

Checklist: Simple assessment of phosphorus mobilisation potential

for arable land under organic or conventional cultivation

for fields in the Pannonian climate region and the Central European transition zone

Assessment at field level

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Date:

Name of plot:

Collector:

Factor 1: "Soil & climate" (cannot be influenced)

Instructions for completing the questionnaire: Answer each question and mark the rating that applies to you. Only one answer is possible for each question.

Soil "Data from www.bodenkarte.at"

(for compaction and erosion, see the BAW/BFA sub-maps)"

Your own assessment and results of soil tests are more specific and preferable to the data from the soil map.

Parent rock

crystalline

silicate

granite

schist

mica schist

Gneiss

moraine*

Alluvial land*

all others

*if the field is located in the vicinity of one of the above-mentioned source materials, then moraines and alluvial deposits are to be evaluated positively.

Soil reaction (pH-Value Calciumchlorid)

alkaline (7,3 - 8)

neutral (6,6 - 7,2)

slightly acidic (5,6 - 6,5) - neutral

all others

Potential risk of compaction

very low

low

medium

high

very high

Soil reaction - pH value water

(Self-measurement with pH test strips*)

pH value (water)

6,0 - 7,5

> 7,5

< 6,5

*Self-measurement on site with test strips from the chemist's, more accurate than soil map

Humus content

slightly humic (<1,5 % Humus)

strongly humic (> 4 % Humus)

all others

Soil depth

shallow (0 - 30 cm)

deep (> 70 cm)

all others

Water conditions

dry

moderately dry

well supplied

wet

all others

Lime content

lime-free

all others

Erosion hazard

low

all others

Climate data

total annual precipitation

< 490 mm

> or (oder) = 490 mm

Classification Factor 1: "Soil & climate"

Number +

7 - 10

4 - 6

0 -3

Classification

high

medium

low

Classification instructions: add up all the ‘+’ values for the factor "soil & climate" and compare the number of ‘+’ values with the table above.

Factor 2: "Management" (influenceable)			
Instructions for completion: Answer each question and mark the classification that applies to you. Multiple answers are also possible here.			
Crop rotation			
Classification refers to a crop rotation cycle*			
* If there is no fixed crop rotation period, then the classification period is conventionally 4–6 years and organically 6–8 years.			
Main crops		Cover crops and undersowing	
Main crop diversity (each crop partner counts as a separate crop)		Mixture partners in cover crops/undersowing (diversity)	
1 - 4 crops	-	1 - 3	-
5 - 6 crops	0	4 - 6	0
> 6 crops	+	> 6	+
Proportion of fodder crops and field vegetables in crop rotation		If the cover crop/under-sown crop is left in place as a green manure: Number of selected mixture partners from the listed crop selection	
> 1/3	-	3 or more of the cultures listed below *	+
< 1/3	0	1 - 2 of the cultures listed below *	0
		none of the cultures listed below *	-
Selected main crops in crop rotation		*Crops: buckwheat, phacelia, niger (ramtillweed), oil radish, oil flax (linseed), vetch, sudan gras	
Small-seeded forage legumes (e.g. clover, lucerne grass) mulched (> 25% of biomass growth)	+	Proportion of undersowing or cover crops within the crop rotation	
This question concerns the important green manure effect		< 15 %	-
		15 - 30 %	0
		> 30 %	+
Management of soil pH (Has a pH-value outside the optimal range been adjusted through measures to fall within the target range?) (Multiple answers possible)		Management of soil microbiology and/or phosphorus availability (multiple answers possible)	
pH neutral salt (KCl or CaCl ₂): 5.9 – 6.9	+	Application of solid organic products (e.g. farmyard	+
pH in water (H ₂ O): 6.5 – 7.5 (optimal for microbial biodiversity)	+	Remaining grain straw in the field (> 50% of crops)	+
		Remaining green matter in cover crops in the field (> 50%)	+
Classification Factor 2: "Management"			
Instructions for classification: add up all ‘+’ and ‘-’ values for the factor "management" and compare the total with the table above. The value 0 does not change the total.			
Number +	6 - 10	0 - 5	< 0
Classification	high	medium	low

Review of Phosphorus Mobilization Strategies?
Sufficient supply of trace elements (cobalt, molybdenum, iron) for microbiological turnover processes: verifiable by the formation of nodules on legume roots or Soil analysis (relevant phosphorus parameters are listed in the "assessment analytics") ?
Balanced humus budget (can be verified through humus balance calculations)
Phosphorus Mobilization Strategies
Supply of competing ions silicic acid or sulfur. Explanation: In soil, phosphorus exists as negatively charged phosphate ions, which are bound to positively charged exchange surfaces. Silicic acid and sulfur are also negatively charged and can therefore displace phosphate ions. This displacement increases the availability of phosphorus for plant uptake.
Phosphorus-solubilizing microorganisms (e.g. <i>Bacillus megaterium phosphaticum</i>). Explanation: <i>Bacillus megaterium phosphaticum</i> specifically mobilizes phosphorus from organic matter.
Cultivation of phosphorus-mobilizing plants (e.g. buckwheat, phacelia, niger (ramtillweed), oil radish, linseed, vetch, sudan gras).

