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WE'RE ABOUT INNOVATION

POLY4: New potassium and magnesium fertilizer from polyhalite

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CIEC

September 2018

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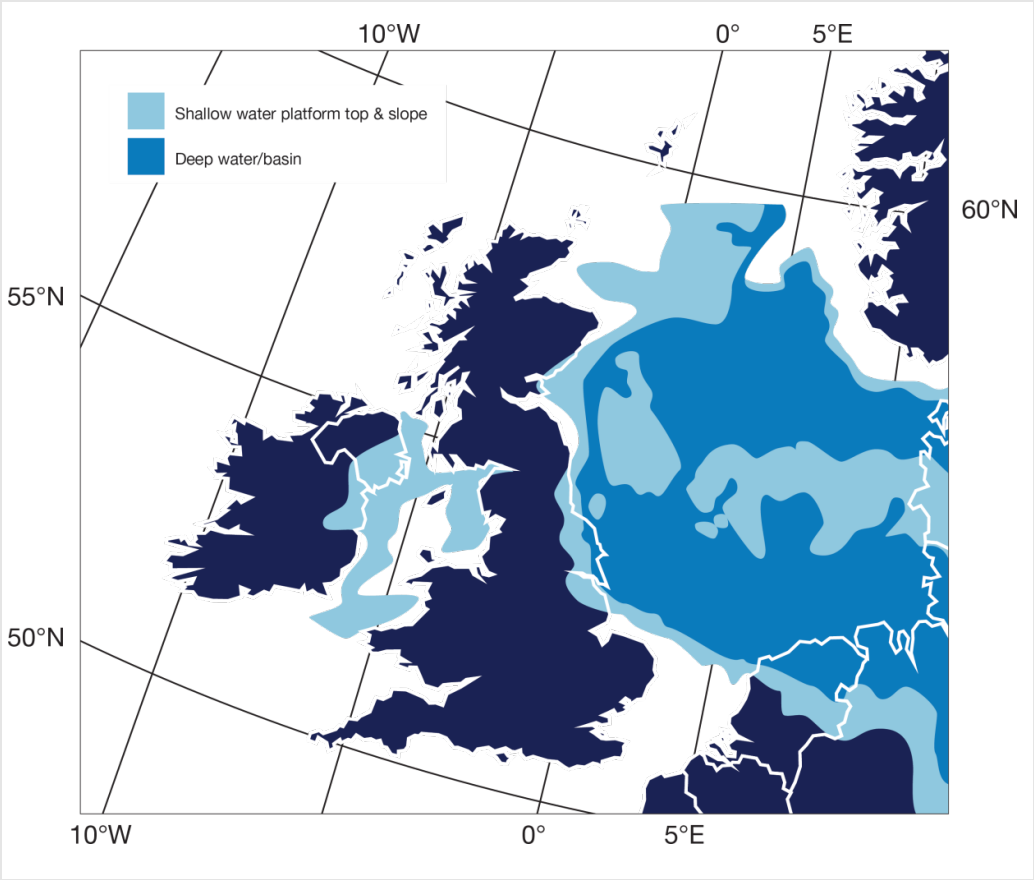
THE EUROPEAN ZECHSTEIN DEPOSIT



- The disappearance of the Zechstein Sea was part of a general marine regression that preceded and accompanied the Permian-Triassic extinction
- Polyhalite is an evaporate mineral deposited here 250-260 million years ago
- Initially discovered in 1818 by Stromeyer
- Polyhalite is a hydrated sulphate of potassium, calcium and magnesium with formula: $K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$
- A triclinic crystal structure with a hardness index of 2.5-3.5 Mohs
- Sirius Minerals will mine polyhalite to produce POLY4 fertilizer

KEY TAKEAWAY:

