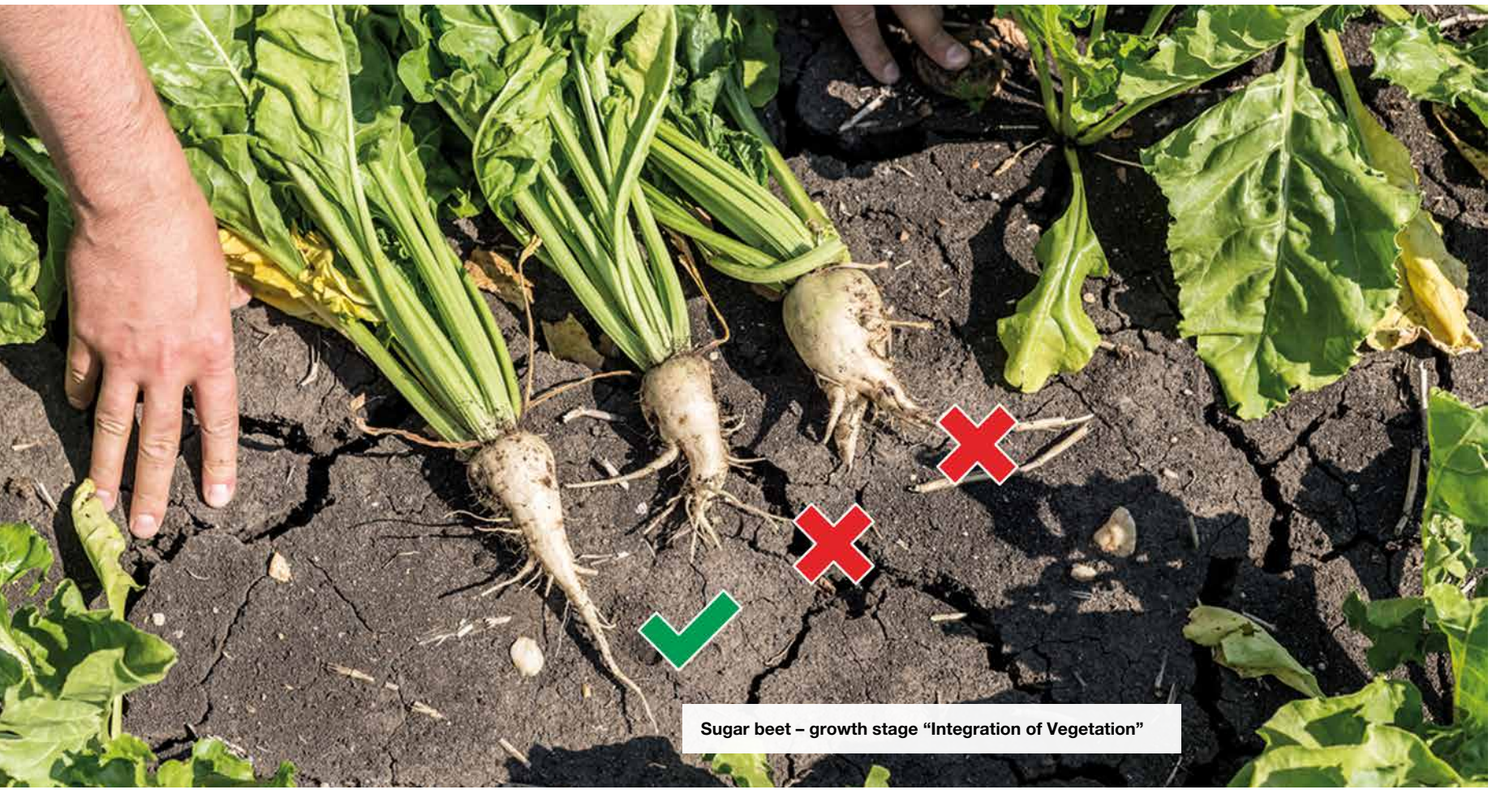
Deep soil loosening using TERRALAND chisel ploughs is a field operation that verifiably increases the yield of the individual plants. The yield increase is mainly achieved by aeration and disruption of compacted soil horizons and by starting the water regime. Deep cultivation also activates old soil power.

A sufficient amount of oxidised air in soil and trouble-free access of roots to underground water are the prerequisites for high yields. The air in soil creates the gaseous stage of soil important for biological and chemical reactions taking place in soil and it is one of the unnecessary conditions for the life of plants. The air in soil fills the pores without water. The soil air includes more CO^2 (by 0.2 to 0.7%), the content of oxygen in soil is 20% lower than in the atmosphere. TERRALAND chisel ploughs enrich (oxidise) soil during a single pass, even in deeper layers. The plant responds more effectively and faster in the aerated soil.



Deep cultivation improves soil environment for the root system of plants that becomes richer and stronger, subsequently affecting the yield.

Oilseed rape
– growth stage “Extending Growth”



Sugar beet – growth stage “Integration of Vegetation”

METHODS OF SOIL CULTIVATION THAT SIGNIFICANTLY CONTRIBUTE TO AERATION AND THUS INCREASE THE YIELD

1. **Deep soil cultivation** – soil with deep cultivation allows for the development of the root systems and thus creates favourable conditions for intake of water and nutrients. Thanks to deep cultivation, compacted layers are disturbed, water regime starts to work and soil is enriched with air.

Most farms that have tried the positive effect of deep cultivation with supply fertilisation for winter rape, corn and sugar beet, gradually switched to this technology also for cereal. The positive experience motivated companies to transfer to this technology completely.

Comparison of the crops of winter wheat in ZS Sloveč in spring 2014. Technology of cultivating by a share cultivator without supply fertilisation versus technology of aeration with a chisel plough and supply fertilisation (Amofos 150 kg/ha, placement of Amofos at two depth levels: 15cm and 35cm).

