NUTRI-CHECK NET
OPTIMISING CROP NUTRITION

Deliverable 1.2
Report: Drivers, needs, challenges and barriers for farmers to improve arable crop nutrition and the adoption of nutrient management decision tools and technologies

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Report: Drivers, needs challenges and barriers in relation to arable crop nutrition and the adoption of nutrient management decision tools and technologies

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Public Summary

Agricultural industry stakeholders were engaged to assess the needs of farmers in relation to improving arable crop nutrition across the 9 partner countries involved in the NUTRI-CHECK NET. The main aim of this stakeholder engagement was to identify challenges and barriers to adoption of tools and technologies that could aid the growers of arable crops to improve the precision of nutrient management decisions.

The results show that most farmers are motivated to improve crop nutrition to gain increased yield and economic benefits. However, there are other drivers to manage nutrients on arable farms such as the need to meet market specifications for crops grown, to increase environmental sustainability, and compliance with environmental policy and regulations.

The main challenges and barriers to adopting tools and technologies on farms that help with nutrient management decision-making were lack of awareness by farmers, lack of education and skills and the high cost of the tools and low-income levels on farms that limits investment.

This information and consideration of the needs of arable farmers and the wider agricultural industry stakeholders will used by NUTRI-CHECK NET when developing a short list tools and technologies with high potential to improve crop nutrient management and increase crop nutrition levels. It will also help NUTRI-CHECK NET to focus on the key areas where support, information and education is required by farmers in the future, to reach their ambition to improve crop nutrition on their farms

Executive Summary

NUTRI-CHECK NET Task 2.1 report aims to capture the "**Drivers, needs, challenges and barriers for farmers to improve arable crop nutrition and the adoption of nutrient management decision tools and technologies"** across arable farms in Europe.

Arable farming industry stakeholder groups (total 971 individual stakeholders) were engaged across the 9 partner countries involved in the NUTRI-CHECK NET project; Denmark, France, Greece, Ireland, Lithuania, the Netherlands, Portugal, Poland, and United Kingdom.

Three groups of stakeholders were consulted using different methods. Members of (1) National Expert Groups (NEG) were interviewed (n=122), the (2) wider national stakeholder actors were surveyed (n=714) and (3) an evaluation workshop was conducted with the farmer Crop Nutrition Clubs (CNC's) (n=135 farmers).

The NEG's were comprised of arable crop industry representatives, farm advisors, agronomists, agri-media, researchers and policy makers. The national stakeholders were a wider group with a stake in agricultural crop production and nutrient management. The CNC's comprised of 5-10 farmers including some farm advisors and covered all partner countries.

This report summaries the results of the stakeholder engagement across the NUTRI-CHECK NET partner countries.

The drivers and motivations of farmers to improve the precision of crop nutrition were primarily driven by yield enhancement and improvements in economic outcomes. However crop market specifications and the desire for better environmental sustainability of crop production systems were also important to farmers. Environmental policy drivers were also identified as a motivation factor for farmers to improve nutrient management practices on their farms.

Broadly similar information was used by farmers across the different countries for calculating crop nutrient input requirements, indicating a somewhat similar basic process is being employed across the countries surveyed. However, the overall level of accuracy and precision in crop nutrient management decision making was perceived by stakeholders to by moderate or average. This indicates that significant improvements in crop nutrient management decision making and ultimately in crop nutrition outcomes are needed.

Significant challenges and barriers were identified for the adoption of tools and technologies to aid farmers to make best nutrient management decisions and more precise nutrient applications. These included awareness raising and education for farmers in order to build their skill sets and knowledge. The high cost of tools and access to independent research, advisory and knowledge support were also identified as challenges for adopting these tools and technologies.

Finally, many different actors who could help farmers to overcome these challenges and barriers were identified. Across all countries, farmers require access to professional advisors and agronomists and also to independent research organisations, educators and farmer training providers. In some countries industry representatives, policy makers and agri-contractors were identified as key actors that could potentially help farmers. This report serves as a current baseline status for crop nutrition management in Europe and highlights the various gaps and needs of farmers where support, information and education is required in the future, to reach their ambition to improve crop nutrition on their farms.

1. Introduction

NUTRI-CHECK NET is establishing a self-sustaining, multi-actor, thematic network which will improve the precision of crop nutrition across Europe by compiling nutrition decision tools, promoting farm-by-farm nutrient checking, and facilitating knowledge exchange amongst all relevant stakeholders package. Under work package (WP1) “stakeholder engagement”, Task 1.2 aims to capture the urgent needs of farmers in relation to nutritional decision tools and to identify the challenges and barriers for uptake of nutritional decision tools across European stakeholders. The NUTRI-CHECK NET partners span across 9 EU countries (Figure1); Denmark, France, Greece, Ireland, Lithuania, the Netherlands, Portugal, Poland, and United Kingdom.

Key stakeholder groups were consulted in each of the NUTRI-CHECK NET countries (n=9) in order to generate a clear understanding of farmers’ most urgent needs and drivers in relation to crop nutrition decisions. In addition, the challenges and barriers to adopting and using tools and technologies that aid nutrient management decision making were identified. The stakeholder groups consulted in each country were the National Expert Groups (NEGs), the

national stakeholder actors, and the farmer Crop Nutrition Clubs (CNC's). Three different stakeholder engagement methods; interviews, surveys and evaluation workshops were used.

These methods enabled NUTRI-CHECK NET to cross validate the responses submitted by the different stakeholder actors who participated to "Identify farmer needs and stakeholder drivers".

These results from this stakeholder engagement are presented in this report and help to establish the current status of nutrient management practices, including the information used as a basis for crop nutrition decision making and the challenges and barriers to adoption of crop nutrient management support tools and technologies on arable farms.

This report serves as a current baseline status for crop nutrition management in Europe and highlights the various gaps and needs of farmers where support, information and education is required in future. The information and outputs in this report will inform the work of NUTRI-CHECK NET when developing and disseminating appropriate information and solutions for farmers and other stakeholders to overcome the challenges and barriers identified.

Figure 1. Map of the 10 NUTRI-CHECK NETwork partner locations across 9 European countries

2. Objectives of this work

The overarching aim of the stakeholder engagement in NUTRI-CHECK NET Task 1.2 is to assess the primary needs and drivers for farmers to increase the precision of arable crop nutrition across Europe.

The objectives for Task 1.2 are to;

- capture the urgent needs of farmers in relation to crop nutrition and use of nutrient management decision tools,
- identify challenges and barriers for uptake of crop nutrition decision tools across European stakeholders
- provide feedback on stakeholder needs to the other NUTRI-CHECK NET work-packages (WP's)

3. Methods of stakeholder engagement

Three different stakeholder engagement methods were employed; interviews, surveys and evaluation workshops were used. These methods enabled NUTRI-CHECK NET to cross validate the responses submitted by the different stakeholder actors who participated (Task 1.2) to "Identify farmer needs and stakeholder drivers".

The stakeholder groups who engaged were as follows;

- National Expert Groups (NEGs): The members of the NEG in each partner country which composed the leading experts connected with arable crop nutrition including, researchers, policy makers, KT and advisory services, fertiliser industry, and technical teams in crop input industry, service industry including laboratory services etc, crop purchasers and technology and machinery supply industry. Interviews were conducted with the NEG stakeholder members individually in each partner country.
- National Stakeholder Actors: A survey of the wider stakeholders connected to arable crop production and crop nutrition was distributed through the stakeholder networks of each of the NUTRI-CHECK NET partners (see appendix 2). These stakeholders included a wider population of farmers, advisors, researchers, trainers, policy makers and industry representatives and was used to identify and capture the needs, drivers, challenges and barriers that may hinder the broader adoption of innovative tools to support nutritional decision making in each country or region.
- Crop Nutrition Club (CNC) Farmers: Finally, the members of the different CNC (arable farmers and farm advisors) were invited to participate in an evaluation workshop to

identify farmers views and their needs in relation to increasing the precision of crop nutrition in more detail.