SIRIUS MINERALS 2.66 BILLION TONNES RESOURCE REPRESENTS 7% OF THE AREA OF INTEREST

Notes: Sedimentary rock layers of the middle to late Permian period. Further details can be found Kemp et al (2016) An Improved Approach to Characterize Potash-Bearing Evaporite Deposits, Evidenced in North Yorkshire, United Kingdom. *Economic Geology*. V111. pp 719 – 742. Source: Sirius Minerals (2018)

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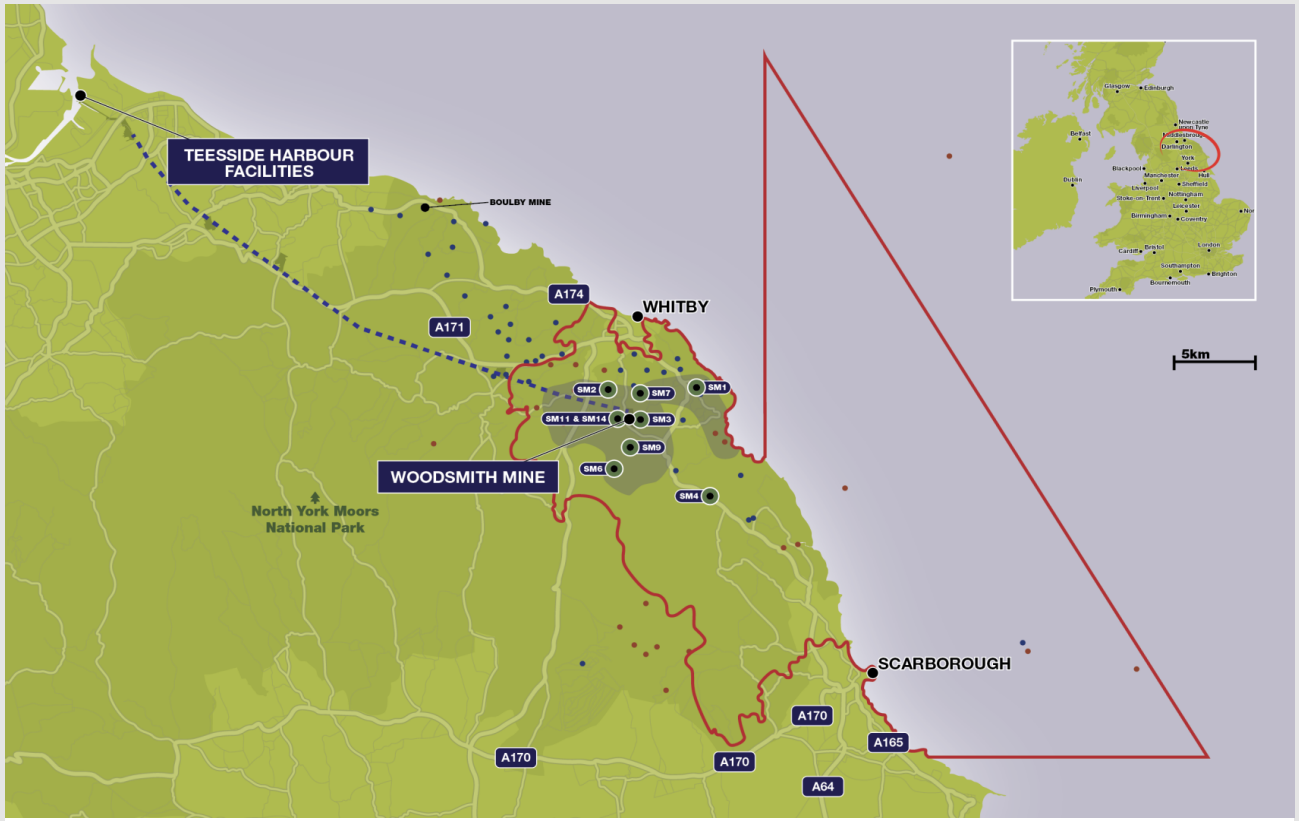
WORLD'S LARGEST AND HIGHEST GRADE POLYHALITE RESOURCE

LOCATED IN THE UK AND ONLY 37KM FROM DEEP-WATER HARBOUR FACILITIES



Notes: 1) JORC compliant probable reserve 280m tonnes with a mean grade of 88.4% polyhalite, JORC compliant indicated and inferred resource of 2.66bn tonnes with a mean grade of 85.7% polyhalite.