AIR IN SOIL IS IMPORTANT FOR SPRING BARLEY AS WELL

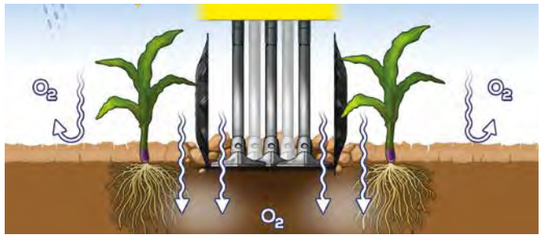
Benefits of Deep Cultivation Technology

- Better sprouting.
- Better plant vitality.
- Better use of industrial fertilisers. Elimination of deterioration of phosphorus (P) into a form of phosphorus that is hard to access.
- Verifiable increase of the yield potential from 10% to 15% in relation to the soil and climate conditions.

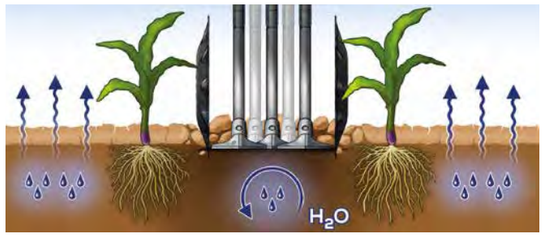
Disadvantages of Deep Cultivation Technology

- Increased demands of chisel ploughs on the required pulling force when compared with traditional share cultivators.
- Increased fuel consumption in the first year of deep cultivation. If the farm is switching to the deep cultivation technology, the fuel consumption in the first year is between 20 L/ha and 25 L/ha. After 3 years, the consumption is 10 L/ha –15 L/ha.

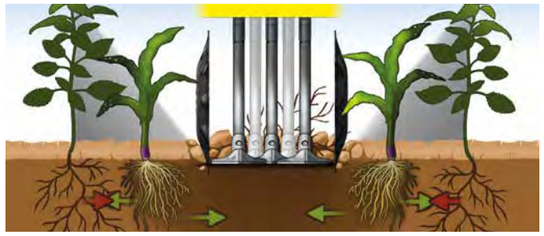
2. **Inter-row cultivation of row species** – precisely sown crops respond positively to fertilisation between rows (weeding) during vegetation, namely due to the elimination of the soil crust that blocks access to air and water regime. Moreover, it is suitable to use inter-row cultivation for application of solid fertilisers or foliar feeding.



Access of roots to air – elimination of the soil crust



Interruption of capillarity in rows means reduced vaporisation in the dry season



Weeding

WATER REGIME, KEY TO HIGHER YIELDS IN DRY AND WET YEARS

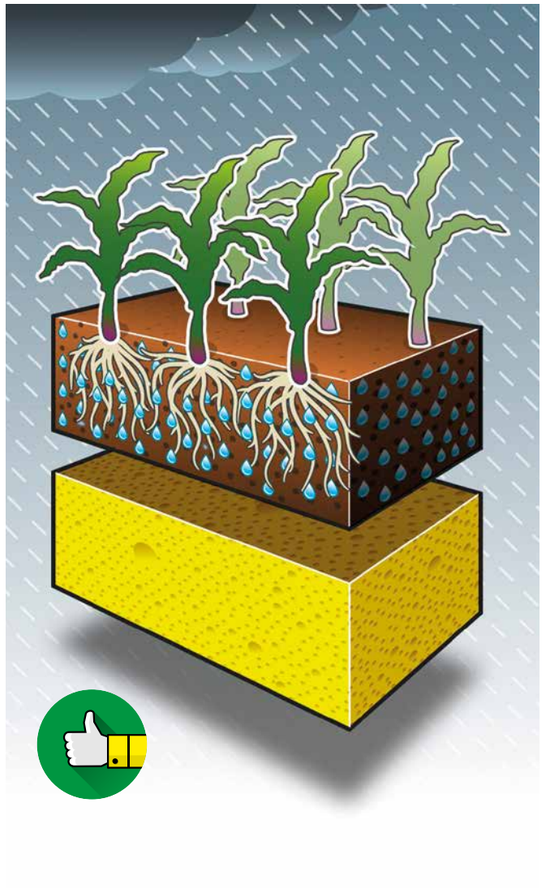
Deep cultivation to the depth of 35–40cm in autumn forms the foundation for establishing a strong root system through which the plant draws water and nutrients. Deep cultivation starts the water regime.

We cannot influence the precipitation but we can influence how your plants use water. An active water regime is the key to higher yields in dry and wet years. Understanding how water acts in soil is necessary if we want to achieve higher yields.