3.1. Crop nutrition needs interviews with Nutrient Expert Group (NEG) members

- The first stakeholder group that were engaged to identify the needs and drivers of crop nutrition management were the National expert groups (NEGs) in each partner country. Each NUTRI-CHECK NET partner identified a NEG facilitator with good knowledge of crop nutrition and was motivated to help farms improve their crop nutrient management. The facilitators conducted the interviews either in-person, by phone or on-line (e.g. MS Teams), with each of the NEG members (n=122) and recorded the information provided in the responses from the NEG members to the questions posed, including ideas, views, & decision-making related to nutrient management and crop nutrition.
- The facilitators conducted these interviews with the NEG members between July and September 2023. Informed consent was established from all NEG participants.
- The facilitators acted as the main link between the stakeholders (stakeholder responses) and the wider NUTRI-CHECK NET and were the conduit for information exchange and dissemination between the other WP's and the NEG's.

3.2. Crop nutrition needs survey questionnaire for national stakeholders

- Within each country, the Task 1.2 coordinator from the partner institute identified a range of relevant stakeholders with a stake in crop nutrition management (up to 100 stakeholders in total per country).
- Although the survey was disseminated widely and open for all stakeholders to respond, the aim was to capture a range of stakeholders including farmers (n=35-40), advisors and agronomists (15-20), researchers (5-10), trainers (5-6), policy makers (n= 5-6) and industry representatives (10-15).
- The stakeholders were required to have a good knowledge of crop nutrition and crop nutrient management planning and, or, the implementation. Knowledge of the nutrient management planning process was considered essential and knowledge or working experience of decision support tools that support more precision in nutrient management was advantageous.
- Informed consent was established for all survey participants.
- The prepared on-line survey questionnaire of stakeholders needs for crop nutrition (Appendix 2) was sent to the stakeholders to complete during the months of July and August 2023.
- The Task 1.2 coordinator in each country followed up with these stakeholders to ensure that the on-line survey was fully completed prior to submission. Further clarification to vague responses to open questions was sought in some cases to ensure that there is clear comprehension of the key points made by the stakeholders.

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3.3 Evaluation workshop on farmers needs with the crop nutrition clubs (CNC's)

- The CNC facilitator's in each partner country organized a farmer needs evaluation workshop with each CNC to review the information collected during the interviews and surveys of the NEG and National stakeholder groups. The aim of this evaluation workshop was to gather the farmers views on the needs and drivers for crop nutrition management identified by these stakeholder groups in order help develop a final concise inventory of these needs.
- The CNC facilitator obtained informed consent from all CNC participants.
- The evaluation workshop guidelines included the format and questions and a standardized report form for collating the responses.
- The Task 1.2 leaders held training meetings with all CNC facilitators prior to the rollout of these evaluation workshops.
- These evaluation workshops took place during November- December 2023.

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4. Results

4.1. Stakeholder categories that responded

Figure 1 and 2 show a breakdown of the National Expert Group (NEG) stakeholders who were interviewed. In total 122 stakeholders were interviewed across the 9 EU countries that participate in the NUTRI-CHECK NET project. These stakeholders were categorized in to 7 stakeholder categories. Farm advisors and agronomists made up 47% of the stakeholders combined. The next stakeholder categories in order of decreasing share of stakeholders were researchers (17%), industry representatives (16%), farmers (12%) and policy makers (7%), respectively. Other stakeholders such as IT and media made up the remaining 1% of stakeholders interviewed.

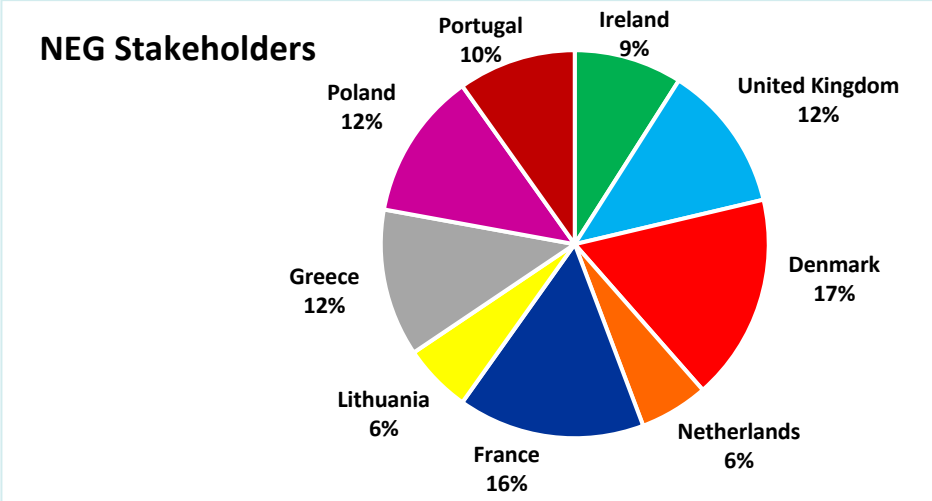

Figure 1. Proportion of the total NEG stakeholders who were interviewed (n=122) in each of the 9 partner countries.

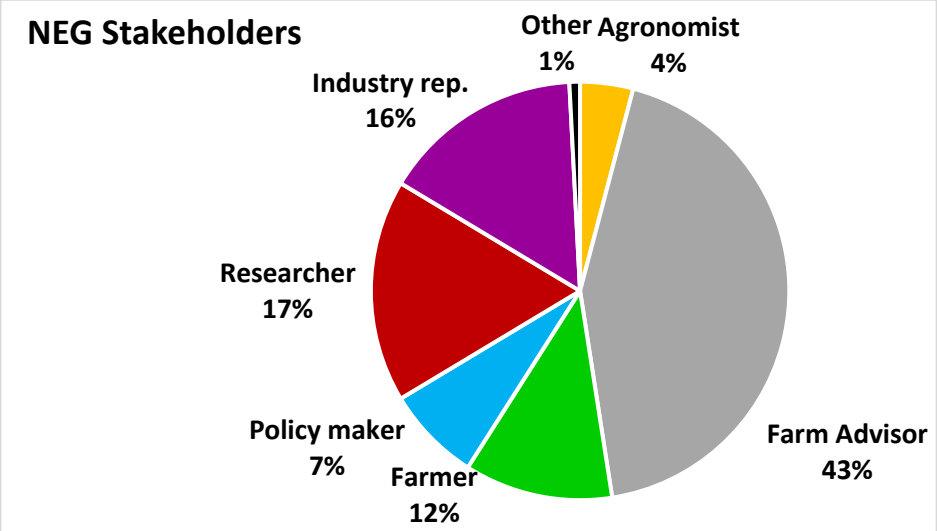

Figure 2. Proportion of the NEG stakeholders who were interviewed according to stakeholder category across the 9 partner countries.

Figures 3 and 4 show a breakdown of the wider stakeholders who responded to the farmer needs survey. In total 714 stakeholders completed the survey across the 9 EU countries that participate in the NUTRI-CHECK NET project. These stakeholders were categorized into 7 stakeholder categories. Farmers / Land managers made up the largest proportion of stakeholder respondents at 46%. The next stakeholder categories in order of decreasing share of stakeholders were farm advisors (19%), crop agronomists (11%), industry representatives combined (10%), researchers (9%) and policy makers (2%), respectively. Other stakeholders such as consumers and agri-media made up the remaining 3% of stakeholders who completed the survey instrument.