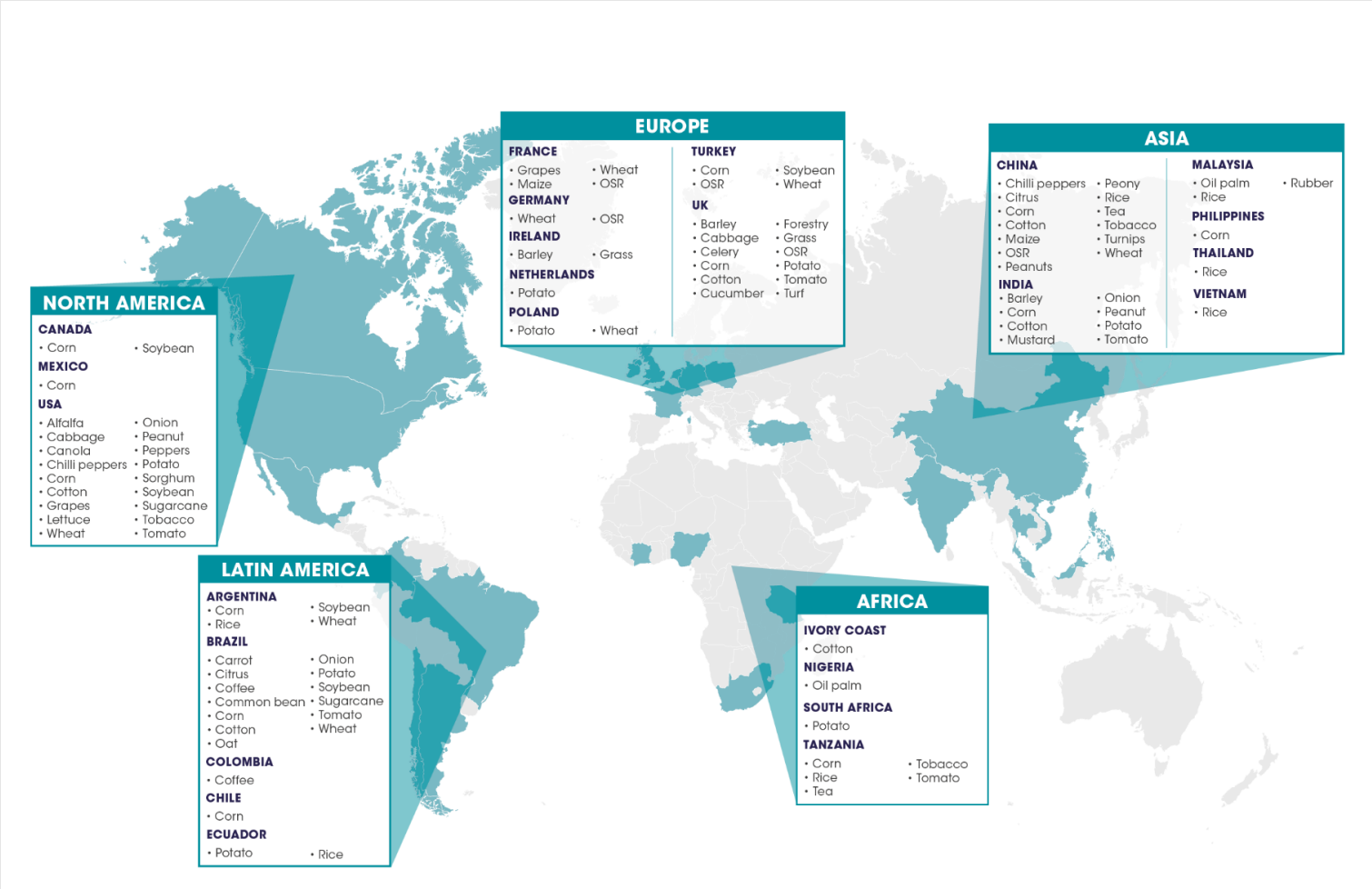
SIRIUS MINERALS R&D PROGRAMME

Trials
334

Crops
35

Countries
25

Collaborators
117