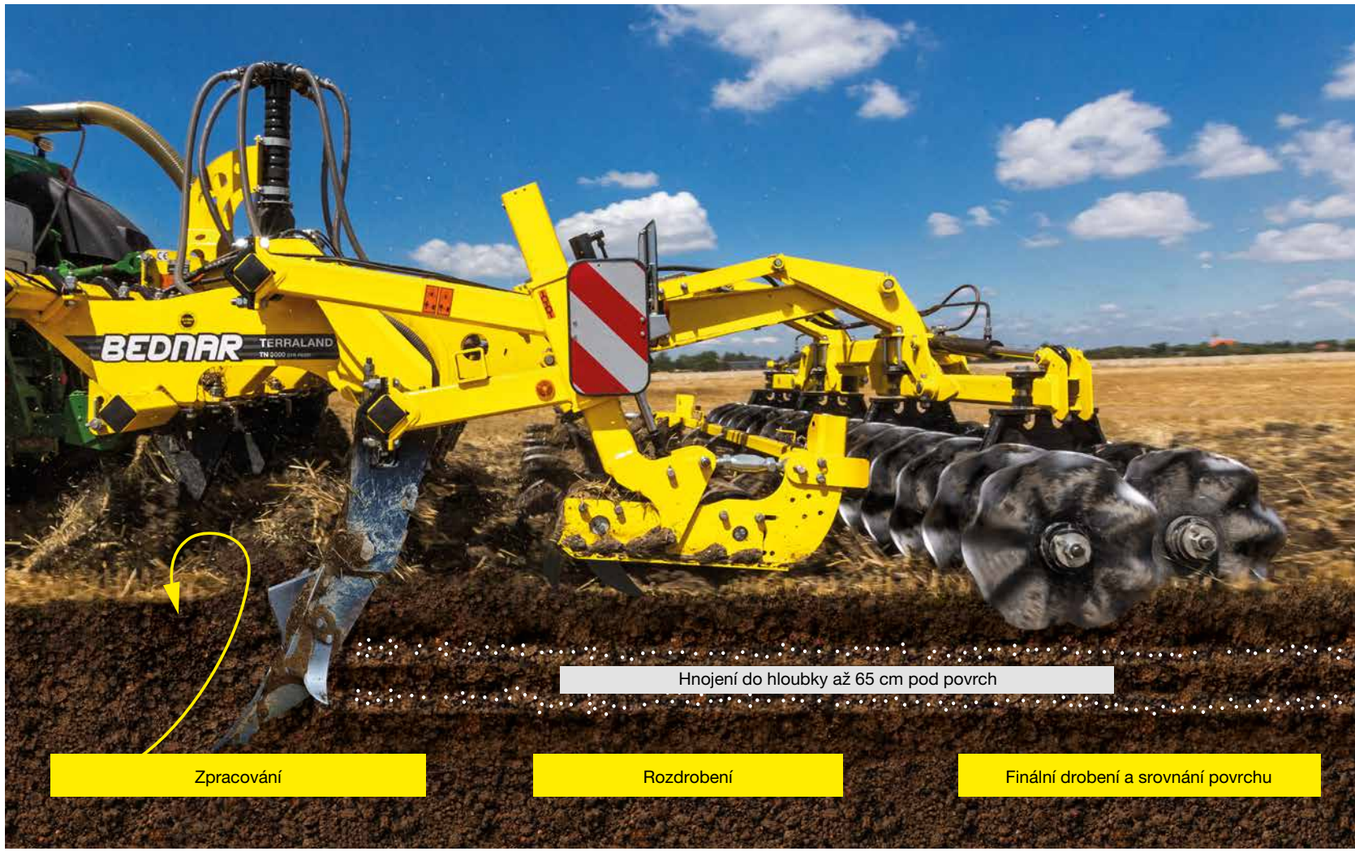
Basic characteristics of soil with a functional water regime:

- **Infiltration:** Soil has to have such a structure that allows for quality infiltration (absorption), which prevents the formation of soil crust or the plough basin.
- **Permeability:** Easy movement of water in soil layers, both downwards and upwards to the roots.
- **Percolation:** The ability of soil to deal with excess water by draining it into deeper soil profiles.
- **Soil maturity:** The ability of soil to absorb water but also to keep it in the dry season.

Compacted, blocked soil is like concrete. That means with zero or reduced ability of water infiltration in case of sudden rainfall. At the time of dry spells and drought, it does not let the root system permeate deeper to the moisture from underground supplies.



Deep cultivated soil without a created compacted layer works as a “sponge”. Such soil is able to take in corresponding quantity of atmospheric precipitation. At the time of dry spells and drought, corn roots can effectively take in moisture from the underground layers.



In case of a dry period, deep cultivation disturbs subsoil horizons and allows rising of the underground water to the roots of the plants.

In case of larger precipitation, the plot can become blocked without disturbed subsoil horizons. Soil is not able to absorb water. Plants stay “flooded”, which disturbs their vitality or completely destroys the growth.

PLANT ROOT NUTRITION

DEEP ROW LOOSENING AND SOIL FERTILIZATION FOR CORN

Corn-growing systems require crop establishment innovations in order to reduce the negative effect of short-term droughts and long dry seasons, together with the rising legislative demands on anti-erosion soil protection. The use of the new deep row cultivation technology with local fertilizer application directly at the points (depots) of follow-up seeding is a suitable innovation of intense corn growing systems. All of that is provided by BEDNAR machines. In particular, farmers can use the FERTI-CART hopper or the COMBO SYSTEM in aggregation with the TERRASTRIP chisel plough. The outcomes of soil cultivation using the aforesaid machines indicate a substantial increase in the corn vegetation comfort, with faster growth and development in consequence of localizing the entry of water into the soil profile. This is ensured by the wider profile of the cultivated strip, especially at the foot of the strip. Fertilizers applied to the bottom of the cultivated rows are more efficient thanks to their higher dissolving capacity and use by the nearby developing root systems, usually from the beginning of the developed 4th or 5th corn leaf. The technology of local soil cultivation and fertilization brings significant savings in phosphorous fertilizers and medium savings in nitrogenous fertilizers. When the soil has a good supply of phosphorus, i.e. with the average need for fertilization according to the crop sample norm and the need of slight replenishment of the soil supply, it is possible to achieve savings of EUR 15– 25 per hectare, and even EUR 20– 40 per hectare when NP fertilizers (Amofos) are used as the source of phosphorus. With regular nitrogen batches for corn, it is possible to save from EUR 20 to 30 per hectare in fertilizers thanks to the local application.

