Warsaw University of Life Sciences

Faculty of Agriculture and Biology

FERTILIZATION AS A FACTOR DETERMINING QUALITY OF PLANT MATERIALS IN SUSTAINABLE AGRICULTURE

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PLAN OF THE PRESENTATION

- ⇨ The relativity of the concept of quality of the crops
- ⇨ The place of fertilization in determining of crops quality
- ⇨ Nitrogen – main factor influencing on quantity and quality of yield
- ⇨ Influence of potassium on yield quality
- ⇨ Significance of phosphorus, magnesium and sulfur for yield quality
- ⇨ Micronutrients and yield quality
- ⇨ Interaction of mineral and organic fertilizing in the forming of the quality of the crop
- ⇨ Summary

GLOBAL CONTEXT

- ⇨ Biological progress is becoming the driving force of the farming. It is more than 50% of agricultural progress
- ⇨ Height of the human population and the decreasing surface of the farmlands per 1 resident
- ⇨ Environmental increasing problems - legal restrictions on the use of fertilizers

Quality the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs

FOCUS ON PRODUCT

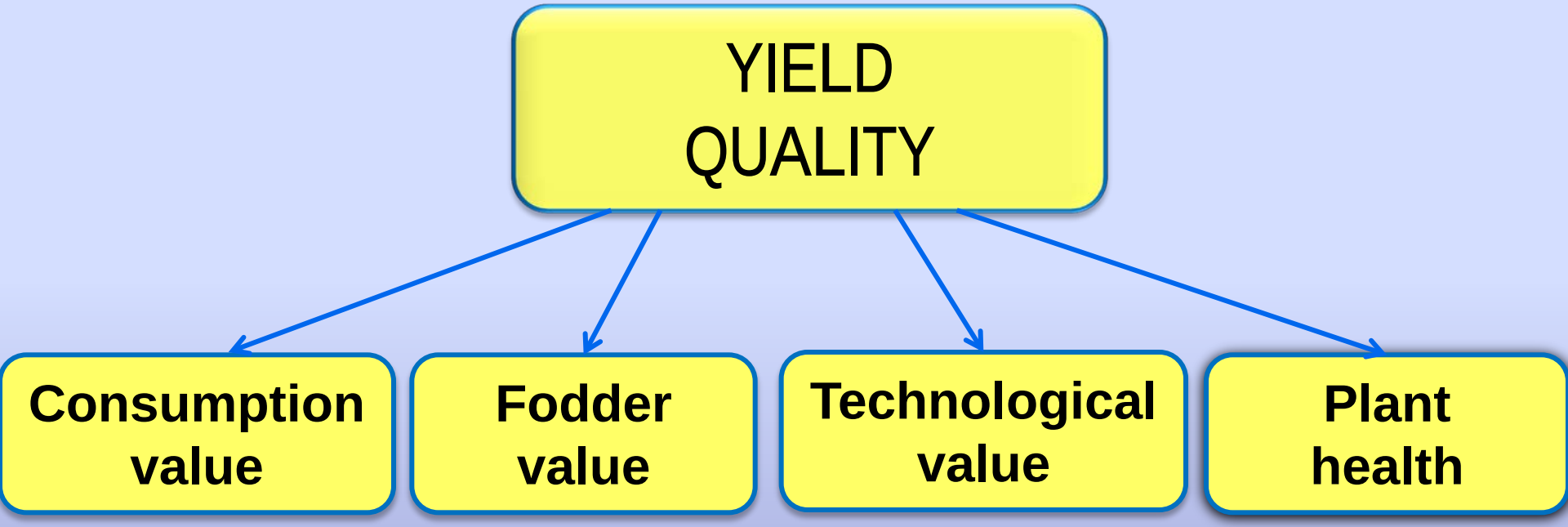
on the level of the agricultural raw material