Notes: Trials as of August 2018

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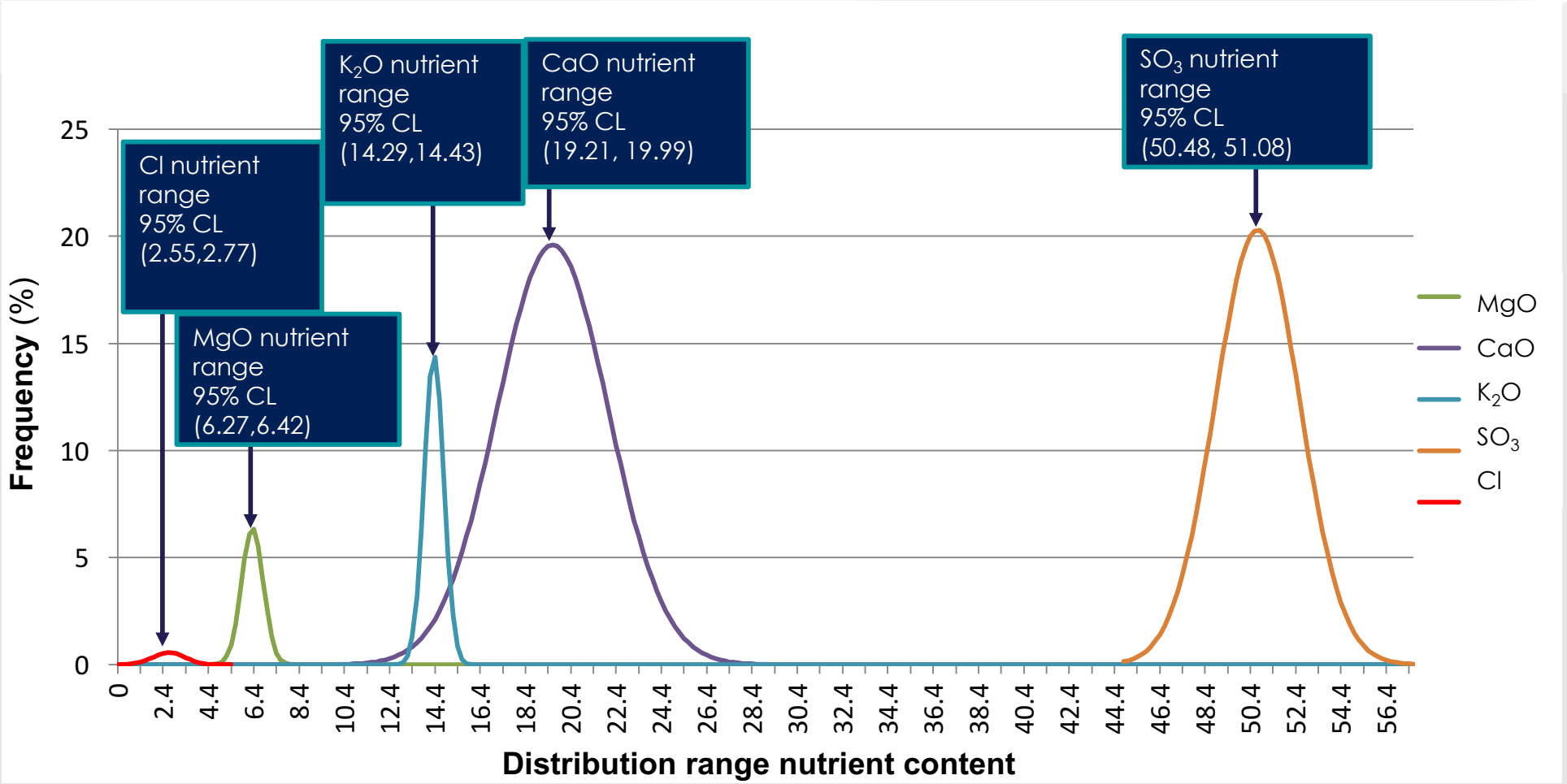
PRODUCT CHARACTERISTCS