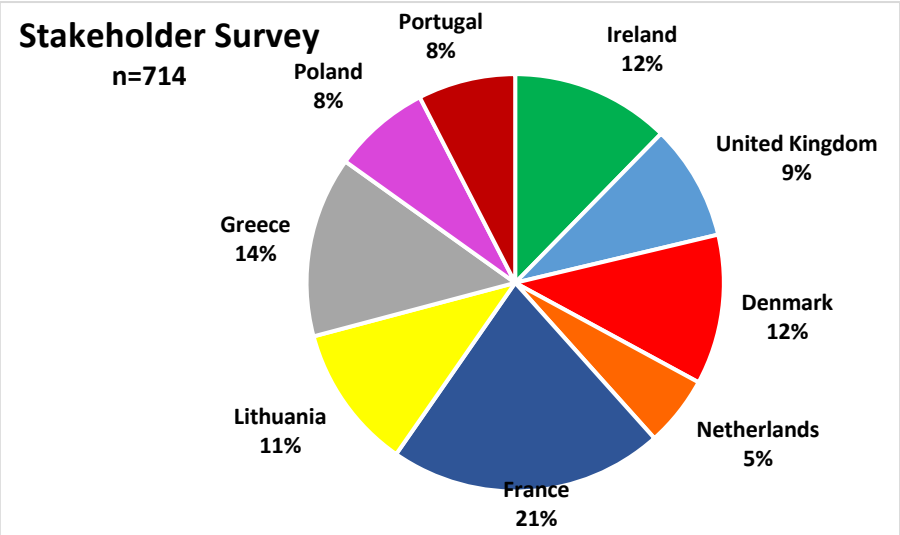

Figure 3. Proportion of the wider stakeholders who responded to the farmer needs survey (n=714) in each of the 9 partner countries.

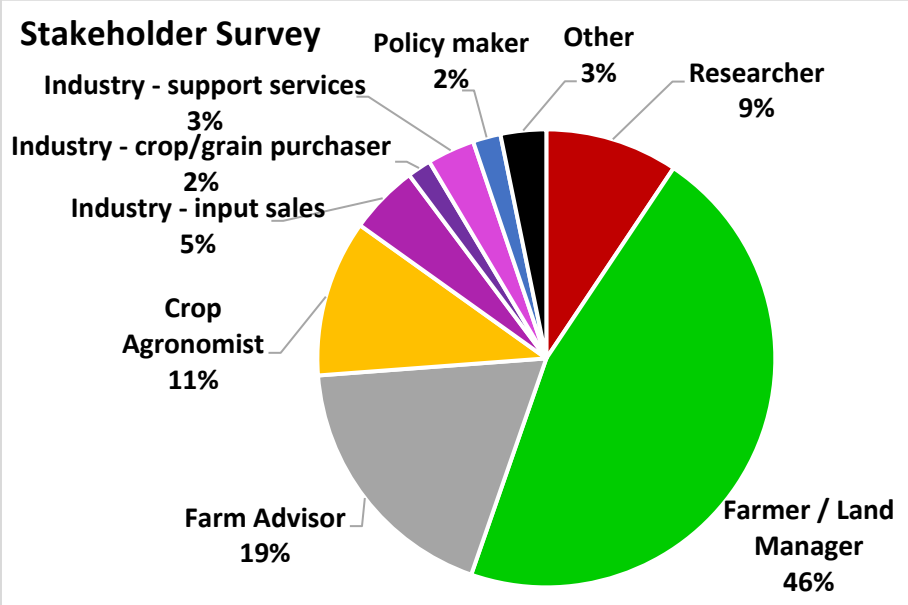

Figure 4. Proportion of wider stakeholders who responded to the farmer needs survey according to stakeholder category across the 9 partner countries.

4.2. Validation of results from the stakeholder engagement by farmers

Farmers members of the 26 CNC's across the 9 partner countries were asked about their motivations for improving crop nutrition and their needs to help improve nutrient management decision making at the CNC evaluation workshops. In addition, the farmers gave their opinions on the main challenges and barriers they face when adopting tools and technologies that may help them to make more informed decisions on crop nutrition management. At these evaluation workshops farmers expressed their need for "methods for translation data to actions". Farmers views concurred with those from the national experts (NEG interviews) and wider stakeholder survey responses on these needs, challenges and barriers. The farmer responses and consensus views to these questions confirmed and validated that the results presented in the following sections at national and across the 9 partner countries scales are representative of their main needs, challenges and barriers to adoption of tools and technologies to aid decision making on farms.

4.3. Main motivations and drivers of crop nutrition management

Across the different stakeholder groups surveyed the primary motivation for improving crop nutrition was to increase crop yield which is key driver of profitability (Figures 5 and 6), provided that variable and fixed costs of production are controlled. Other motivations of farmer engagement with crop nutrition management were to remain compliant with environmental regulation while farmers were also motivated by increasing the environmental sustainability of their crop production systems and farming businesses. Finally, farmers were somewhat motivated to improve crop nutrition in order to meet the market specifications for specific crops and to compare favorably when their performance was benchmarked compared to average industry norms.

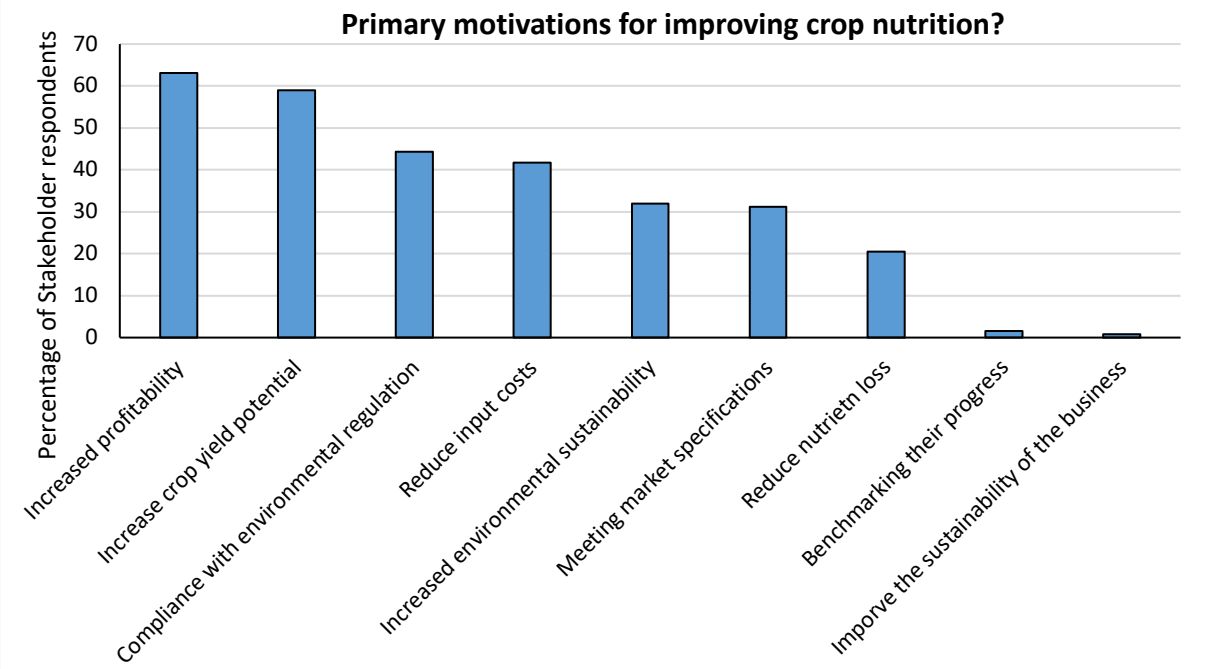

Figure 5. Percentage of NEG stakeholder responses indicating their perception of farmers primary motivations for engaging with crop nutrition management across the 9 partner countries.

