2016 ANNO INTERNAZIONALE DEI LEGUMI

UNIVERSITÀ DEGLI STUDI DI PALERMO

Dipartimento Scienze Agrarie e Forestali

Faba bean (*Vicia faba* L.) in cropping systems: results of 25 years of research in a Mediterranean environment

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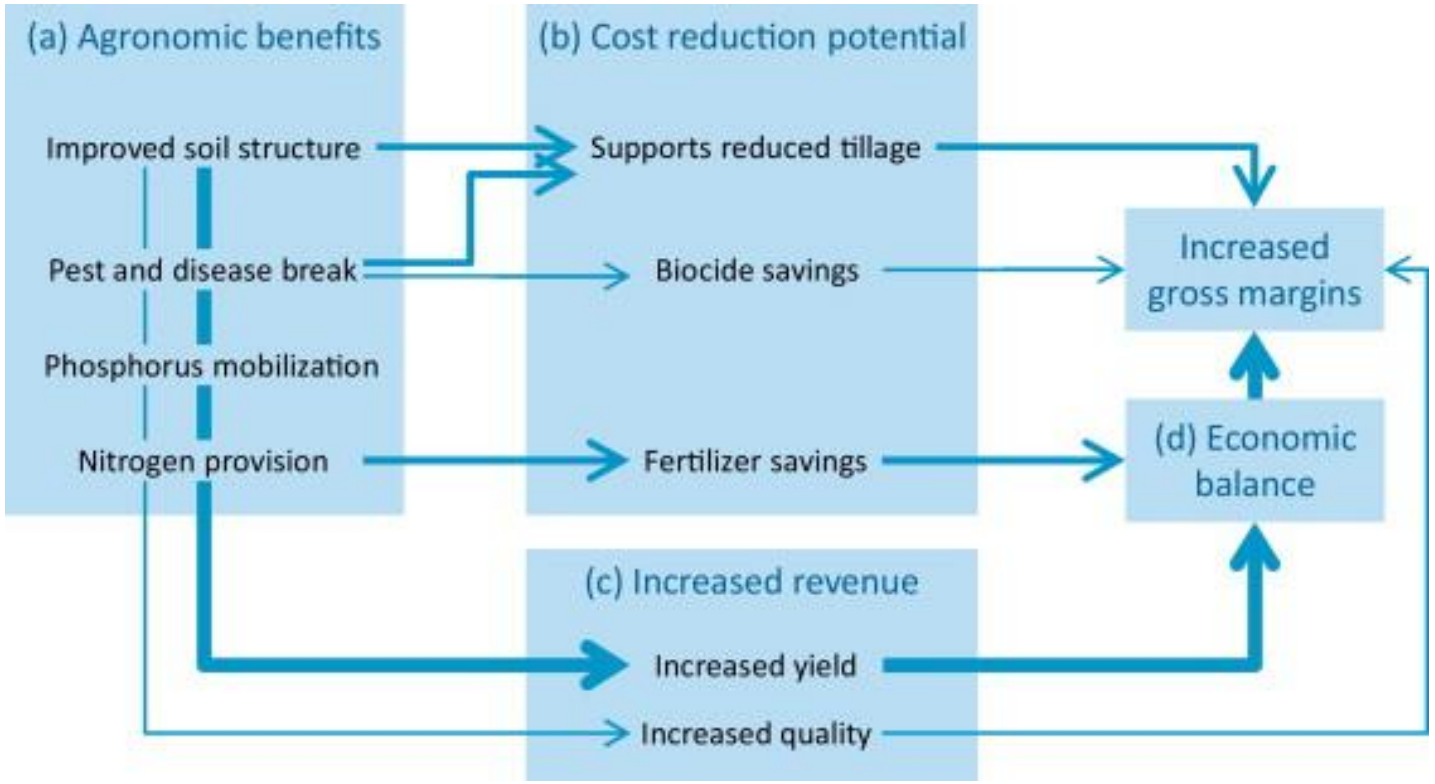
XLV Convegno Nazionale della Società Italiana di Agronomia
"La ricerca agronomica verso il 2030: gli obiettivi globali di sviluppo sostenibile"
20-22 Settembre 2016 - Università degli Studi di Sassari

Pre-crop benefits of grain legumes to cropping systems

Weight of arrows indicates farm-economic relevance of the effect



from Preissel et al. 2015. Field Crops Research 175:64–79

We analysed jointly the results from several experiments carried out by us during the last 25 years on faba bean

<u>Focus</u>:

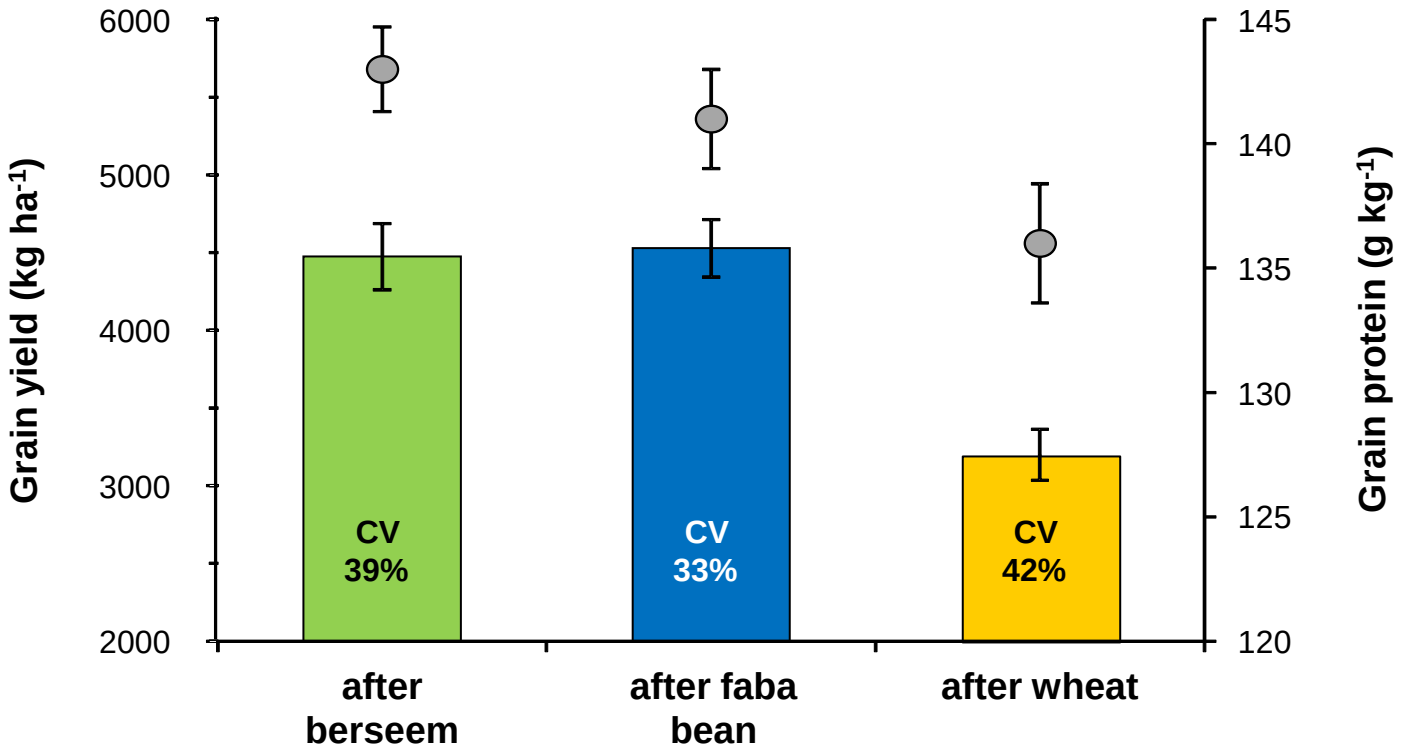
- Quantify faba bean pre-crop benefits
- Improve knowledge of the involved mechanisms

Information useful to maximize the potential value of faba bean within the Mediterranean cropping systems

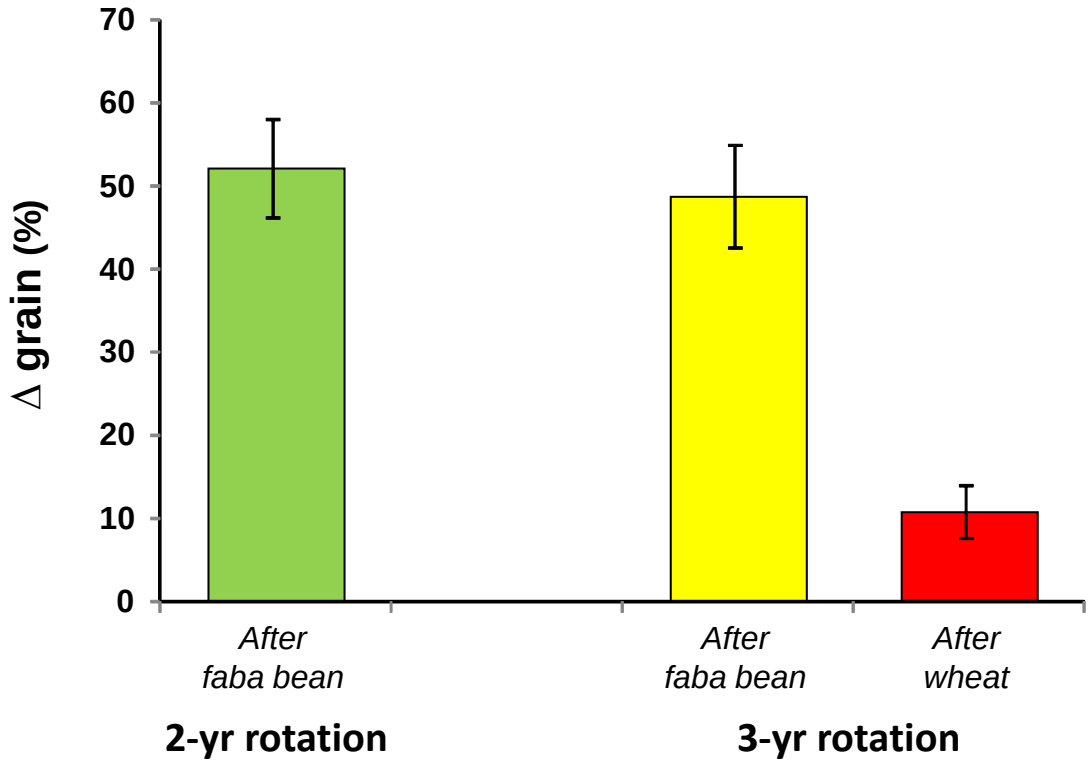
All experiments were conducted at the Pietranera farm

(Santo Stefano Quisquina, AG; 37°30’ N, 13°31’ E)