The basic procedure of the new technology is to prepare soil by stubble cultivation after the intercrop is harvested and then to perform autumn row cultivation in optimal moisture conditions, however, with a better effect of cultivating aerated strips under the conditions of a slight short-term drought than when the soil is saturated with water. The row cultivation can also be executed after summer intercrop. Optimally, the technology requires a cultivation depth of up to 35 cm (the bottom of the cultivated strip) and up to 35 cm at least in more shallow soil. The recommended depth for placing fertilizer is 20 cm, however, not less than 15 cm. For the main autumn version of the technology, it is recommended to only apply phosphorous or potassium, or combined PK fertilizers, or when the soil has a low pH, together in mixtures with granulated limestones that locally improve pH and phosphorus availability in soil. The nutrient batch is determined on the basis of the analysis of the available nutrients in soil, preferably using the standard soil supply maps for the application of a variable batch of nutrients in the field according to soil heterogeneity. The spring version of the technology is suitable for the application of nitrogenous fertilizers (preferably urea). It is possible to apply the whole nitrogen batch to the depot, except in moister areas. It is recommended to add phosphorous fertilizer to the nitrogenous one in the spring. At the same time, it is possible to apply fertilizer under the seeds by the seed drill in well-supplied soils. It is not possible to perform deep spring row aeration in soils that contain more than 35% of clay particles (<0.01 mm), i.e. outside heavier clay soils and heavy clay-loam soils, where this should only be done in autumn. The technology is a suitable innovation for the stabilization of the production and quality of corn silages under the conditions of drought and soil erosion exposure provided that the basic recommendations have been met.

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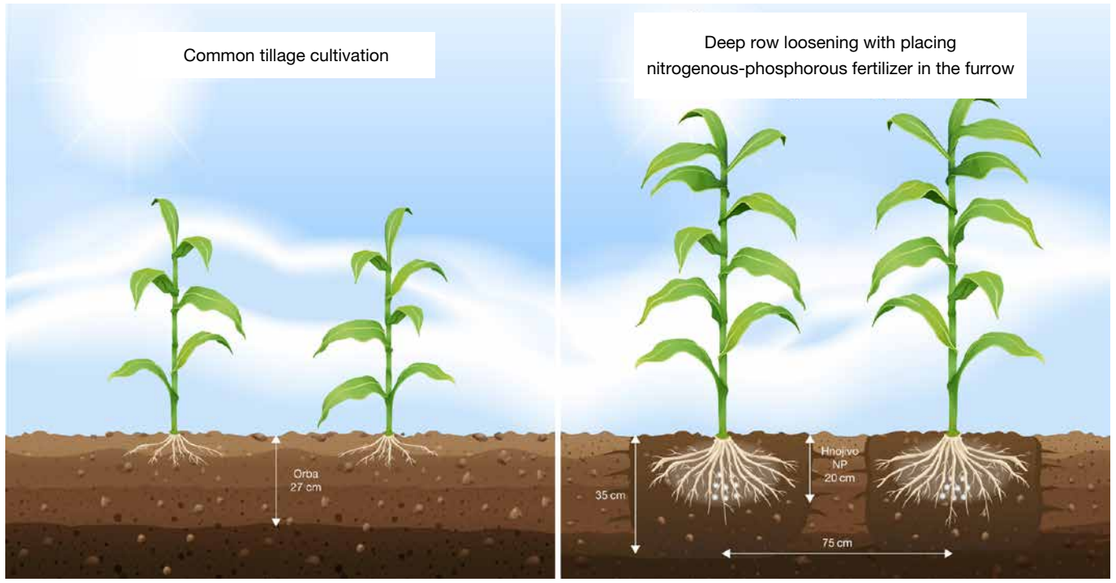


The effect of profile fertilisation on the architecture of the root system, field trial in Rychnov nad Kněžnou – oilseed rape. Plants in the plot processed by the TERRALAND chisel plough with fertiliser applied into the soil profile (25cm) with a strong collar of the ball root reaching to the depth of approx. 30cm (on the left). The root system of plants from the plot processed by tillage showed a weaker root collar and the architecture of the system was shallow with a weaker network of lateral fine roots (on the right).

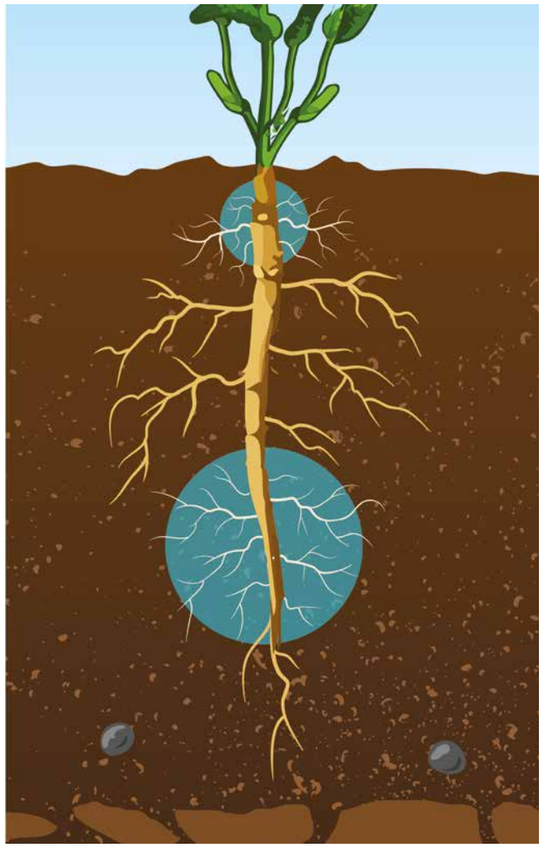
The effect of profile fertilisation on the architecture of the root system, field trial in Opatov – corn. On both plots processed by the TERRASTRIP chisel plough, the plants had a rich root system with the corresponding vertical architecture and rich lateral fine roots. In the version with fertiliser applied into the soil profile, the roots were visibly growing deeper. The root system in the plot processed by standard tillage was shallow with a simple architecture of the root system when compared with the plots processed by the TERRASTRIP chisel plough.