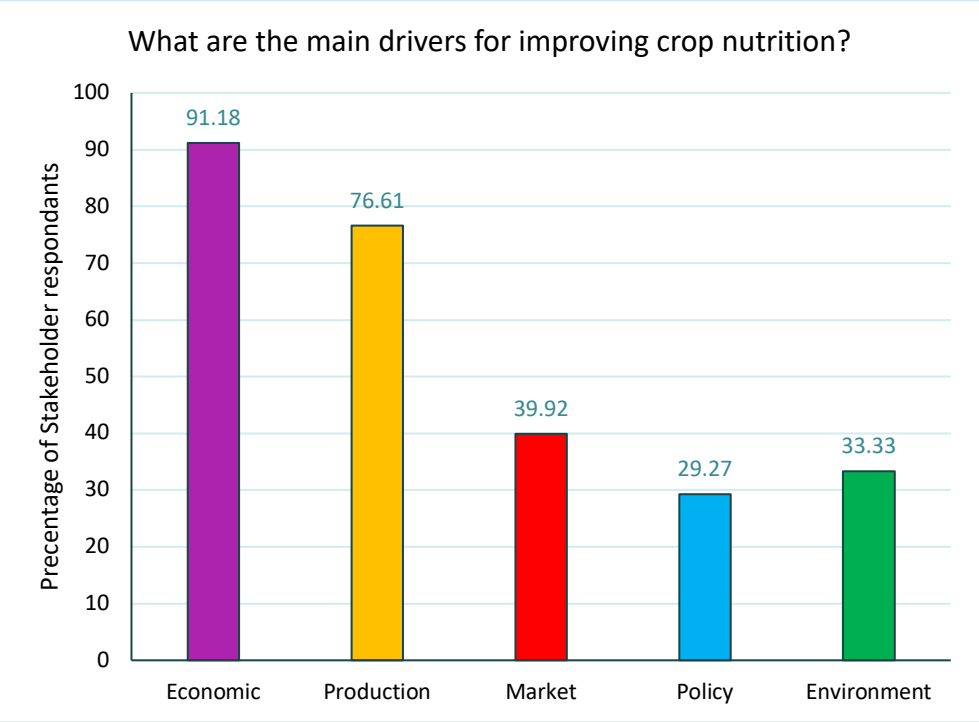

Figure 6. Main drivers for improving crop nutrition expressed by the stakeholders who responded to the wider stakeholder survey (n=714) across the 9 partner countries.

4.4. Key data and information used to make crop nutrient management decisions

There was much similarity and convergence between the 3 stakeholder groups responses around the key data that was used to make crop nutrient management decisions. Both soil type and analysis data and crop type and yield potential information were most widely used on farms (55-80%) across the different countries (Figure 7). Information on previous soil and crop management such as soil amendments, crop residues and organic manures were used on 30 to 35% of farms to help make crop nutrient management decisions. Environmental nutrient limits and nutrient balances were taken into consideration by ~30% of stakeholders, while only 10-15% of stakeholders used crop tissue or harvested crop (grain) analysis to help with subsequent crop nutrient management decision making.

The National Experts across all countries identified (1) soil nutrient analysis, (2) expected crop yield and (3) soil conditions as key information for calculating crop nutrient input requirements (Table 1). Soil type, previous crop type /rotation and previous organic manure applications were also identified as important information in most countries. The NEG members in Denmark Greece and Portugal indicated that crop tissue analysis was important information for calculating the crop nutrient inputs required, while crop residue management was only identified by Denmark Overall the NEG's and the wider stakeholders surveyed identified a core shortlist of similar information as a basis for calculating crop nutrient input requirements.

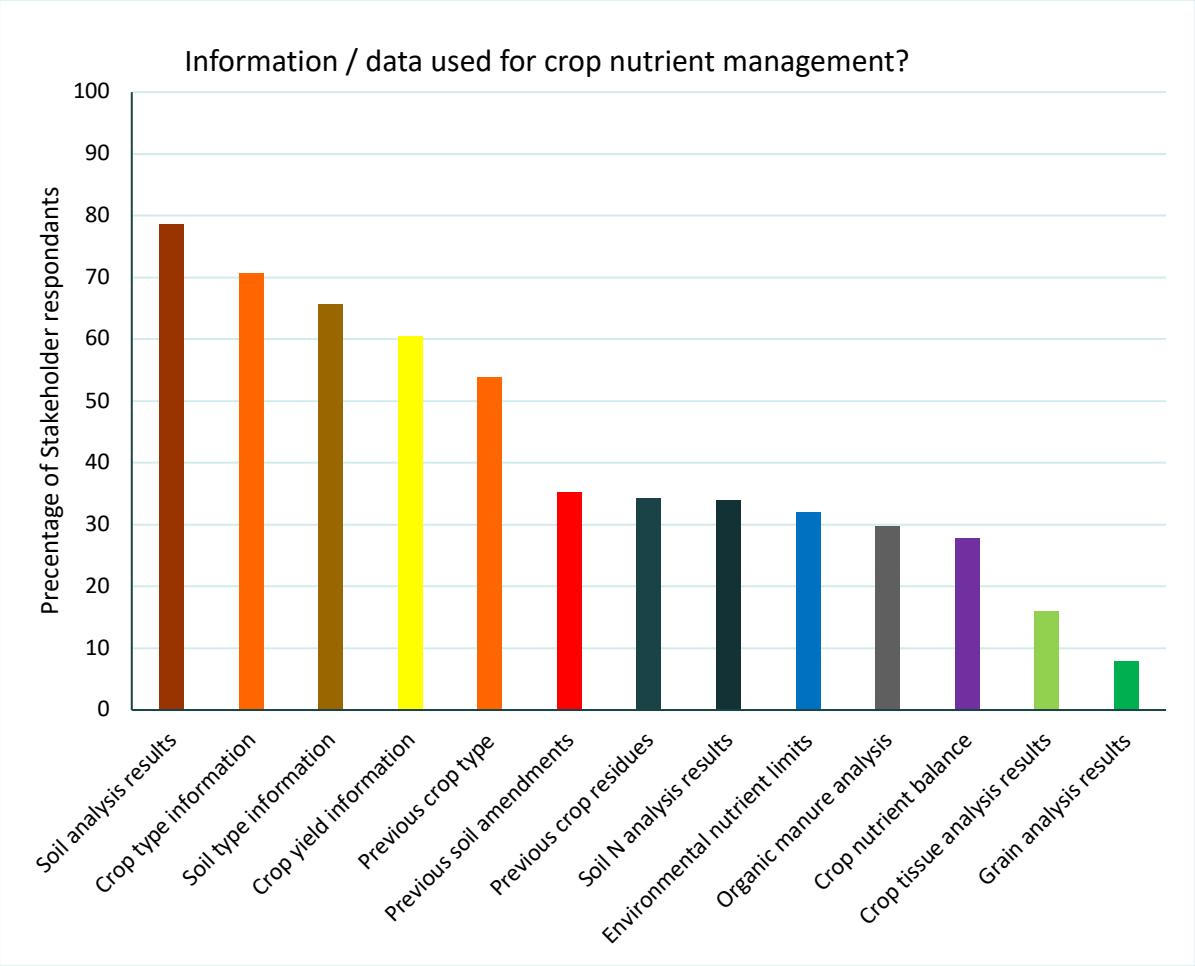

Figure 7. Key data and information used to inform crop nutrient management decision making for arable crop production according to the wider stakeholder survey (n=714) across the 9 partner countries.