Effects of different crop sequences *(continuously applied for 25 yr)* on gran yield *(histograms)* and grain protein *(circles)* of wheat



Faba bean pre-crop benefits varying the duration of the crop rotation



The crop sequences were applied continuously for 6 years and data refers to the last 4 years of the experiment. Data are expressed as percent variation of the grain yield obtained in the continuous wheat

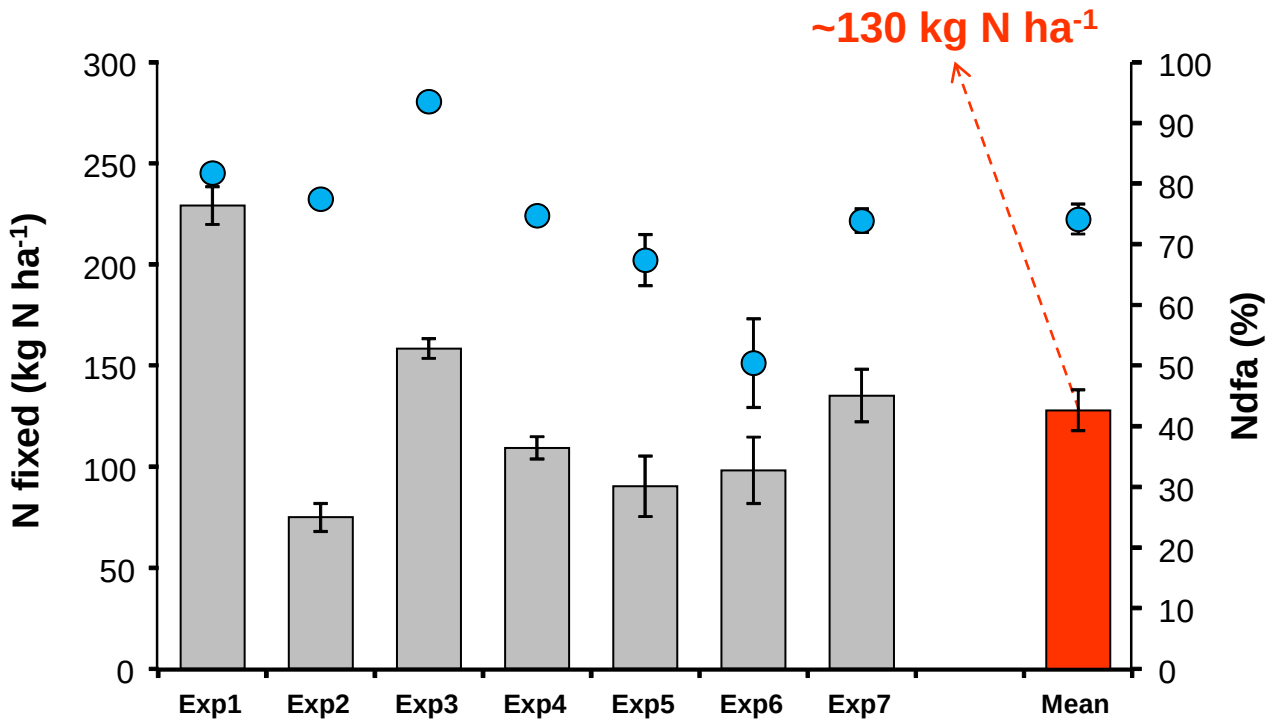
The advantage provided by faba bean to subsequent crops are attributed to:

- **non N-benefits**: *pest and disease break, reduction of weeds, enhancement of soil fertility*

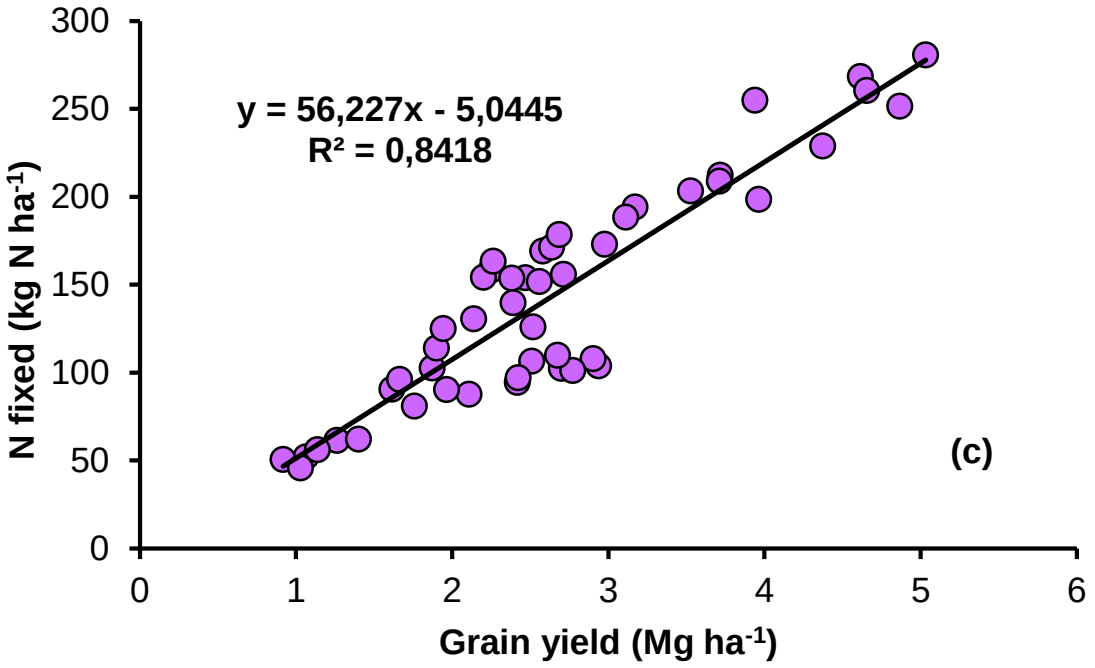
- **N-benefits**: *N-sparing, release of N from crop residues*