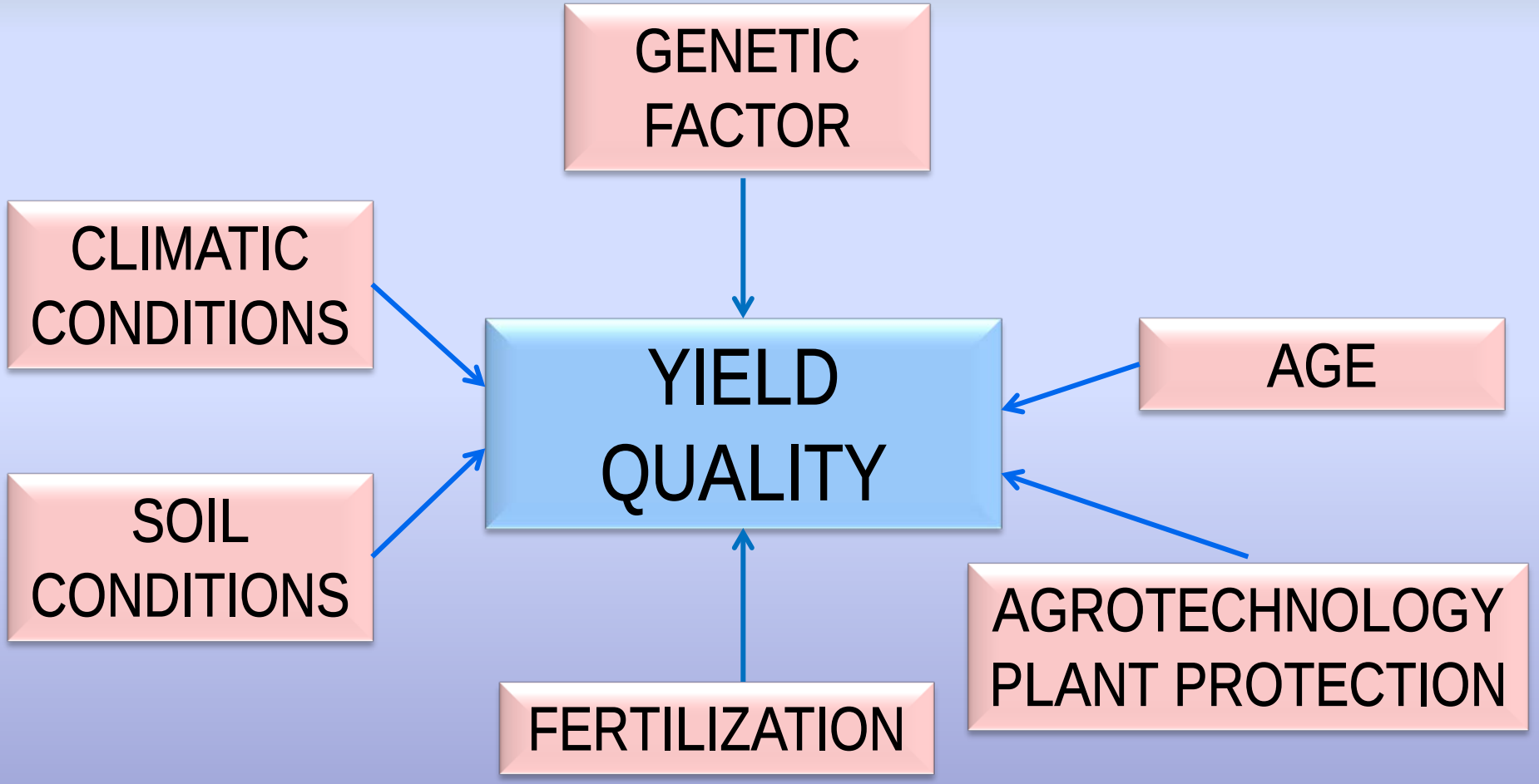
FOCUS ON THE PRODUCTION PROCESS

on the level of the farm or processing plant

FOCUS FOR SALE

social concept of quality


YIELD
QUALITY
Consumption value
Fodder value
Technological value
Plant health


GENETIC FACTOR
CLIMATIC CONDITIONS
YIELD QUALITY
AGE
SOIL CONDITIONS
AGROTECHNOLOGY PLANT PROTECTION
FERTILIZATION

The role of the traditional tools of determining yields in sustainable agriculture to biological development is reduced?