Table 1. Most important information required for calculating crop nutrient input requirements according to the NEG members in each of the partner countries.

Information required for calculating the crop nutrient input requirements	Denmark	France	Greece	Ireland	Lithuania	Netherlands	Poland	Portugal	United Kingdom
Number of NEG Stakeholders that responded	*21*	*19*	*15*	*11*	*7*	*7*	*15*	*12*	*15*
				% of stakeholder responses					
Soil nutrient analysis	76.2	94.7	13.3	100	42.9	85.7	100	83.3	66.7
Expected crop yields	52.4	100	66.7	18.2	100	85.7	66.7	50.0	26.7
Soil type	76.2	100	73.3	-	28.6	57.1	33.3	16.7	26.7
Previous crop type /crop rotation	95.2	-	46.7	72.7	14.3	-	53.3	8.3	33.3
Organic manure application	47.6	89.5	20.0	45.5	28.6	28.6	53.3	-	13.3
Soil conditions	27.7	73.7	33.3	36.4	13.8	57.1	13.3	50.0	13.3
Past crop preformance	4.8	78.9	40.0	9.1	-	-	6.7	41.7	40.0
Crop tissue analysis	52.4	-	6.7	-	-	-	-	25.0	-
Crop residue management	4.8	-	-	-	-	-	-	-	-

4.5. Levels of accuracy and precision in crop nutrition decision making

In general, across the different stakeholder groups that provided responses for this analysis the majority perceived the overall levels of accuracy and precision in crop nutrient decision making as moderate (66.8%) (Figure 8). A further 17.1% indicated that they perceived the levels of accuracy in crop nutrient management as low. Just 15.6% of stakeholder respondents thought that high levels of accuracy were being achieved on farms across the EU.

However, when stakeholders were asked how they assessed the levels of accuracy the majority (between 55-58%) either compared current year crop yields with yields from previous years or made a judgement based on the visual appearance of the standing crop (Figure 8). These assessment methods are somewhat subjective and may not provide sufficient evidence to make an accurate assessment of crop nutrient success. Just 18-24% of stakeholders indicated that they used nutrient analysis information of plant tissue or the harvested crop parts to make their assessment of success in crop nutrition. While a further 18% of respondents indicated that they used no evidence to make such an assessment and only estimated or guessed their levels of success in crop nutrition management.

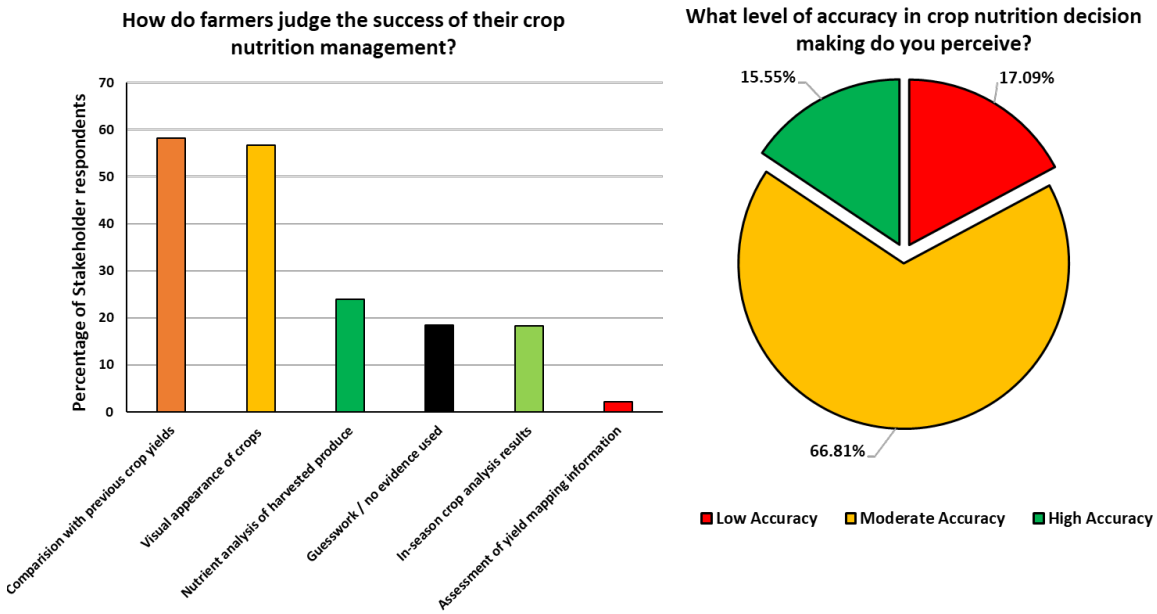

Figure 8. Percentage of the wider stakeholders surveyed (n=714) that indicated different methods for judging success of their crop nutrition management and the level of accuracy they perceived in crop nutrition decision making.

4.6. Challenges and barriers to adopting tools and technologies on farms

Stakeholders were asked to identify the main challenges and barriers to adopting tools and technologies that would help them to utilize the data and information that is being collected on their farms to improve decision making concerning nutrient management and ultimately improve the precision of crop nutrition. There was close agreement of the main challenges and barriers between the different stakeholder groups that were engaged.

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When these challenges and barriers to adoption were analyzed across all 9 countries (Figure 9), the cost of tools and technologies and lack of farmer awareness appeared to be the biggest challenge and barrier respectively. The need for improved education and capacity to interpret and action on the data or advice outputs from tools and technologies were also put forward by stakeholders as major barriers to achieving improved crop nutrition on farms. Other issues that were raised by the stakeholders were lack of time, low adoption rates related to farmer age, and technical issues with receiving analysis results or gaining access to the most appropriate fertilizers.

At a country level the challenges and barriers identified by the stakeholders in each of the individual countries closely mirrored one another (Table 2). One challenge that was identified in all countries was that farmers appeared to be somewhat removed from making the decisions on crop nutrition as farm advisors, agronomists and to some degree agri-contractors were developing the nutrient management plans (NMP) and applying the nutrients (fertilizers, manures, foliar treatments etc.).