POLY4 NUTRIENT CONTENT

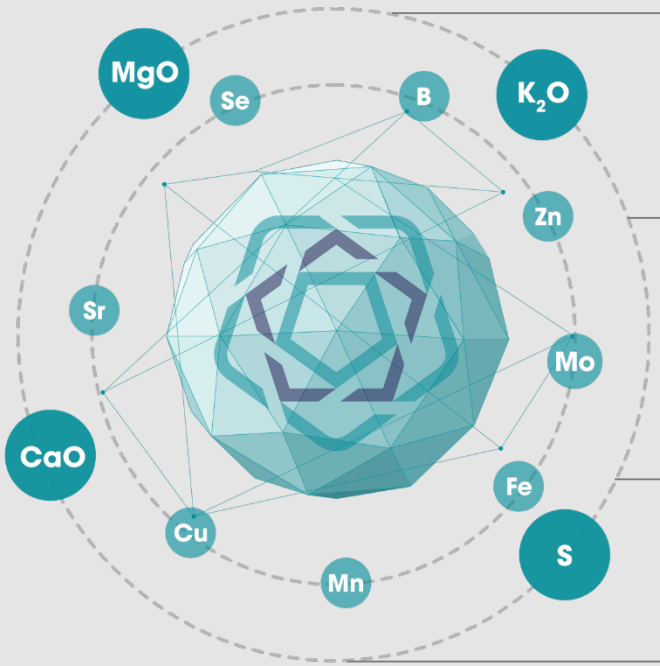


KEY TAKEAWAY: POLY4 NUTRIENT CONTENT IS CONSISTENTLY ABOVE THE MINIMUM SPECIFICATION

Notes: 1) Confidence Limits (CL) for each nutrient are based on analysis of 135 polyhalite samples ; 2) POLY4 nutrient content is 14% K_2O; 17% CaO; 6% MgO; 48% SO_3 (19% S)
Sources: Sirius Minerals; SGS France 2013 - 2014

POLY4

A SINGLE SOURCE OF BULK NUTRIENTS AS FOUNDATION FOR EFFECTIVE, EFFICIENT, FLEXIBLE AND SUSTAINABLE FERTILIZATION



EFFICIENCY

- Delivers greater nutrient uptake, a key profit driver for farmers
- Delivers four macro nutrients in one product
- Desirable nutrient release profile

EFFECTIVENESS

- Improves both yield and quality
- Improves macro and micro nutrient uptake
- Minimises crop losses through disease resilience
- Handles, stores, blends and spreads effectively

FLEXIBILITY

- Low chloride and pH neutral
- Excellent compatibility profile
- Flexible application timing