NO

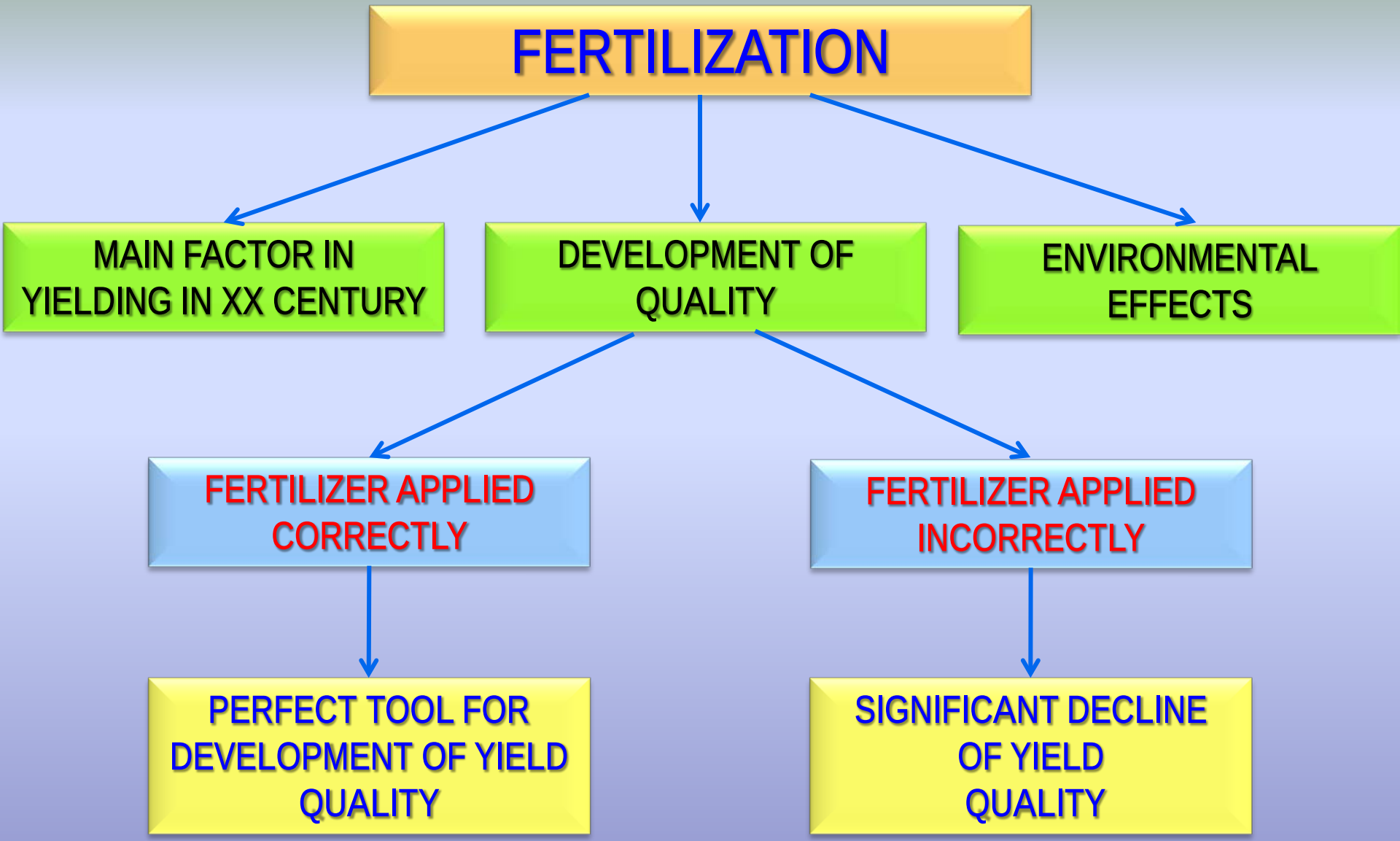
Requires more precision in the application than the traditional agriculture in order to the expected yield quality characteristics resulting from the genotype could be fully realized