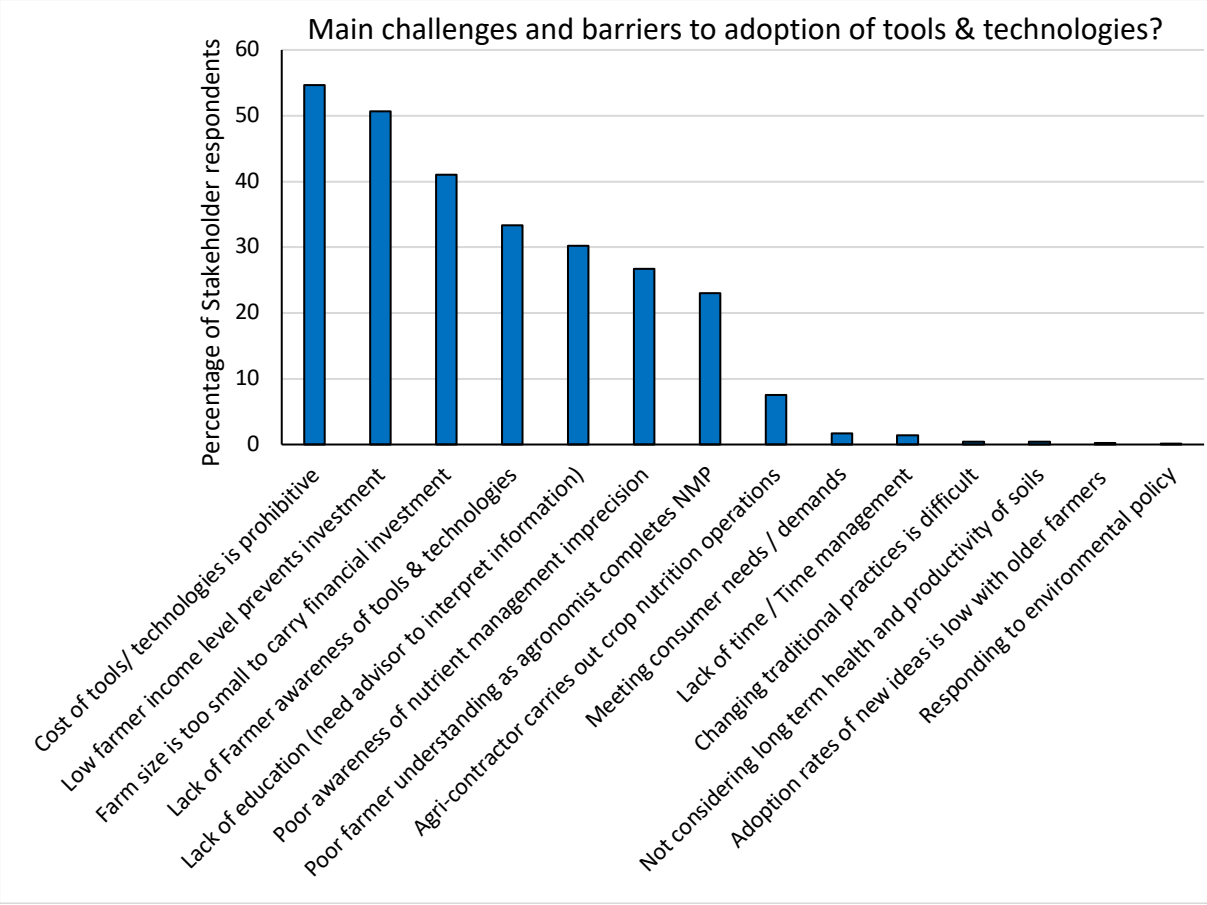

Figure 9. Main challenges and barriers to adoption of tools and technologies that support crop nutrient management decision making and improved precision in crop nutrition according to stakeholders surveyed (n=714) across the 9 partner countries.

Table 2. Main challenges and barriers to adoption of tools and technologies that support crop nutrient management decision making and improved precision in crop nutrition according to the NEG members in each of the partner countries.

Main challenges and barriers to adoption of tools and technologies	Denmark	France	Greece	Ireland	Lithuania	Netherlands	Poland	Portugal	United Kingdom
Number of Stakeholder that responded (n)	*83*	*152*	*100*	*88*	*80*	*39*	*54*	*54*	*64*
				% of stakeholder responses					
Cost of tools/ technologies is prohibitive	41.0	69.1	55.0	55.7	56.3	61.5	35.2	40.7	57.8
Low farmer income level prevents investment	36.1	38.2	69.0	55.7	67.5		55.6	59.3	62.5
Farm size is too small to carry financial investment	20.5	38.8	62.0	46.6	40.0		55.6	38.9	48.4
Lack of Farmer awareness of tools & technologies	19.3	31.6	61.0	29.5	32.5	17.9	29.6	33.3	31.3
Lack of education (need advisor to interpret information)	14.5	37.5	13.0	38.6	27.5	23.1	25.9	50.0	43.8
Poor awareness of nutrient management imprecision	27.7	36.8		33.0	33.8	28.2	48.1	1.9	28.1
Poor farmer understanding as agronomist completes NMP	33.7	18.4	21.0	29.5	5.0	48.7	1.9	14.8	32.8
Agri-contractor carries out crop nutrition operations	3.6	7.9	5.0	12.5	8.8	7.7	16.7	3.7	15.6

4.7. Farmer needs and key people that can support farmers to increase the precision of crop nutrition.

The National Experts perceived that education and awareness raising of crop nutrition and demonstration of tools were the key needs of farmers to increase the precision of crop nutrition in all countries (Table 3). In addition, the experts thought that farmers also needed independent research results on crop nutrition to help make informed choices and access to a farm advisor or agronomist for guidance, except in Greece, the Netherlands and Portugal. Access to finance for investment in tools and technologies were identified as potential needs of farmers in Denmark, Greece, Lithuania, Poland and Portugal. Incentives from government to help improve nutrient management in line with environmental targets were perceived as needs of farmers in Greece, Ireland, Poland, Portugal and the United Kingdom.

The wider stakeholders identified key needs of farmers to overcome these challenges and barriers to increasing the precision of crop nutrition which are summarised in Figure 10. The needs of farmers perceived by the National Experts are in-line with the wider stakeholders views.

In responding to the main challenges and barriers, needs such as education on crop nutrition, upskilling in using IT to help farmers improve their interpretation of data and information were identified. Improved awareness raising of effective tools and technologies and information on the cost – benefit of these tools, were identified as key stakeholder needs. Access to finance and financial incentives to help farmers access tools and technologies were identified as key needs to overcome the cost barrier. Finally, access to independent research results was also identified, as this would help build farmers trust and confidence in tools and technologies that aid in the crop nutrient management process.

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Table 3. Key needs of farmers to increase crop nutrition according to the NEG members in each of the partner countries.

Key needs of farmers to increase the precision of crop nutrition in each country	Denmark	France	Greece	Ireland	Lithuania	Netherlands	Poland	Portugal	United Kingdom
Number of NEG Stakeholders that responded (n)	*21*	*19*	*15*	*11*	*7*	*7*	*15*	*12*	*15*
				% of stakeholder responses					
Education on soil fertility and crop nutrition	57.1	84.2	73.3	63.6	42.9	14.3	47	33.3	40.0
Improved IT skills	-	-	6.7	-	-	-	-	-	-
Availability of independent research results	14.3	36.8	-	100	28.6	-	40.0	33.3	33.3
Availability of economic cost-benefit information	4.8	10.5	-	-	-	-	6.7	-	13.3
Awareness-raising and demonstration of tools	23.8	31.6	53.3	63.6	28.6	42.9	26.7	16.7	13.3
Access to Farm Advisor / Agronomist	9.5	31.6	-	72.7	28.6	-	33.3	-	20.0
Independent crop nutrition advice	4.8	-	-	18.2	-	14.3	13.3	25.0	-
Incentives for government (meeting env. targets)	-	-	6.7	27.3	-	-	13.3	16.7	6.7
Incentives from industry (e.g. sustainability bonus)	-	-	-	-	-	-	-	16.7	-
Access to finance for tools & technologies	4.8	-	60.0	-	42.9	-	33.3	25.0	-