N_2 fixation

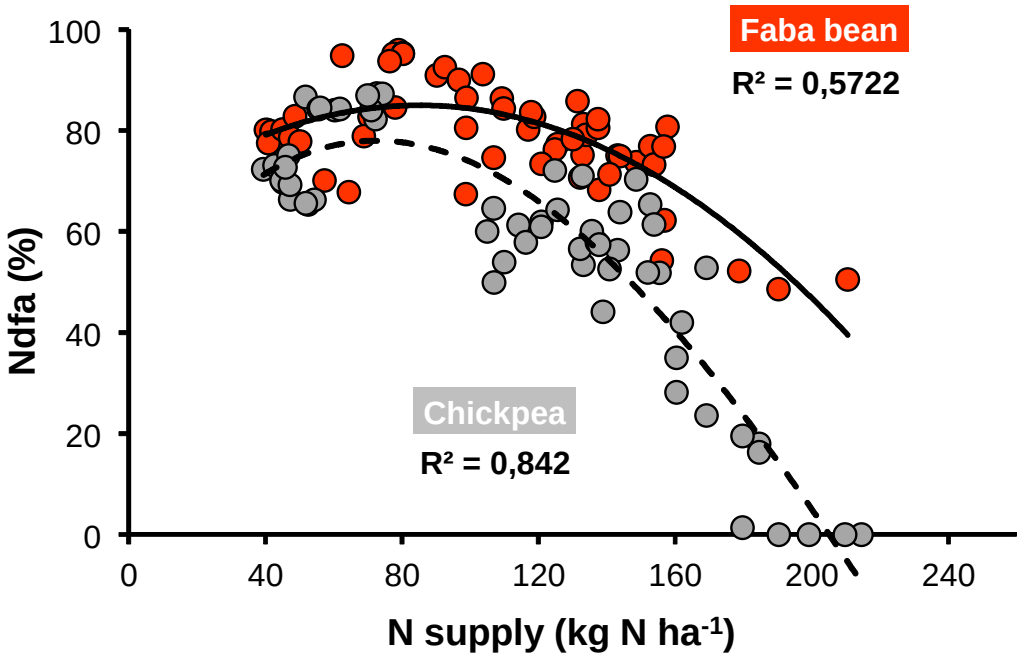
Proportion *(Ndfa, blue circles)* and amount *(gray histograms)* of N fixed by faba bean in seven different experiments



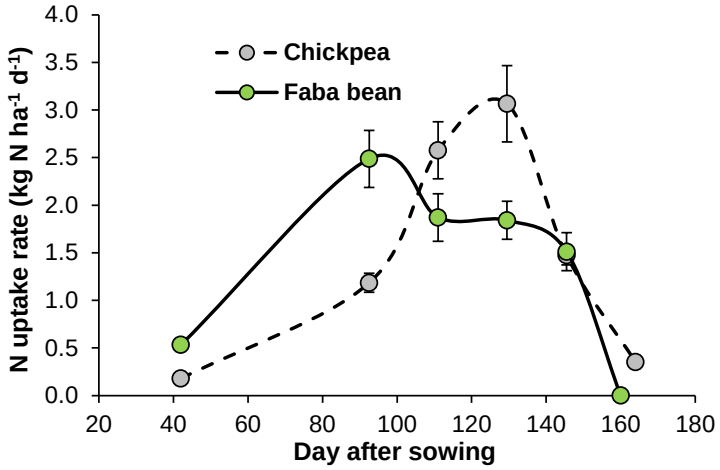
Relationships between the amount of N fixed and biomass yield of faba bean