PRECISION AGRICULTURE

THE RECIPIENT OF THE AGRICULTURAL PRODUCE DETERMINES THE QUALITY PARAMETERS DEPENDENT ON THE PURPOSE - COMPLYING WITH THE REQUIREMENTS OF THE QUALITY IS A CONDITION OF THE COST-EFFECTIVE PRODUCTION

IN OUR TIMES ABOUT QUALITY DETERMINES THE APPROPRIATE SELECTION OF THE VARIETY, WHICH IS ONLY A POTENTIAL PATTERN OF THE REQUIRED CHARACTERISTICS THAT COULD BE ACHIEVED UNDER OPTIMAL GROWTH CONDITIONS AND PLANT NUTRITION

THE FARMER MUST MANAGE OF FIELD ENVIRONMENT, SO THAT DESIRED QUALITY FEATURES SAVED IN THE GENOTYPE CAN BE FULLY REALIZED


FERTILIZATION
MAIN FACTOR IN YIELDING IN XX CENTURY
DEVELOPMENT OF QUALITY
ENVIRONMENTAL EFFECTS
FERTILIZER APPLIED CORRECTLY
FERTILIZER APPLIED INCORRECTLY
PERFECT TOOL FOR DEVELOPMENT OF YIELD QUALITY
SIGNIFICANT DECLINE OF YIELD QUALITY

INFLUENCE OF FERTILIZATION ON YIELD QUALITY

DIRECT

on value traits of yield

INDIRECT

Improvement of soil properties:

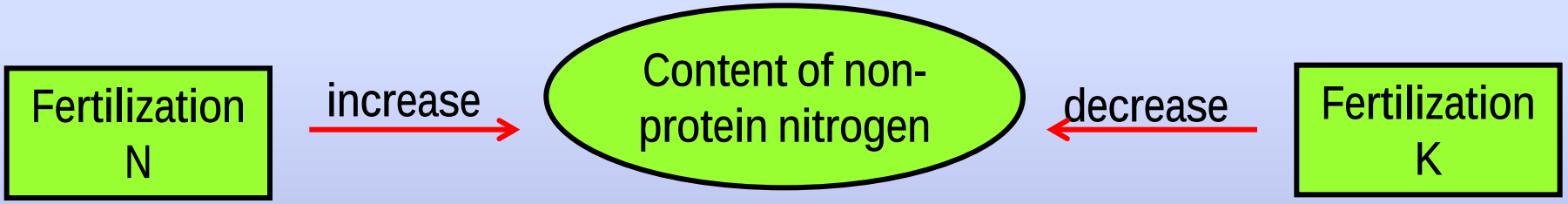
- abundance in nutrients
- soil reaction
- content of organic matter

The indirect impact of fertilization is particularly important in sandy soils

Influence of nitrogen fertilization on yield quantity and yield quality

Non-protein nitrogen content

- free amino-acids
- amides
- nitrate



In fertilization the ratio of N: K is important

Effect of potassium on carbohydrate metabolism

1. Potassium increases the synthesis of disaccharides and polysaccharides

mono-saccharides →

Sucrose → sugar beet

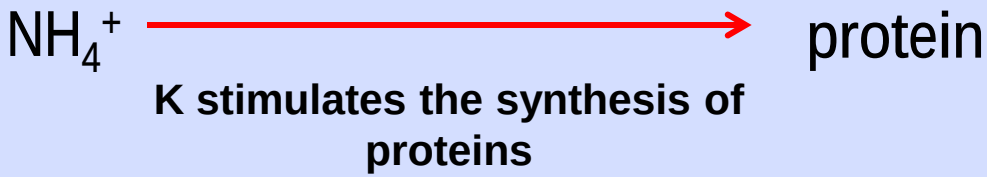
Starch → potatoes, cereales

Cellulose:
- lodging of cereals
- the technological value of fiber of flax and hemp