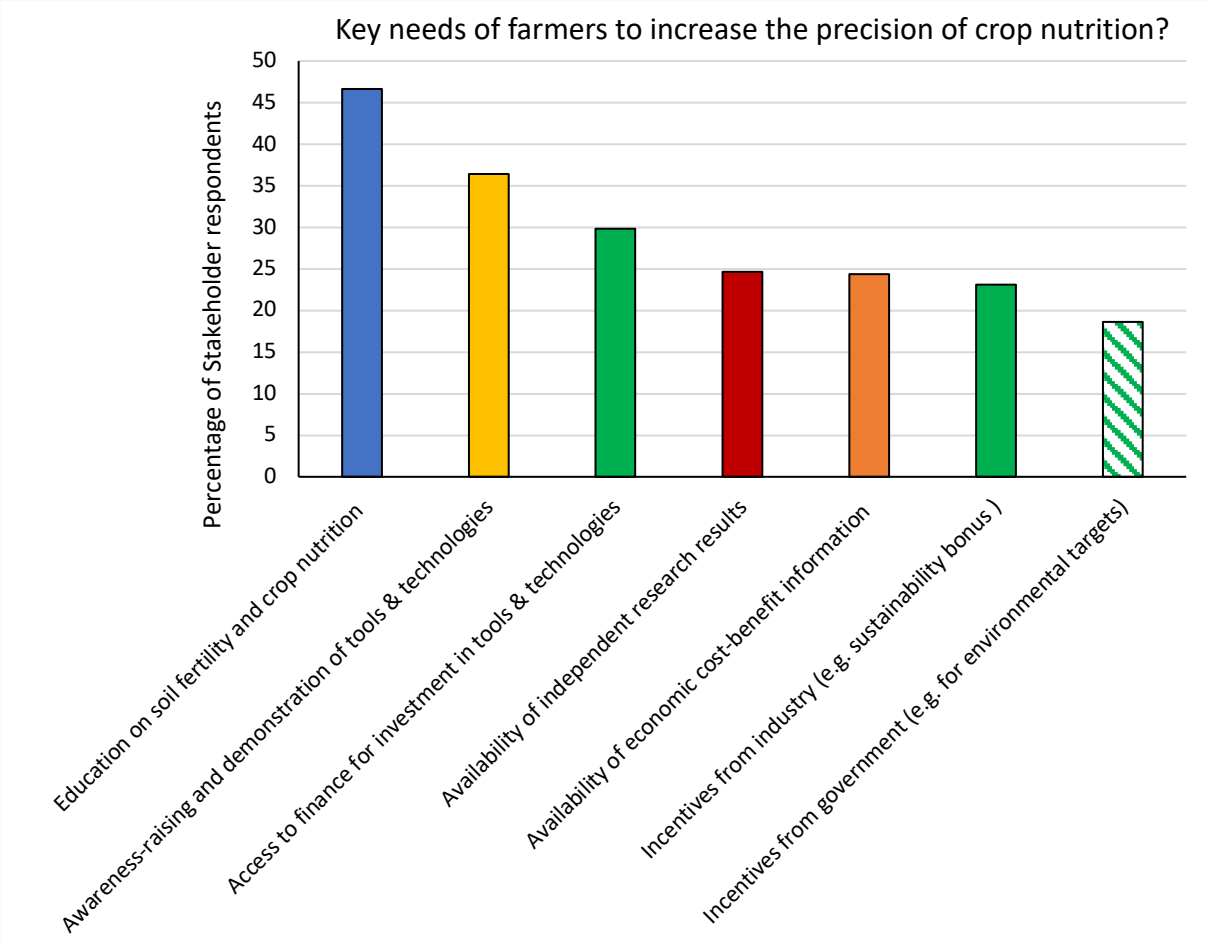

Figure 10. Key needs of farmers to increase crop nutrition according to the wider stakeholders (n=714) across the 9 partner countries.

Key stakeholder groups that can help farmers meet these needs are summarised in Table 4 for each partner country. Professional farm advisors / agronomists were the main stakeholder group identified by the majority of respondents. Agricultural universities and training organizations were also identified as important in all countries as they can help farmers to respond to the education and training needs identified (Figure 10). Agricultural researchers were identified as important for providing independent assessment of tools and developing independent nutrient advice for farmers. Industry representatives were also identified as being important in helping farmers to meet their needs while agri-contractors and national or local media were identified as also playing a lesser but yet important role in supporting farmers to meet their need in order to improve nutrient management and increase crop nutrition precision.

The National Experts expressed the view that support from stakeholder groups on farms "must be farmer driven and farmer led". They agreed that professional "impartial" farm advisors are best placed to provide one-to-one support for farmers as they will have knowledge of proven best practices. The Experts view was that "advice must be independent" to achieve effective outcomes of improving crop nutrition status. This approach will also put the farmer at the center of the decision making process and build their knowledge capacity and skills in this area. However, the National Experts recognised the need for farmer education as "without training an increase in the precision of crop nutrition will be much slower to achieve"

Table 4. Key stakeholders who can best support farmers to meet their needs in order to improve precision in crop nutrition according to the wider stakeholders surveyed (n=714) in each of the partner countries.

Key stakeholders who can best support farmers to meet their needs	Denmark	France	Greece	Ireland	Lithuania	Netherlands	Poland	Portugal	United Kingdom
Number of Stakeholder that responded (n)	*83*	*152*	*100*	*88*	*80*	*39*	*54*	*54*	*64*
				% of stakeholder responses					
Professional farm advisors / agronomists	78.3	80.3	63.0	33.0	78.8	79.5	75.9	70.4	28.1
Agricultural University & Farmer training providers	57.8	21.1	80.0	51.1	57.5	-	44.4	74.1	53.1
Agricultural researchers & organisations	45.8	42.1	27.0	29.5	43.8	84.6	27.8	51.9	28.1
Policy makers	24.1	-	31.0	13.6	30.0	17.9	13.0	11.1	-
Industry - farm input sales	27.7	-	17.0	4.5	27.5	5.1	35.2	13.0	3.1
Industry - support services	0.0	-	36.0	18.2	13.8	23.1	14.8	24.1	15.6
Industry - crop purchasers (incl. grain/crop trade etc.)	13.3	-	10.0	-	-	7.7	18.5	-	-
National / local media	7.2	-	9.0	0.0	7.5	-	13.0	7.4	-
Agri-contractors	10.8	-	9.0	10.2	15.0	23.1	20.4	-	-
Consumers / General society	7.23	-	18.00	-	-	-	9.26	1.85	-

5. Summary

This document outlines the key drivers, needs, challenges and barriers to improve the precision of nutrient management and increase the crop nutrition on arable farms across 9 countries representing different regions in Europe. The responses from the different stakeholder groups and engagement methods converge to provide a relatively clear indication of farmer needs and the barriers to adoption of tools and technologies to aid crop nutrition decision making on arable farms.

In general, the information currently used by farmers across the 9 countries involved in this assessment was broadly similar for calculating crop nutrient requirements. However, the perceived levels of accuracy and precision with respect to crop nutrient management decisions was identified by the stakeholders as moderate on average. This indicates that there is considerable room for improvement in crop nutrient management on farms.

The main challenges and barriers to adopting tools and technologies that could help farmers to make better decisions or improve the accuracy of nutrient applications identified by the different stakeholders were high their high cost, low farmer income level, poor farmer awareness, poor education levels and reliance of farm advisors, agronomists and agri-contractors who make key crop nutrition decisions on behalf of the farmer.

The information gathered will be used to inform the inventory of farmers needs for crop nutrition management and challenges and barriers to adoption support tools and technologies on farms. This inventory will be used to inform the tasks in other NUTRI-CHECK NET work packages. This information will enable the NUTRI-CHECK NETwork to gain new insights to the strengths and weaknesses of current approaches to nutrient management planning and practical implementation and to help the wider network to respond the most urgent needs in each country or pedo-climatic region. The network will build new understanding of why different approaches, tools and technologies have been adopted by farmers and farm advisors to help them make crop nutrition decisions, and also why others have not been adopted. This information will also help to further evaluate the readiness and adoptability of the shortlisted crop nutrition tool and technologies being compiled by NUTRI-CHECK NET.