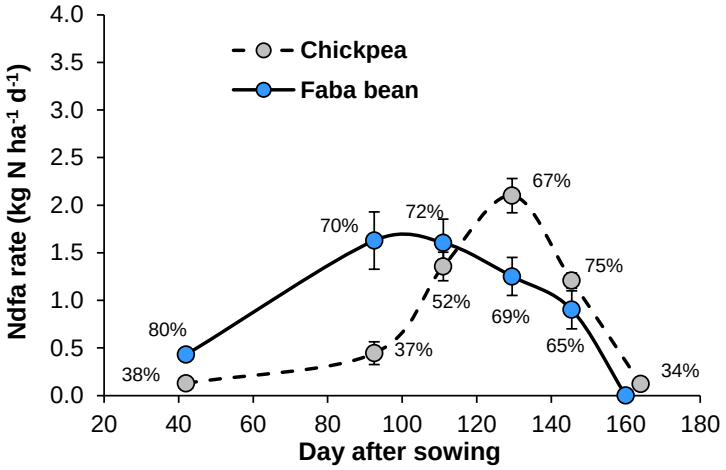


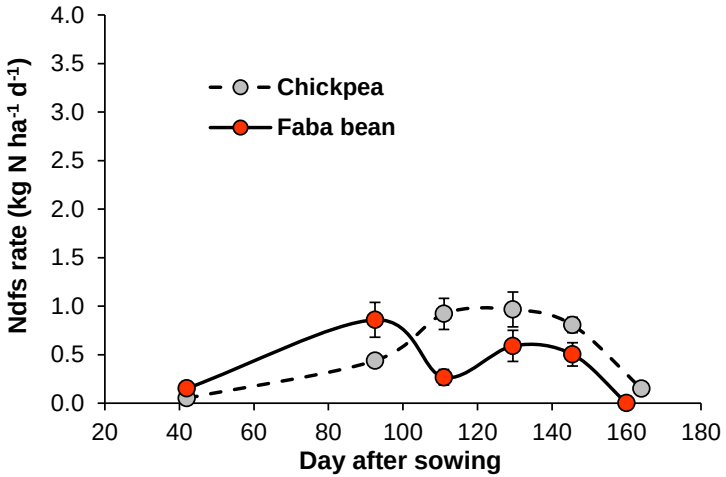
Relationships between the proportion of N in biomass derived from atmosphere (Ndfa%) and soil N supply



Rates of N uptake, N fixed, and N derived from soil for faba bean and chickpea



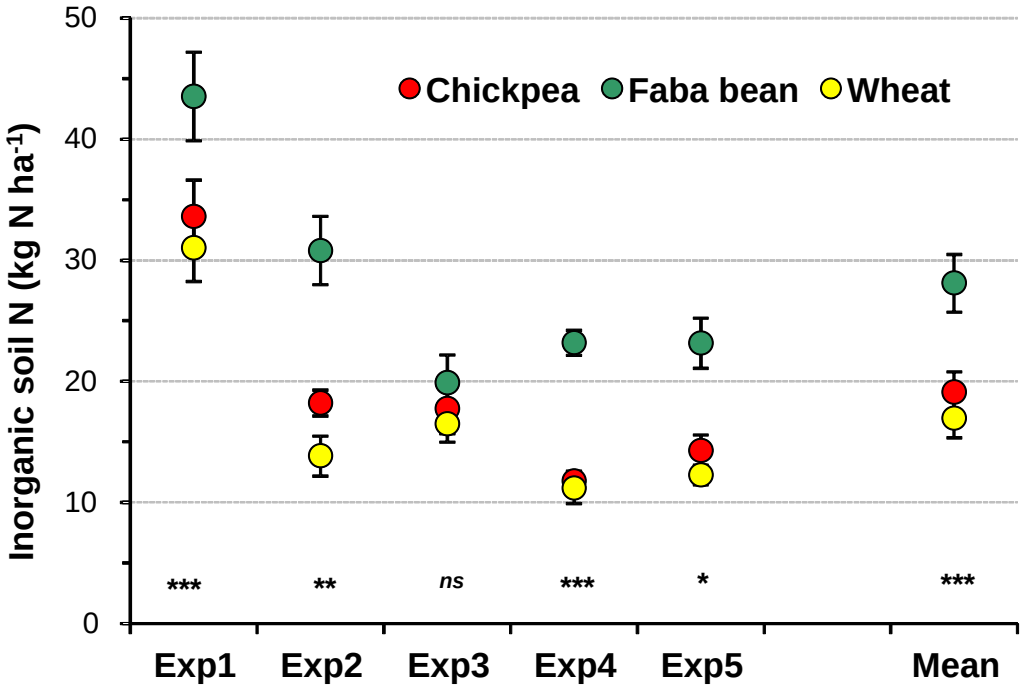




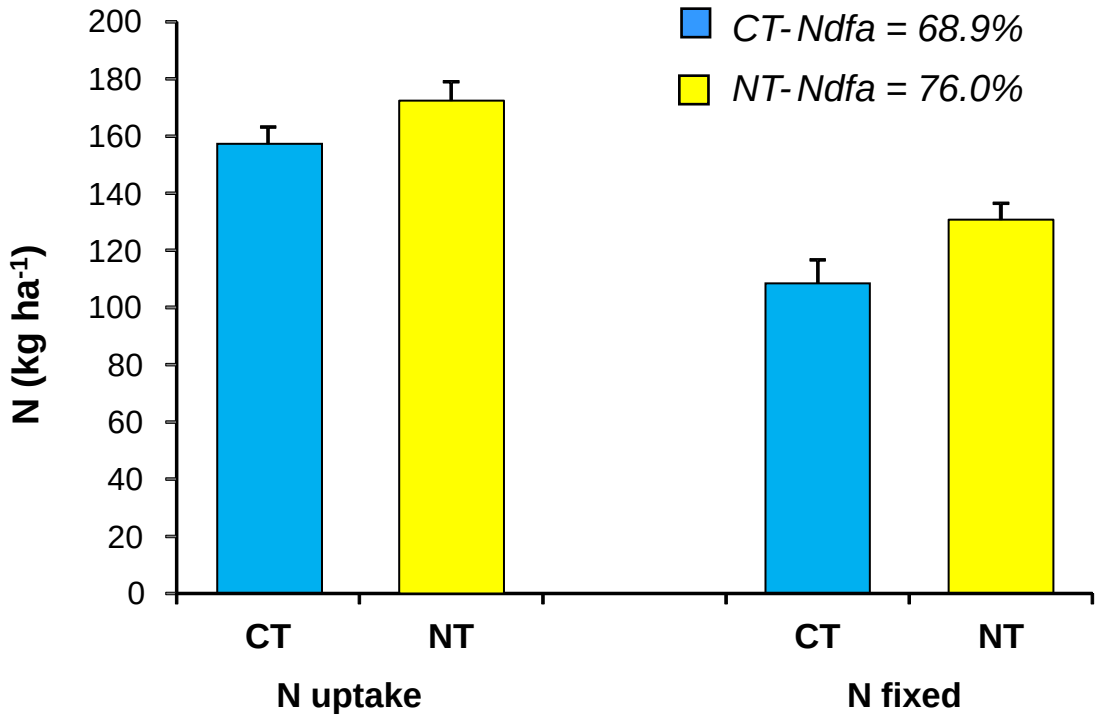
Faba bean:

- ✓ low ability in utilizing soil mineral N, especially during the late growth phases
- ✓ high reliance on N_2 fixation to satisfy its N needs
- ✓ increase of risks of environmental releases of not utilized N
- ✓ high levels of residual mineral N in the soil at harvest (*N sparing*)

Soil mineral N at harvest of faba bean, chickpea, and wheat (*N sparing*)



N uptake and N fixed by faba bean under different soil tillage technique: CT = conventional tillage; NT = no tillage *(N = 22)*



Effects of mycorrhizal symbiosis on growth, N_2 fixation, and N transfer of faba bean grown alone or in intercrop

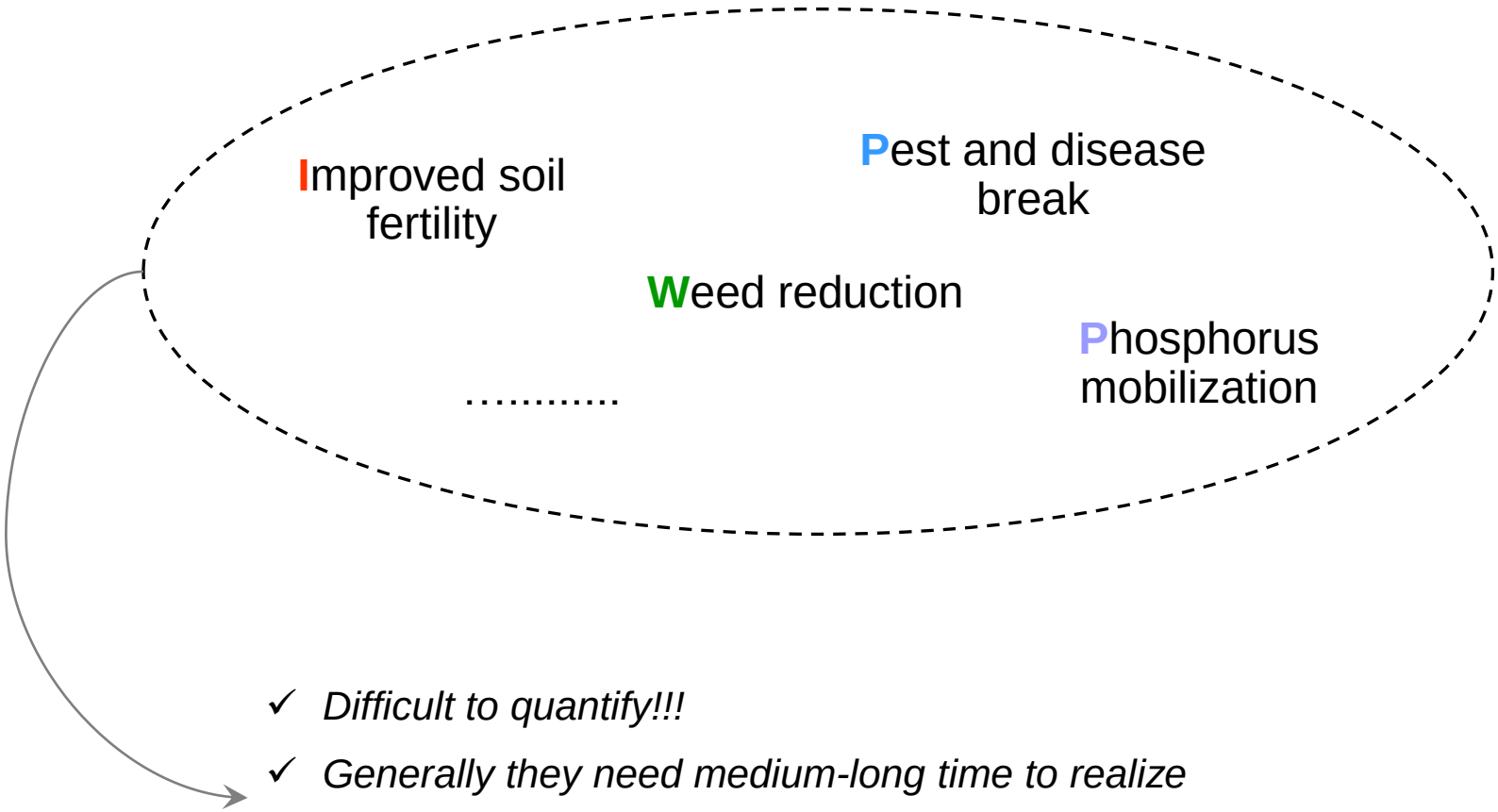
		Sole crop		Intercrop	
		+Myc	**-Myc**	**+Myc**	**-Myc**
Shoot biomass	*g DM per pot*	23.9	22.2	5.4	4.7
Root biomass	*g DM per pot*	6.7	6.5	2.2	1.9
Root density	*cm cm^{-3}*	1.34	1.27	0.35	0.30
Total N uptake*	*g N per pot*	0.57	0.50	0.12	0.09
Ndfa**	*%*	24.9	23.1	60.9	48.5
N transfer***	*%*	-	-	3.7	0.3
Mycorrhizal infection	*%*	39.1	1.2	60.6	2.6