What does ‘phosphorus mobilisation’ mean?

Phosphorus mobilisation is the process of converting phosphorus bound in the soil – which is unavailable to plants – into a form that is available to plants.

What factors influence phosphorus mobilization?

factor	explanation
Parent rock	Crystalline rocks are rocks that consist of a crystalline (regular, with repeating patterns) structure. They are formed by the solidification of molten rock (magmatic rocks, e.g. granite) or by the transformation of existing rocks under pressure and heat (metamorphic rocks, e.g. gneiss, schist). These rocks contain phosphorus-bearing minerals.
Soil reaction (Bodenreaktion) (pH value calciumchlorid)	Phosphorus is strongly bound in both acidic and alkaline soils. In acidic soils, phosphorus is bound to iron and aluminium; in alkaline soils, it is bound to calcium. The neutral range is therefore the most favourable for mobilisation.
Potential risk of compaction	Compacted soils contain less oxygen and are therefore less microbiologically active. The root zone is also restricted in compacted soils.
Humus content	Phosphorus is stored in humus in an organic form. It is made available to plants through mineralisation by microorganisms. The more humus the soil contains, the higher the proportion of organic phosphorus in the soil. Humus also improves soil structure, water retention and the living conditions for microorganisms, which also play a role in nutrient availability.
Soil depth	Depth refers to the volume of soil that roots can potentially penetrate. The deeper the soil, the greater the volume available for mobilising bound phosphorus. Roots can penetrate into deeper zones and mobilise the nutrients present there.
Water conditions	All chemical reactions in the soil require a certain water content. This aids the conversion of organic matter and enables bound phosphorus to be released by plant roots and soil organisms.
Lime content	In calcareous soils (alkaline conditions), phosphorus binds with calcium to form insoluble calcium phosphates.
Erosion hazard	Erosion leads to a loss of nutrients. Soil structure is impaired. This results in poorer air and water conditions, which in turn decreases microbial activity.
total annual precipitation	Water is important for all soil processes. A certain amount of rainfall and soil moisture is therefore necessary to set soil processes (the decomposition of organic matter, nutrient mobilisation) in motion.
Soil reaction (pH value water)	The pH measured in water is an indicator of biodiversity. If this value falls within the range of 6.5–7.5, conditions are very favourable for microorganisms.
Main crops	The greater the biodiversity of a crop rotation, the better the conditions created for soil life. Diverse root systems mean that different root zones are populated by soil organisms. A wide variety of plants introduces different root exudates into the soil. The more varied the plant material, the more diverse the soil life.
Cover crops and undersowing	Covering the soil with cover crops or undersown crops outside the growing season of the main crops brings further benefits for the soil. It reduces or prevents erosion and provides food for soil fauna and microorganisms.
Proportion of fodder crops and field vegetables in crop rotation	Intensive tillage has a negative impact on soil structure and soil organisms, as their habitat is damaged or destroyed.
buckwheat, phacelia, niger (ramtillweed), oil radish, oil flax (linseed), vetch, sudan grass	In the PhosVer trial, these crops exhibited high concentrations of phosphorus in their above-ground parts.

What do the classifications ‘high’, ‘medium’ and ‘low’ mean?

The classification of the result indicates the natural potential of the soil and climatic conditions at the site to mobilise the phosphorus present in the soil (Factor 1). Furthermore, the effects of various management practices on the phosphorus mobilisation potential are estimated (Factor 2). Actual P mobilisation varies from case to case and can be estimated using soil analyses (see the ‘Analytical Assessment’ table).

Classification of soil	Explanation
high (7-10)	The conditions for phosphorus mobilisation, based on soil properties and climatic conditions, are very good; the soil has the potential to mobilise phosphorus from its reserves. Nutrient-activating management practices (e.g. varied crop rotations, various cover crops, undersown crops, phosphorus-mobilising crops) can help to improve the conditions for increasing the potential for phosphorus mobilisation.
medium (4-6)	The conditions for P mobilisation, based on the soil properties and climatic conditions at the site, are average. On these soils, management practices are crucial for increasing the soil’s P mobilisation potential. Nutrient-activating management practices (e.g. varied crop rotations, various cover crops, undersown crops, phosphorus-mobilising crops) can help to create the conditions needed to increase the potential for phosphorus mobilisation.
low (0-3)	The conditions for phosphorus mobilisation are rather unfavourable due to the soil properties; the soil has a low potential to mobilise phosphorus from its reserves. In this case, nutrient-activating management practices (e.g. varied crop rotations, various cover crops, undersown crops, phosphorus-mobilising crops) are the decisive factor in increasing phosphorus mobilisation from the soil.

Classification of Management	Explanation
high – medium – low	The results show the impact of farming practices on the potential for phosphorus mobilisation. Depending on the results, these practices should be critically reviewed, as the potential for phosphorus mobilisation can only be realised through nutrient-activating farming methods (e.g. varied crop rotations, various cover crops, undersown crops, and phosphorus-mobilising crops).