Appendix 1.

Survey questionnaire for the National stakeholders

Each survey questionnaire will take approximately 15 minutes to complete

A more standardized approach to stakeholder responses are sought using the check box and multiple choice answers supplied.

The survey questionnaire will be made available using an on-line survey platform

NUTRI-CHECK NETwork (Task 1.2) **- Crop nutrition needs survey**

- **Aim of this stakeholder survey is to assess the main needs, drivers and barriers for farmers to increase the precision of crop nutrition.**
- **Please answer all questions. This survey will take approximately 15 mins to complete**
- **Responses to this survey will only be used by the NUTRI-CHECK NET project team**
- **Individual responses provided will remain anonymous**

Section 1: Stakeholder information

Project purpose, participation and confidentiality procedures

Project Purpose: The NUTRI-CHECK NET project (funded by the EU Commission through Horizon Europe funds (Project: 101086525) and also through UKRI) aims to maximise site-specific precision in managing the nutrition of arable crops across Europe.

Participation: Stakeholder participation is voluntary. Participants are free to ask questions of the consortium without negative consequences.

Confidentiality procedures: For surveys participants will be asked complete on-line questionnaires or surveys which will be recorded, stored and reported anonymously, according to the project's data protection procedures. Project reports and publications will only include anonymized data. At the end of the project, anonymized data may be retained and used by consortium partners but still in accordance with the project's data privacy policy; it may be shared for use in further research, but will not be sold.

Personal data: Any personal data collected from participant to this survey will be recorded and stored in accordance with the General Data Protection Regulation (GDPR).

I freely agree to participate in this study
Yes

E-mail
*

This form is collecting emails.

Name (*names will only be used by NUTRI-CHECK NET project administration and all responses will remain anonymous)*

Country *(also in include region if applicable using "Other" below)*

Denmark
France
Greece
Ireland
Lithuania
Netherlands
Poland
Portugal
United Kingdom
Other…

What stakeholder group best describes you in relation to your interaction with crop nutrition management?

Farmer/Land manager
Farm Advisor *(Technical & Business)*
Agronomist *(linked with Agri-business)*
Industry - support services *(e.g. laboratory, financial, business, technology, machinery etc)*
Industry - farm input sales *(e.g. seeds, fertilisers, plant protection products etc.)*
Industry - grain/crop purchasers *(incl. grain/crop commodity trading, food processor etc.)*
Policy maker *(regulator, schemes / incentives etc)*
Other…

Briefly describe your direct role in relation to crop nutrition management? *e.g. I develop crop nutrient management plans for farmers etc.*

Open text answer

Are you a member of a NUTRICHECK Crop Nutrition Club (CNC)?

Yes
No

Are you a member of a NUTRICHECK National Expert Group (NEG)?

Yes
No

Section 2. Farmer motivations and information used for crop nutrition management planning

What are the top 3 drivers for farmers to improve crop nutrition in your country or region?

Production *(e.g. increased crop yield)*
Economic *(e.g. increased profitability, increased return on investment)*
Market *(e.g. meeting market specifications for grain)*
Environment/Sustainability *(e.g. contribute to better environmental outcomes)*
Policy *(e.g. environmental regulation & targets related to soil, water, climate, biodiversity etc.)*
Other…

Select the top 3 motivations (drivers) for farmers to improve crop nutrition in your country or region?

Increase crop yield potential
Increase crop quality - achieve crop specifications for market
Reduce nutrient /fertiliser costs
Reduce nutrient losses *(e.g. N & P)* to the environment
Increase soil fertility (medium-term objective)
Increase economic return on investment in fertiliser
Compliance with agri-environmental legislation *(e.g. EU Nitrates Directive)*
Other…

Select the key data/information required for crop nutrient management planning in your country or region? *i.e. data /information used for developing fertilisation recommendations for a crop.*

Soil type (affecting nutrient supply & nutrient losses)
Soil nutrient test (soil pH, P, K, ... fertility level)
Soil nitrogen test (soil N supply)
Crop type (in current year)
Crop yield (target crop yield expected)
Pervious crop type (including crop rotation, cover crop or green manure)
Crop tissue (plant) analysis (during growing season)
Grain analysis (nutrient analysis of the harvested crop)
Previous crop residue management (e.g. straw chopping & incorporation)
Previous soil amendments (e.g. organic manure applications)

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Organic manure nutrient analysis (concentration N, P K.....)
Calculate a crop nutrient balance (or crop nutrient budget)
Environmental policy constraints (e.g. nutrient use within limits)
Other…

Briefly describe how the key information is used for calculating the nutrient (N, P, K) **input requirements for crop production?**
Open text answer

Please rate the level of accuracy you perceive in the crop nutrient recommendations developed using this process? *(i.e. how close is the nutrient management advice to what the crop actually needs)*

High Accuracy
Moderate Accuracy
Low Accuracy

Section 3. Adoption of tools & technologies to assist precision crop nutrient management on farms

Select the tools/technologies currently used, to support more accurate information capture for crop nutrient management planning and nutrient application to crops on farms in your country or region?

National crop nutrient application recommendations (fertiliser manual)
Crop nutrient calculator (paper or computer based)
Computer/IT software (nutrient management planning software)
Results of Soil nutrient analysis
Results of Crop nutrient analysis
Field maps (e.g. yield maps)
In-crop sensors (incl. remote sensing technology)
Precision nutrient application technology (assisted headland management systems incl. GPS)
Variable rate nutrient application technology
Other…

Select the main challenges & barriers to the adoption of crop nutrition tools & technologies by farmers?

Low farmer income level (lack of funds to invest in new tools / technologies)
Cost of tools/ technologies is prohibitive
Size of farm is too small (small scale)
Agronomist / Advisor completes the crop nutrient management plan for the farm
Farmers do not carry out machinery operation related to crop nutrition *(e.g. agricultural contractor carries out these operations)*

Lack of farmer awareness of tools & technologies
Lack of education *(e.g. farmer currently requires an advisor or agronomist to interpret information)*

What are the top 3 key needs of farmers to increase the precision of crop nutrition in your country or region?

Education (e.g. on soil fertility and crop nutrition management)
Training on computer software and IT skills *(e.g. using nutrient calculators)*
Availability of independent research results to support decision making in the region or country
Availability of national or regional crop nutrition advice
Awareness-raising and demonstration of relevant tools & technologies
Availability of economic cost-benefit information related to relevant tools & technologies
Access to finance for investment in relevant tools & technologies
Access to professional farm advisor or agronomist
Incentives from industry *(e.g. sustainability bonus on grain /crop sold)*
Incentives for government *(e.g. help to meeting environmental targets)*
Other…

How could farmers be supported to meet these needs in future?
Open text answer

Select the top 3 key stakeholders who can best support farmers to meet these needs?

Agricultural University and Farmer training providers
Professional farm advisors / agronomists
Farm contractors *(providing machinery operations related to crop nutrition)*
Industry - support services (*e.g. laboratory, financial, business, technology, machinery etc)*
Industry - farm input sales *(e.g. seeds, fertilisers, plant protection products etc.)*
Industry - grain/crop purchasers *(incl. grain/crop commodity trading etc.)*
Food processor industry
Agricultural researchers & research organisations in the region or country
Policy makers
General society
National and local media outlets
Other…

Please provide any final reflections in relation to increasing the precision crop nutrition management?
Open text answer

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I confirm that I'm happy to receive communications from the NUTRI-CHECK NET project regarding future updates and workshops.
Agree
Disagree