**N in shoots*

*** N_2 fixation was estimated using the ^{15}N natural abundance method*

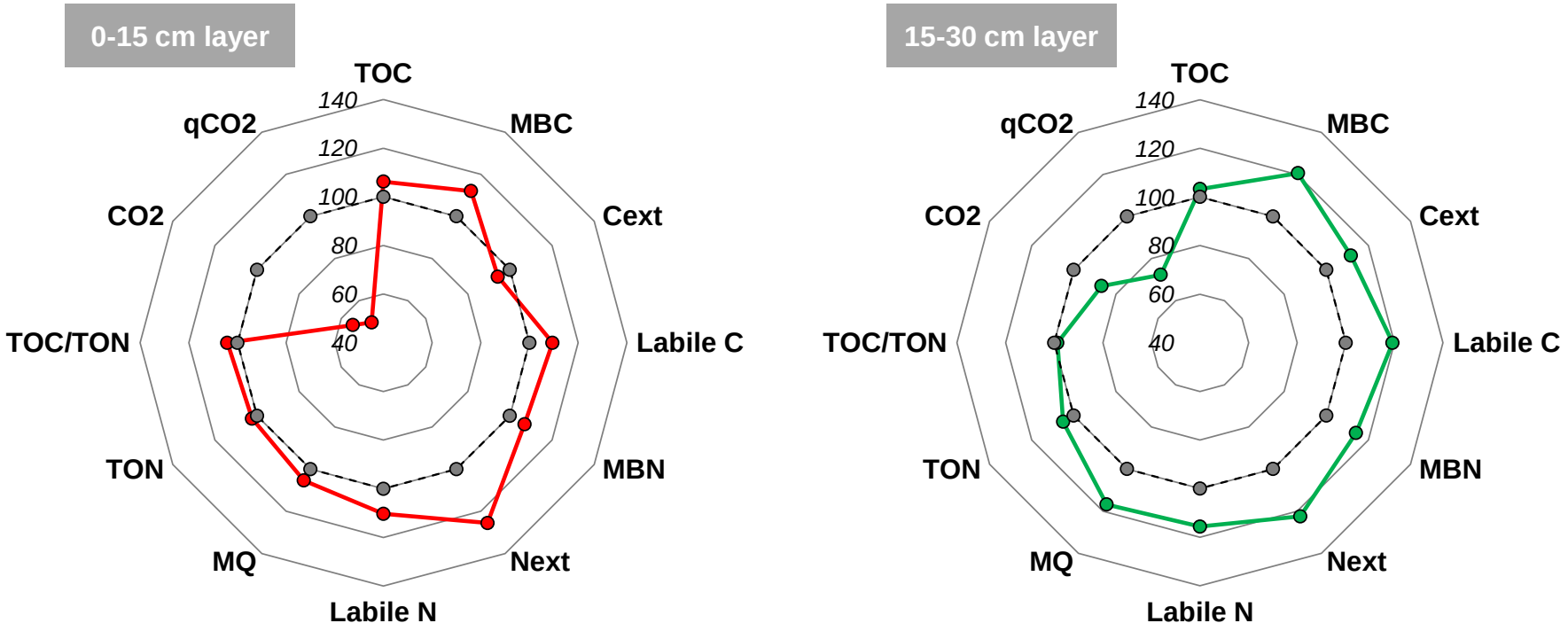
**** Estimated through labelling the faba bean by absorption of the ^{15}N-enriched solution via the stem. It indicates the proportion of faba bean N transferred to the associated wheat*

Non-N agronomic benefits



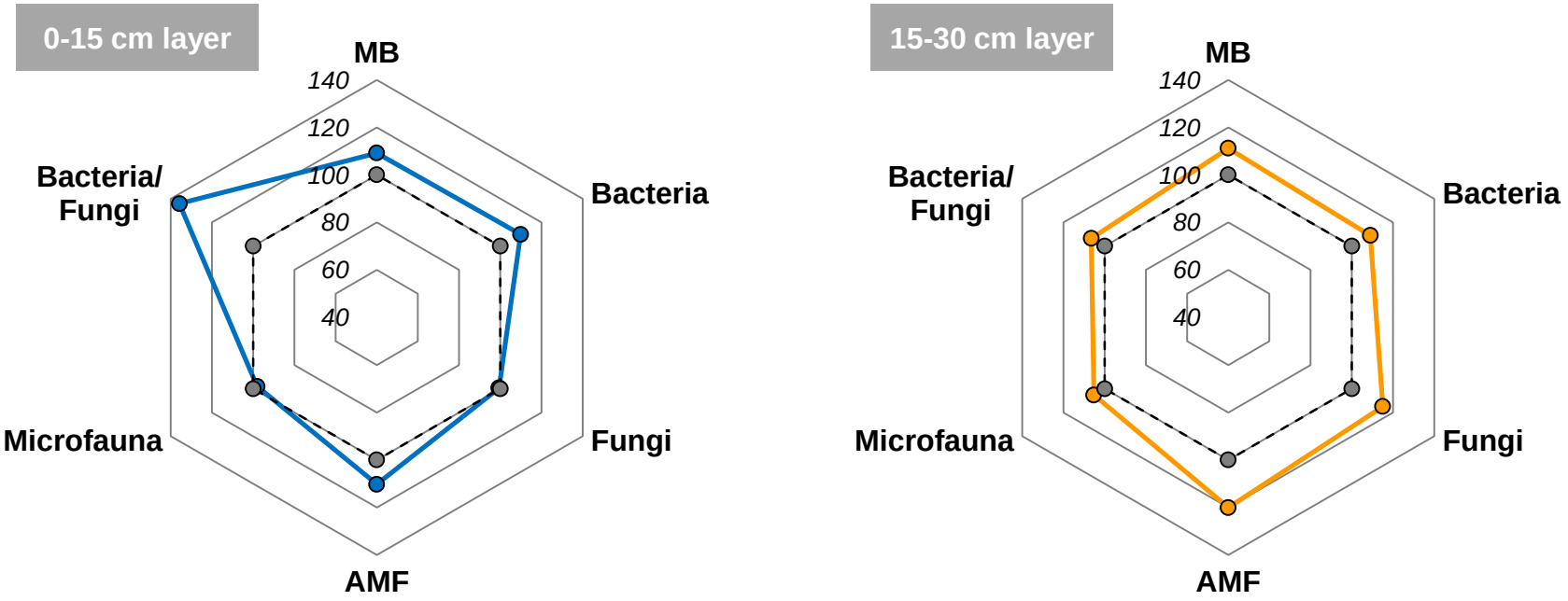
- ✓ *Difficult to quantify!!!*
- ✓ *Generally they need medium-long time to realize*
- ✓ *Data in literature often contradictory and acquired in non-Mediterranean environments*