2. Potassium fertilization is supporting collecting reserves of carbohydrates in spare organs of perennial and winter plants:
   - better wintering
   - better spring shoot
3. Moreover potassium fertilization leads to:
   - growth in manufacturing of organic acids - improvement of the quality of fruits and vegetables
   - rise in the content of the vitamin C

Effect of potassium on nitrogen metabolism

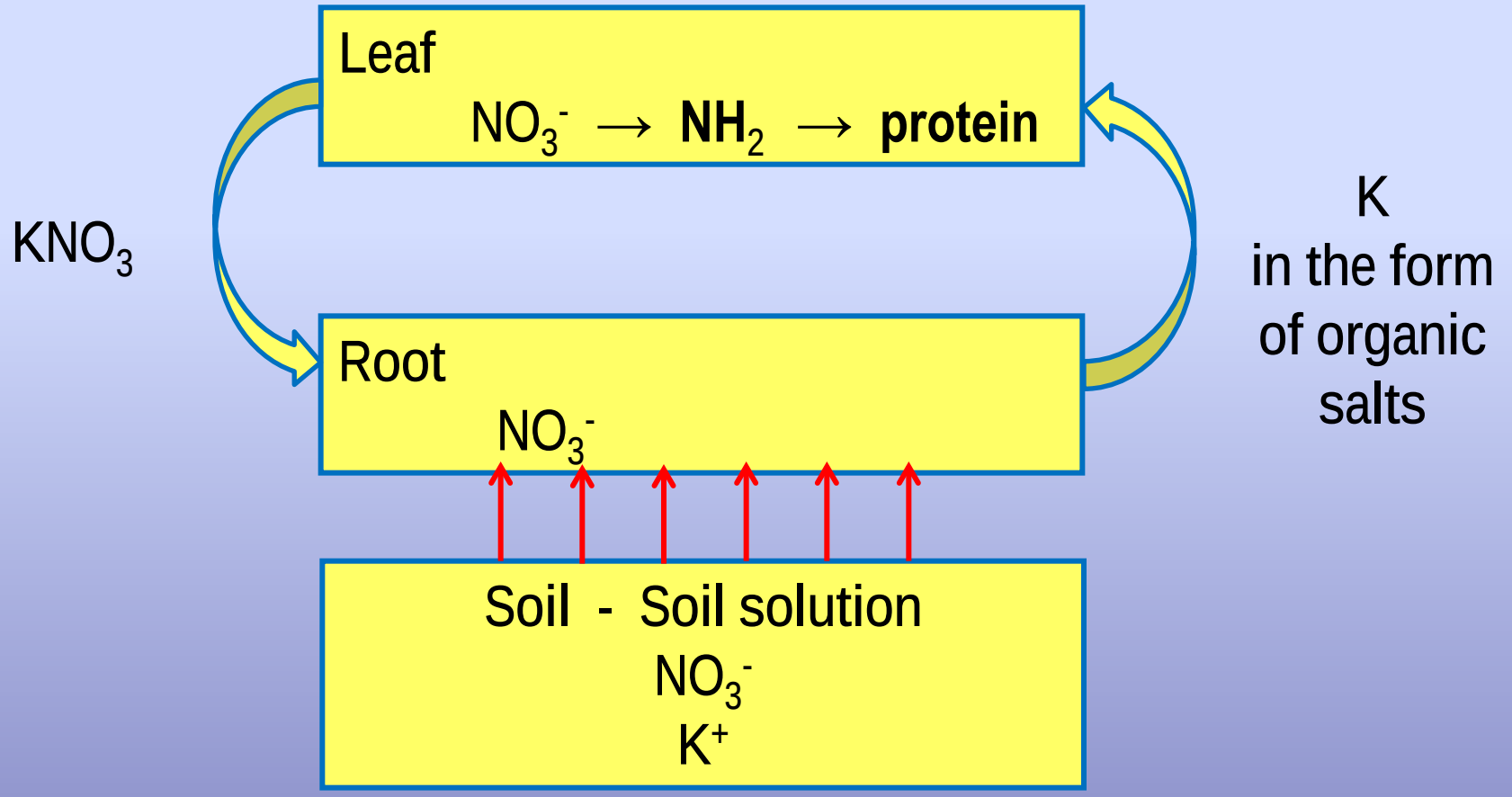
1. Reduction of high concentration of NH_4^+ in plant