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Europäischer
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ländlichen Raums:
Hier investiert Europa in
die ländlichen Gebiete.



Assessment of phosphorus supply based on analysis data

for arable land cultivated using organic or conventional methods
Ersteller:innen (creators): Wohlmuth, Marie-Luise; Surböck, Gollner, Gabriele; Andreas; Bajraktarevic, Armin; Böhm, Manuel und Unterfrauner, Hans

Classification:
+ = optimum
0 = area not optimal, but no action required
- = need for action

sampling depth 0 - 30 cm		sampling depth 0 - min. 20 recommended		sampling depth 0 - 20 cm		
Phosphorus Analysis						
P-Parameter Unterfrauner		P-Parameter AGES		P-Parameter Kinsey		
P soil solution (mg/l) = P wl (water soluble)		plant available P according P - CAL (mg/kg)		P readily available (kg/ha)		
< 0,2	-	< 26	-		pH(KCl) 5,8 - 6,7	pH(KCl) < 5,8 bzw. > 6,7
0,2 - 0,8	+	26 - 46	0	< 25	-	-
> 0,8	-	> 46	+	25 - 40	+	0
P exchangeable (kg/ha) = P at		Phosphate Release Rate /Dynamics (µg P/kg soil x min)		> 40	0	0
< 8	-	Pfr > Value (Pcal*10) +50	+	P stock (kg/ha)		
8 - 20	+	Pfr < Value (Pcal*8)	-		pH(KCl) 5,8 - 6,7	pH(KCl) < 5,8 bzw. > 6,7
> 20	-	P stock (g/kg soil)		< 250	-	-
P organic (organisch) (kg/ha) = P org		>= 0,5	+	250 - 550	0	0
> 700	+	< 0,5	-	550 - 850	+	0
< 700	-			> 850	0	0
P inorganic (kg/ha) = P nl (supply)						
> 800	+					
< 800	-					
P gesamt (kg/ha) = P total						
> 2000	+					
< 2000	-					
Analysis Unterfrauner		Analysis AGES		Analysis Kinsey		
P soil solution (Pwl water soluble)	Phosphorus that is present in the soil solution in dissolved form for plant uptake; parameter is a snapshot, fed from the mineral and organic P pools --> directly available to plants	P - CAL plant available	Phosphorus present in dissolved form in the soil solution; this proportion is directly available to plants; the parameter is a snapshot. It is fed from the mineral and organic P pools.	P readily available	P is determined using weak acetic acid. This analysis reflects the readily available fraction and provides results similar to those obtained using the CAL method.	
P exchangeable (Pat)	The anion phosphate (PO4) can attach itself to iron and aluminum oxides and hydroxides in the soil in an exchangeable manner. The attached phosphate can be displaced by competing ions, e.g., SiO ₂ -, SO ₄ ²⁻ --> mobilizable through ion competition.	P Release Rate	The phosphate release rate describes the rate at which P is released from the solid phase of the soil into the soil solution (= P kinetics) after the plant roots have extracted the phosphate from the soil solution. In the laboratory, the water-soluble phosphate (P content in the soil solution + easily soluble P) is removed, and then the soil is shaken with water for 10 minutes, after which the P content of the extraction solution is measured a second time. The amount of P dissolved within 10 minutes corresponds to the P supply from the solid phase of the soil and describes the rate of P supply, which is very important for P nutrition and yield formation in phases with high P demand.	P stock	The P reserve is determined using the Bray-2 (Bray-II) analysis. Due to the solvent, it can be assumed that only part of the stock (mineral) is represented. To estimate the total stock, a factor of approximately 3 can be applied. It should also be noted that calcium-bound P is insufficiently represented on alkaline, carbonate soils. Kinsey therefore additionally determines the P-Olsen value. In order to make high reserves available, Albrecht and Kinsey recommend increasing the sulfur values at high pH values and increasing the lime supply at low pH values. If reserves are high, they also recommend fertilizing with zinc and copper, as these nutrients are blocked by the reserves.	
P organic (organisch) (Porg)	20 to 75% of total phosphorus is present in organic form, some of which can be converted into a form available to plants through microbiological processes. Organic phosphorus cannot be mobilized by acids --> can be mobilized by microorganisms.	P stock	Determination of the total proportion (organic + inorganic) of phosphorus in the soil using aqua regia digestion. This proportion represents the reserve in the soil, and only a small proportion is immediately available to plants. If the value falls below <0.5 g/kg, measures such as mobilization (silicon fertilization on soil), organic fertilizer (farm manure or commercial organic fertilizer) or raw phosphate (in combination with elemental sulfur and silicon fertilizer) should be taken.			
P inorganic (Pnl supply)	The large P sink in the soil; P from various sources (e.g., fertilizer) is converted into stable Ca-, Fe-, and Al-phosphates depending on the pH value ("aging of phosphates") --> mobilizable by root exudates.					
P gesamt (Ptotal)	Total amount of phosphorus in the soil; in arable agriculture, this is very often > 2000 kg/ha at a depth of 30 cm. Not completely mobilizable, occluded phosphates are excluded from the ecological cycle					

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