Modifications of soil biochemical parameters *after 22 years of continuous application of different crop sequences: wheat-wheat (grey symbols); faba bean-wheat (colored symbols)*



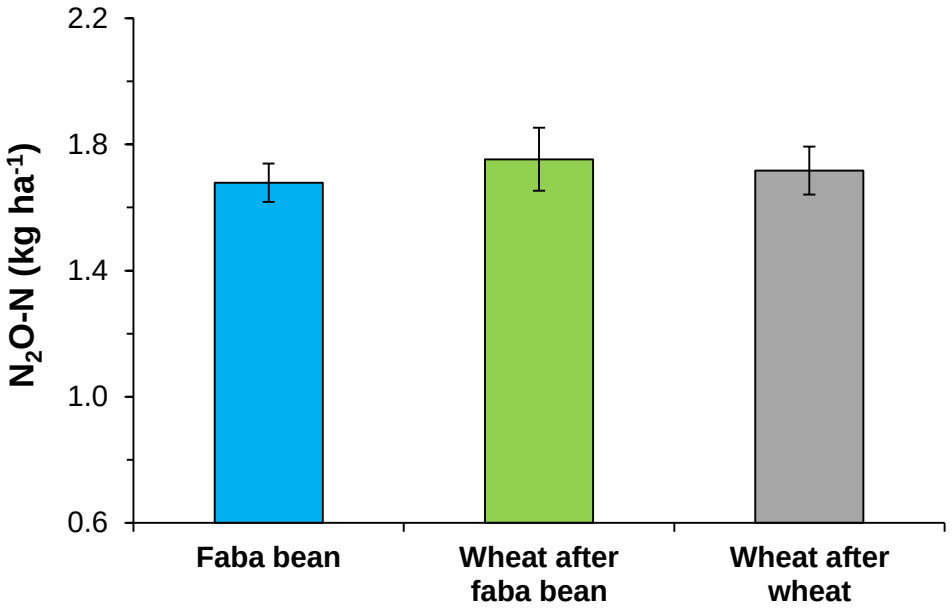
Results are presented relative to wheat-wheat crop sequence (=100%). TOC = total organic C; MBC = microbial biomass C; Cext = extractable C; MBN = microbial biomass N; Next = extractable N; MQ = microbial quotient; TON = total organic N; CO2 = basal respiration; qCO2 = metabolic quotient

Structure of microbial community *after 22 years of continuous application of different crop sequences: wheat-wheat (grey symbols); faba bean-wheat (colored symbols)*



Results are presented relative to wheat-wheat crop sequence (=100%). MB = microbial biomass; AMF = arbuscular mycorrhizal fungi

Total N_2O-N emissions from soils during the cropping season *(N = 12)*



***In faba bean marked reductions of NH_3-N losses** (that were related to the amount of N fertilizer applied) compared to wheat!!!*

Conclusions

- ✓ High ability in fixing N_2 (> than other Mediterranean grain legumes)
- ✓ Lower ability to use mineral soil N than other grain legumes. Such result may be linked to an asynchrony between soil N supply and N plant demand
- ✓ High reliance on N_2 fixation to satisfy N plant demand (values of %Ndfa high even at high levels of soil N supply)
- ✓ High levels of residual mineral N in the soil at harvest (N sparing always higher than other species)
- ✓ Great ability in establishing effective symbiosis relationships with AM fungi that positively influenced N_2 fixation and seemed to play also a positive role in N transfer to companion crops in intercropping systems
- ✓ The introduction of faba bean into cropping systems determines:
  - benefits for subsequent crops higher than other legume crops: yield, quality, and stability
  - general enhancement in soil quality, highlighted by an improvement in most of the bio-chemical parameters (TOC, TON, MBC, etc.)
  - changes in soil microbial community structure
- ✓ Considering the entire cropping system, faba bean, allowing to consistently reduce the use of N fertilizers for the subsequent crop, leads to a reduction of the anthropogenic N emissions


Thanks for your attention!