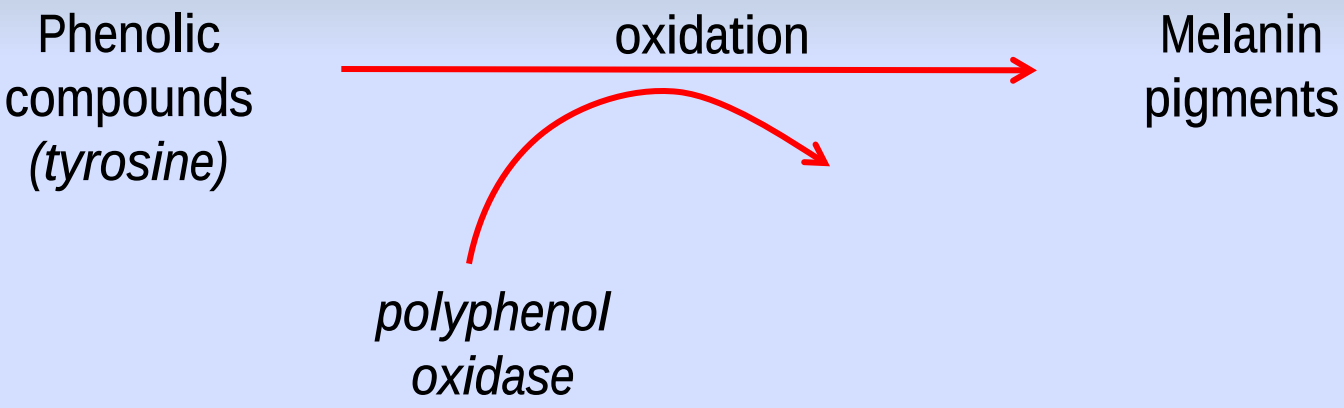
2. K deficiency in the leaves of plants causes symptoms of poisoning NH_4^+ ions
   - leaf chlorosis
   - necrosis
   - damage of shoots