NUTRIENTS SUITABLE FOR THE APPLICATION IN THE SYSTEM OF PROFILE FERTILISATION

The knowledge we have about the behaviour of nutrients in soil is an important factor when selecting how to deliver fertiliser to the soil profile. The fertiliser effect depends on the relation of the mutual effect with soil and on the ability of solubility in water and its speed. For targeted placement into soil profile, it is better to use nutrients that are easily contained in soil by a system of less stable absorptions, from which they are lightly released into the soil solution and the plants are then able to take in the nutrients.

Plants usually receive most nutrients in the roots in the form of ions, positively charged cations, e.g. K^+, Ca^{2+}, NH_4^+, Mg^{2+}, Mn^{2+} etc., or negatively charged anions, e.g. NO_3^-, SO_4^{2-}, $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-} etc.

The method of application of phosphorus into the pre-set uniform depth of the soil profile is a very efficient method in the field of agrochemistry, nutrition and fertilisation of plants. Fertilisers containing phosphorus require this method of application due to the low mobility of phosphorus in soil, caused by a whole range of chemical absorptions. Phosphoric and combined fertilisers (N–P, N–P–K etc.) containing phosphorus are applied into the soil profile in the autumn for intended spring crops. The system of profile fertilisation, by which fertiliser is applied after the chisel share of the cultivator into the uniform pre-set depth, can also be used for early spring phosphorus fertilisation. In medium-heavy soils (sandy-loam to loam) and heavy soils (clay-loam to clay), it is recommended to apply phosphorus by a chisel cultivator for spring crops earlier in autumn. The utilisation of phosphorus from the fertiliser according to the application term (autumn/spring) is comparable for spring crops, but the fertiliser efficiency of phosphorus is limited by a corresponding soil reaction (pH), which has to be within the range from 5.5 to 7.2. Phosphorus fertilisation for winter rape and winter cereals should be done by profile fertilisation system immediately after the previous crop has been harvested (at least 3 weeks before sowing).



Storing phosphoric fertilisers in the soil profile has a positive effect on the stimulation of growth and development of the root system.

Nitrogenous fertilisers that contain the ammonium component of nitrogen, enriched with nitrification inhibitor, are also suitable. Such fertilisers remain in soil after application into soil profile for a longer period of time in the form of ammonium ions NH_4^+, that are subjected to soil absorption and later released and slowly oxidised into nitrate anions NO_3^- that are easier to absorb by plants. It is not recommended to use nutrients weakly bound by soil absorption for fertilising deeper layers of the soil profile, such as highly mobile and percolative nitrates (NO_3^-), sulphates (SO_4^{2-}), chlorides (Cl^-), borates (BO_3^{3-}) etc. In semi-humid and humid areas, it is not suitable to use fertilisers with a higher ratio of nitrate nitrogen for profile fertilisation. In light sandy soils with low absorption capacity, it is recommended to lower (according to the diagnostics of the nutrient content in soil and the standard for the annual need for additional fertilisation) the single batches of potassium, magnesium and also ammonium nitrogen ($N–NH_4$) for profile fertilisation prior to seeding. In sandy and sandy-loam soils, it is possible to do profile fertilisation regularly early in spring for spring crops. For the current demanding hybrid growths of winter rape, it is possible to apply the deficit macro-nutrient, sulphur, by profile fertilisation in the gradually releasable elementary form of sulphur (S^{2-}), that is subjected to microbial decomposition in the soil environment (oxidisation – sulphurization) with the formation of sulphate absorbable by plants (SO_4^{2-}). This gradual form of sulphur in soil is a source of nutrition for the following crop, usually wheat.

DYNAMICS OF THE INTAKE OF PHOSPHORUS AND OTHER NUTRIENTS

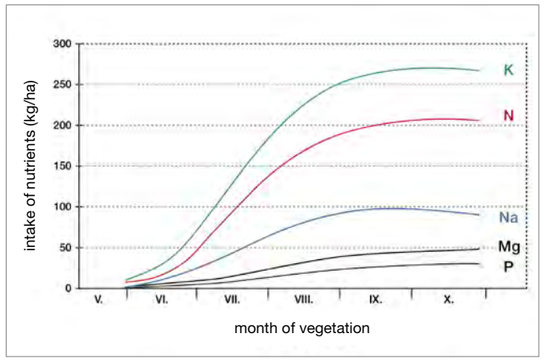
Long-term observations imply that mainly corn, sugar beet, barley and poppy have insufficient phosphorus nutrition during the first half of vegetation. The main reason is that these crops have difficulties with taking in nutrients from the soil supply in the first half of their vegetation due to the poor and shallow root system. At the beginning of their growth and development, they are not able to use phosphorus fractions from the soil supply that are more difficult to absorb. The diagnostics can be provided by the method of agrochemical testing of agricultural soils.

For profile fertilisation, we recommend using the diagnostics for determining the content of water-soluble phosphorus (P_{water}) in the profile of the arable soil, which is related to the nutritional condition of the grown crops, namely when the contents of the potentially absorbed phosphorus (P–Mehlich III) are in the satisfactory or low category, or in situations of frequent dry spells or in soils with low pH (<5.4). The application of phosphorus should be divided into two batches of phosphorus at two different levels of the soil profile based on the knowledge of the content of easily absorbable forms of phosphorus in soil. The main part of the determined phosphorus batch should be applied deeper into the soil profile (according to the crop and soil conditions of the station to the depth from 15cm to 25cm) and the remaining part (however, not more than up to 40–50kg P_2O_5/ha according to the crop and soil supply) should be applied as precise as possible before the seed drill that is designed for the application of fertiliser under the seedbed.