Effect of potassium on nitrogen metabolism

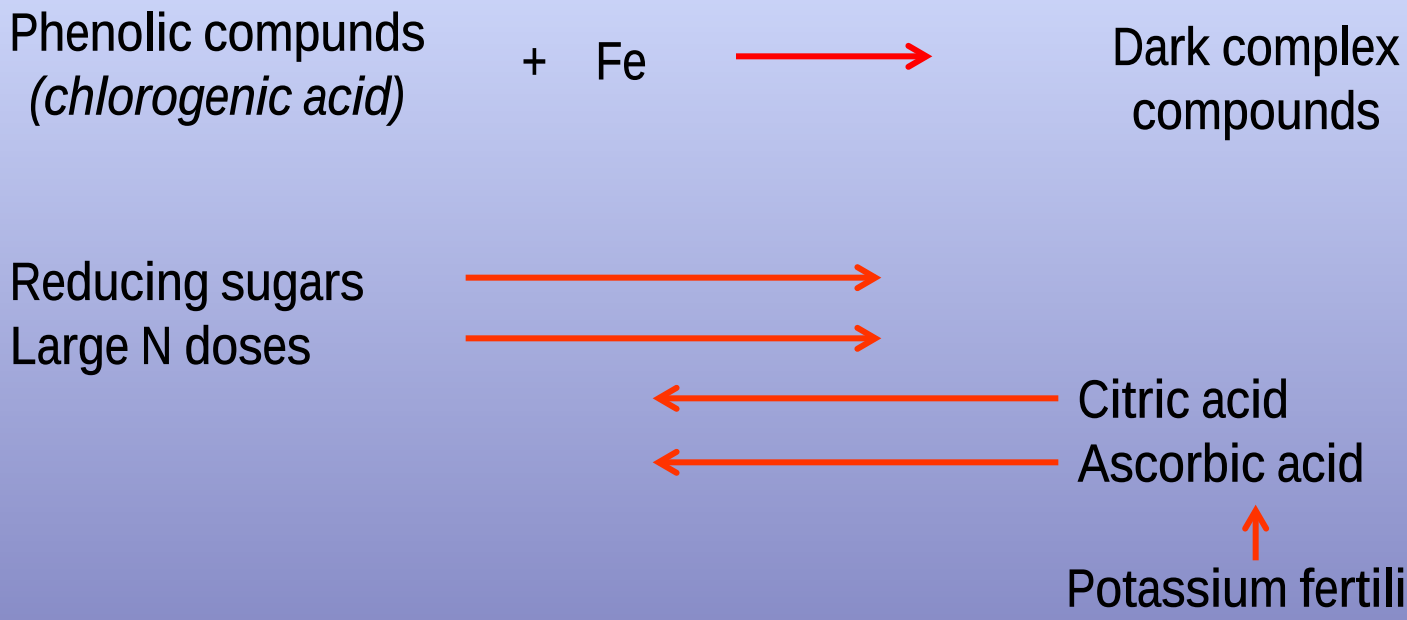
Reduction of nitrate in the roots of crops



Darkening of raw tuber flesh



Darkening of tubers after cooking



Effect of potassium on nitrogen metabolism

nitrosaminesa and potassium fertilization

In conditions of the K deficiency plants accumulate amines (e.g. putrescine)

Content of putrescine μM g^{-1} fresh matter

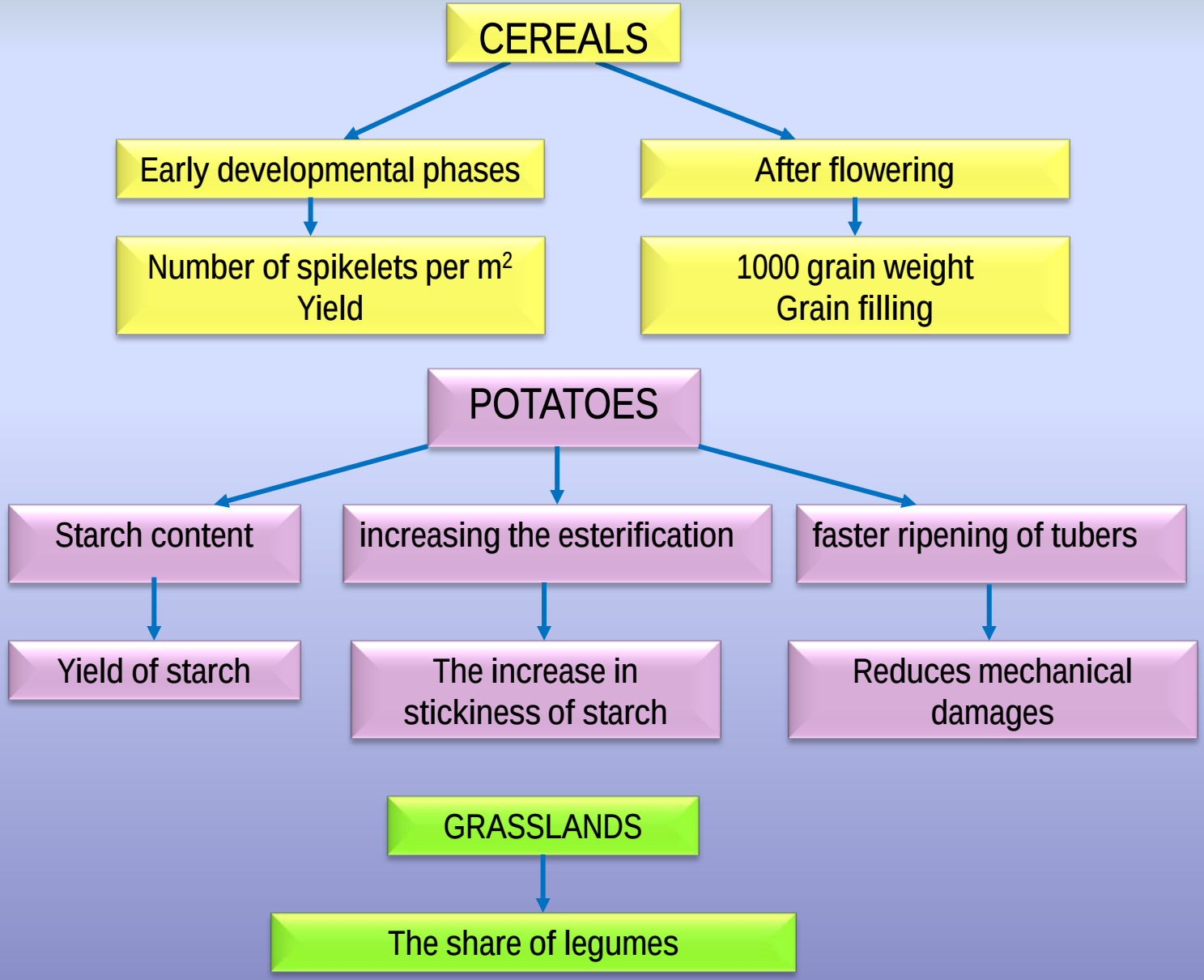
Plant with K deficiency	Plants well stocked with K	Ratio
8.7	0.21	41 : 1

amines + nitrates → nitrosamines

↑

strongly carcinogenic compounds

Phosphorus and yield quality



Effect of sulfur fertilization on selected parameters of wheat grain quality

Feature	Sulfur fertilization	
	- S	+ S
Total protein (%)	12.9	13.3
Glassiness of grain (%)	3.7	4.2
Gluten content (%)	22.9	23.6
Porosity of bread crumb (%)	72.7	75.6
Bread volume (cm^3)	293	334

[Podleśna i in. 2003]

Effect of soil and foliar fertilization on the content of zinc and qualitative composition of the protein in grains

Content in grain	Zn dose (kg ha^{-1})		
	0	7.5	7.5 + 0.33*
Zinc (mg kg^{-1})	11.8	13.2	24.7
protein polymers – glutenin (% of total protein)	36.3	36.7	38.5
Gliadyne (% of total protein)	46.1	45.4	41.5

* - foliar application

[Peck i in. 2008]

INTERACTION OF MINERAL AND ORGANIC FERTILIZATION

- ⇨ Indirect impact on the quality through the influence on the fertility of the soil

- ⇨ Organic fertilizers as a buffering agent to deficiencies or excesses of nutrients

- ⇨ Special significance
  - on sandy soils
  - in conditions of the extensive farming

WAYS OF THE QUALITY ASSURANCE OF THE CROP IN MINERAL FERTILIZATION

- INTERACTION OF MINERAL AND ORGANIC FERTILIZATION
- TERMS OF USE OF FERTILIZERS
- ENSURING THE BALANCE OF THE ELEMENTS IN FERTILIZATION
- ROLE OF TRACE ELEMENTS IN SUSTAINABLE AGRICULTURE