The distribution of the total determined batch of fertiliser containing phosphorus into two levels of the soil profile is recommended due to the known, very little mobility of phosphorus in soil. As a result of the immobilisation processes, phosphorus delivered to soil through the fertiliser may be used by the plant only partially, usually in the zones of the placement of the fertiliser. The divided batch of phosphorus also has an effect on the development of the root system architecture, providing deep rooting with rich secondary lateral hair. A faster and easier vertical growth of roots into deeper layers “to reach the fertiliser” promotes deeper rooting. This is related to a better supply for moisture from deeper layers of soil and it significantly increases resistance of crop to the recurring periodical dry spells.

Sugar beet

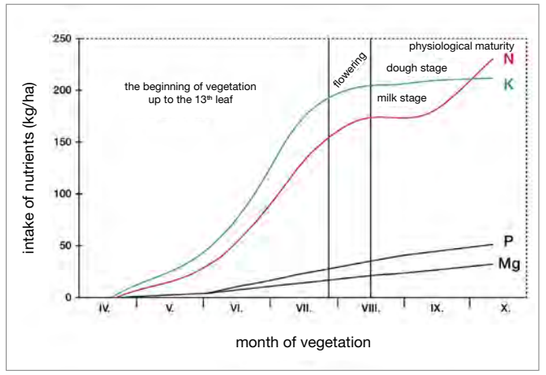
The intake of phosphorus by sugar beet during the entire vegetation is gradual and quite high in the final stages of growth an development. Therefore, it is necessary to provide its sufficient supply for the entire time of the growth and development of sugar beet. Phosphorus is utilised quite evenly by the roots and the leaves above the ground during the initial growth stages. In the second half of vegetation, phosphorus is distributed from soil to the roots and it is also re-utilised there from older leaves. A lack of phosphorus in the beet nutrition leads to a reduced energetic transport of assimilates into the tuber, which reduces the sugar content and white sugar yield.



Dynamics of the intake of nutrients by sugar beet

Corn

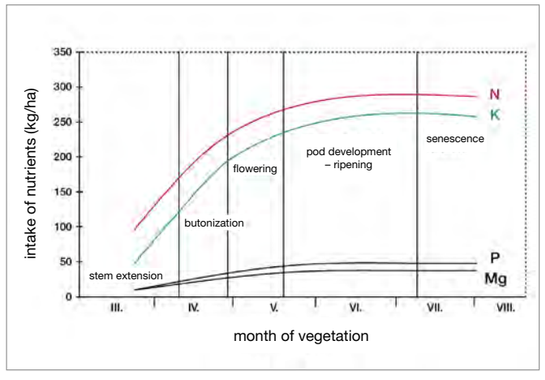
The intake of phosphorus by corn during the vegetation is gradual, almost linear with slight increase until the harvest. However, there are two critical periods in the intake of phosphorus during vegetation. The first one is at the beginning of germination when the root system is being slowly created, and the second one is at the time of blooming. At the beginning of the growth of the young plant, the above-ground parts might be lightly purple if there is a deficiency in the easily absorbed forms of phosphorus in soil and when the deficit continues, the plant stops growing and the internodes of the stalk are shortened. Metabolically, it is required that the plants of the corn receive a sufficient amount of phosphorus until the corn flowers because after blooming, the phosphorus is re-utilised from leaves and the stalk by the production organs of the cob. A sufficient distribution of phosphorus (adequate nutrition with phosphorus at the time of the main growth of phytomass) into cobs during ripening significantly increases accumulation of supply substances, including starch.



Dynamics of the intake of nutrients by corn

Oilseed Rape

Phosphorus has an important energetic and building function in the nutrition of rape from germination to ripening. Phosphorus is a part of the universal energy carrier (AMP, ADP, ATP) that distributes energy from assimilates in the plant to the centre of current need in the given development stage. Sufficient nutrition with phosphorus predetermines the use of other nutrients and assimilates in the growth, development and production of supply substances in the production organs of the cobs. The phosphorus intake of plants is energy-demanding and requires enough sunshine and higher air temperature, when there is a cooling during vegetation, the phosphorus nutrition usually stagnates. A lack of phosphorus in the rape nutrition has a negative effect on the growth of roots, which contributes to reduced phosphorus intake and other nutrients by the production, above-ground part. At the same time, a richly developed root system, caused by the zonal use of phosphorus in the soil profile when the plant is young, produces more root exudates towards the end of vegetation that help adopt hard to access forms of phosphorus in soil.



Dynamics of the intake of nutrients by oilseed rape

WIDE STARTING FERTILISER APPLICATION

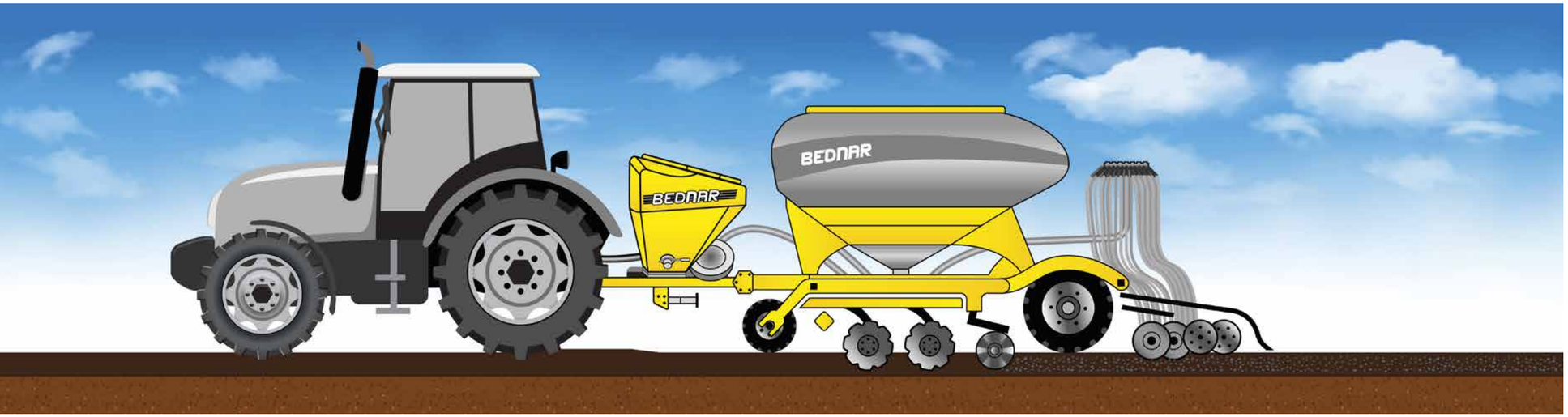
Combining work operations of seedbed preparation and fertilisation

It has been known for several years that the winter crops have issues with plant nutrition including phosphorus (P), potassium (K), calcium (Ca) and also nitrogen (N) due to mild winters (coastal character). The nutrition with these nutrients is insufficient mainly due to the changing climate zone at the expense of the usual course of winter in the mild climate zone. Earlier, vegetation stopped growing temporarily when winter came due to the significant cooling and a continuous snow cover and the growth and development then resumed with warming up weather and melting of the snow cover in spring. A few years ago (at least since 2012), the vegetation of winter crops were showing winter growth and development of the above-ground parts (former regeneration) due to the coastal character of winter, which causes the plant to consume a large amount of nutrients that soils do not naturally supply. The muddy heavy terrain of the plot with winter crops in early spring does not usually permit the required application of nutrients and also, it would cause degradation of the soil aggregates. The deeper growth of roots into the area where fertiliser is stored prior to seeding allows deeper rooting of plants in autumn, which improves the quality of vegetation using soil moisture from deeper layers during spring dry spells we have been experiencing lately. The method solves the long-known issue of spring crop nutrition, namely the need of phosphorus fertilisation of barley for the production of quality grain for malt and for poppy vegetation. Phosphorus in soil profile has a very low mobility (migration through the profile) and so it is necessary to place it into the optimal depth of the soil profile for the given crop before seeding where it stays for a very long time (it is not infiltrated with precipitation).

The SWIFTER seedbed cultivators can be aggregated with FERTI-BOX for fertiliser. The starting batch of the fertiliser is applied in front of the working sections and mixed with the top layer of soil. This saves one operation and reduces the number of passes on the plot.

Application of industrial fertilisers on SWIFTER cultivators

The fertiliser is pneumatically distributed from Ferti-Box to the distribution head located on the SWIFTER machine. The fertiliser is then applied by the application end pieces in front of the working shares that incorporate the fertiliser into the top soil horizon.



A great advantage of connecting FERTI-BOX with the OMEGA seed drill is the option to apply starting fertiliser for the spring crops. For winter crops, the seed drill stays light and simple.

PRECISE STARTING FERTILISER APPLICATION

The precise starting fertiliser application is suitable namely for spring crops and can be done using OMEGA OO_Ferti, seed drills with additional fertilisation. The disadvantage of these machines is their weight and overall complexity. BEDNAR developed a system of connecting FERTI-BOX with the traditional light and simple OMEGA OO machine.

COULTERS ON SEED DRILLS HAVE TWO FUNCTIONS

The coulters loosen and refine the soil structure for seeds. In wet conditions, they do not create lumps like discs, for example. They work independently of the disc cultivation.

The coulters cut the soil profile. There is a carbide application end piece behind each coulter that applies fertiliser into the inter-row for cereals. For winter rape, the coulters can be adjusted to apply fertiliser directly under the rape seeds.

FERTILISER APPLICATION DURING VEGETATION IN ROW CROPS

During inter-row cultivation, it is recommended to apply liquid or mineral nutrition that has anti-erosion benefits (nutrition does not have a direct effect on erosion) but also increases the efficiency of fertilisation and thus plant vitality. Fertilisation during vegetation verifiably increases the yield and the overall resistance of the vegetation against other adverse effects, such as long drought.

Connection of the ROW-MASTER inter-row cultivator with FERTI-BOX mineral fertiliser hopper.

INTEGRATED FERTILISER APPLICATION SYSTEM

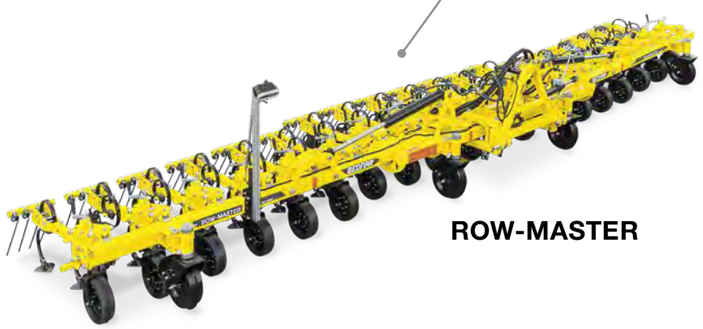
TERRALAND

OMEGA

FERTI-BOX

SWIFTERDISC

SWIFTER



ROW-MASTER

SUSTAINABLE DEVELOPMENT

Sustainable development in plant production means treatment of soil that fulfils the needs of the current generation and does not endanger the use of the same needs of future generations. Thus, there are increased demands on the individual operations in the intensive method of modern farming that contribute to the fulfilment of objectives of sustainable development. This mainly includes:

- green fertilisation,
- inter-row cultivations,
- deep soil cultivation.

GREEN FERTILISATION

Green fertilisation enriches the soil with necessary nutrients in a natural and perfectly accepted form and contributes to soil fertility in the next growing season. Some plant species may even restore soil with regard to the substances they contain and act against pests or diseases, all plants promote the formation of black top soil. Establishing crops for green fertilisation is easy thanks to the equipment available for BEDNAR stubble cultivators: the ALFA DRILL seed unit. Green fertilisation can also be established using FERTI-BOX that can be connected with BEDNAR tools.

Establishing crops for green fertilisation when cultivating a stubble field using ALFA DRILL.

The benefit of green fertilisation is universal.

- In addition to enriching soil with a whole complex of nutrients, green fertilisation temporarily protects uncovered soil from sun drying, wind erosion and washing away nutrients by rain.
- The plants grow roots through the soil and revive it, improve its structure and loosen it, enrich it with the precious top black soil and benefit useful soil microorganisms.
- They also have a phyto-sanitary effects and help remove soil fatigue.
- They also eliminate the growth of undesirable weeds as they are profusely growing and vital plant species.

The vegetation for green fertilisation can be easily established using FERTI-BOX in connection with SWIFTERDISC XE 10000 or XE 12000.

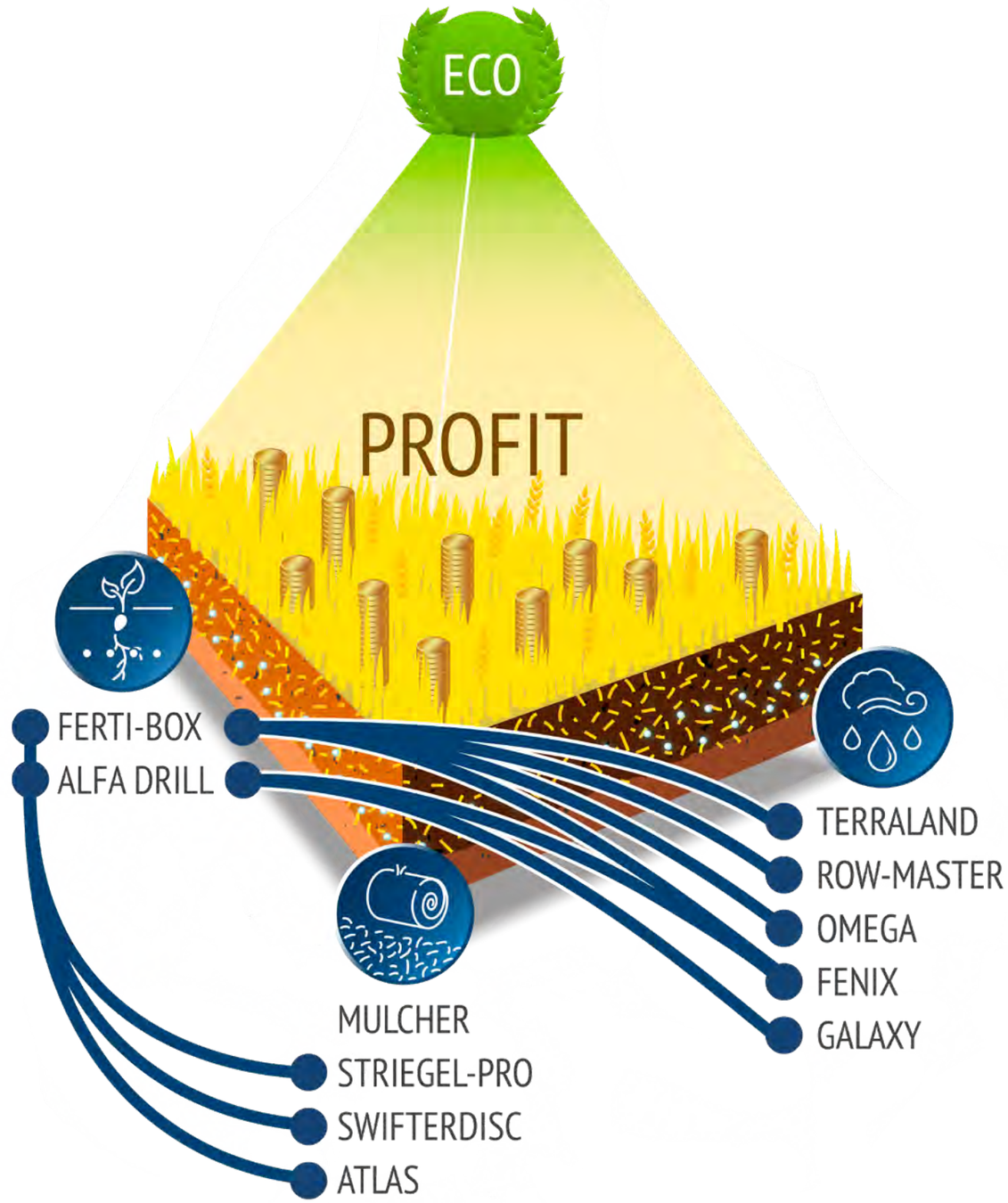
INTER-ROW LOOSENING

Weeding during vegetation of wide-row crops (corn, sunflower, sugar beet) removes the undesirable weeds which leads to reduction in the use of herbicides. However, inter-row cultivation of crops also protects soil. Thanks to loosening the layer of soil in the inter-row, it prevents a fast drainage of surface water and reduces the likelihood of water erosion.

DEEP CULTIVATION

Intensive farming brings negative effects that promote erosion, such as soil compaction, loss of organic mass, incorrect tillage procedures, tillage down the slope and not along the contour line, growing erosion-prone plants (corn, potatoes, rape, beans, soy, sunflower and Indian millet), incorrect seeding procedures on unsuitable plots. Deep soil cultivation with TERRALAND chisel ploughs optimally treats soil structure as well as post-harvest residue, which creates conditions contributing to the reduction of rain wash and protection of soil against erosion, which also helps increase soil fertility.

INDIVIDUAL MACHINES IN THE MODERN FARMING PYRAMID



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