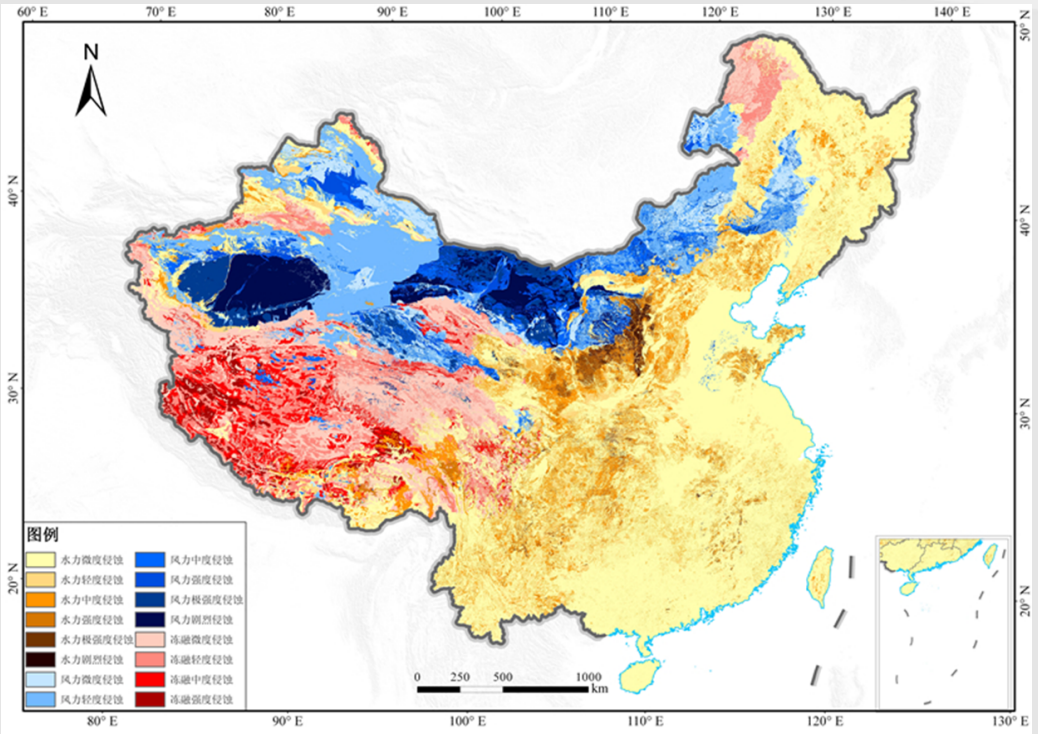
SUSTAINABILITY

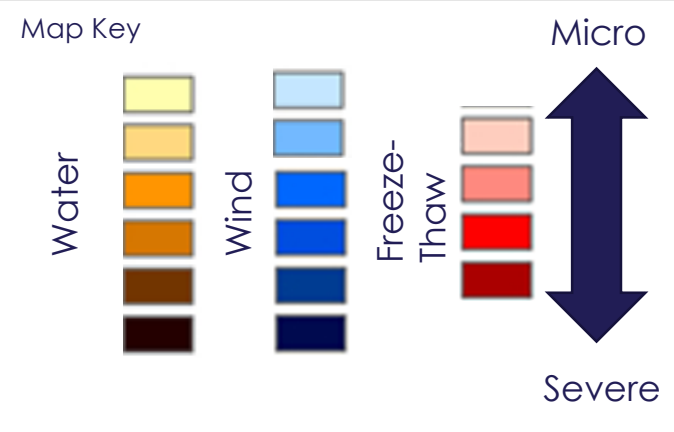
- Improves soil strength, structure and nutrient legacy
- Reduces agriculture's impact by improving fertilizer use efficiency
- Certified for organic use
- Excellent environmental profile

Notes: 1) Based on 90% polyhalite grade. Macro nutrients based on w/w % and micro nutrients based on mg/kg; micro nutrients' content: B 169, Zn 1.9, Mn 3.1, Mo 0.3, Se>0.5, FE>0.5, Cu 1.1, Sr 1414. 2) POLY4 is the trademark name for polyhalite products from the Sirius Minerals polyhalite project in North Yorkshire, *48% SO_3. B – boron, Cu – copper, Se – selenium, Zn – zinc, Fe – iron, Sr – strontium, Mo – molybdenum, Mn – manganese.

EROSION IN CHINA

- Soil erosion in China affects 51% of its landmass
- 5 billion tonnes of soil are lost annually, with the Yangtze river moving 2 billion per year
- On-site impacts are nutrient losses, yield loss and sales reductions
- Off-site impacts are water pollution (eutrophication), food price inflation and flooding
- Soil erosion caused by flooding had economic loss are CNY 62.9 to 264.2 billion per year (US$9.2 - 38.7 billion) in China



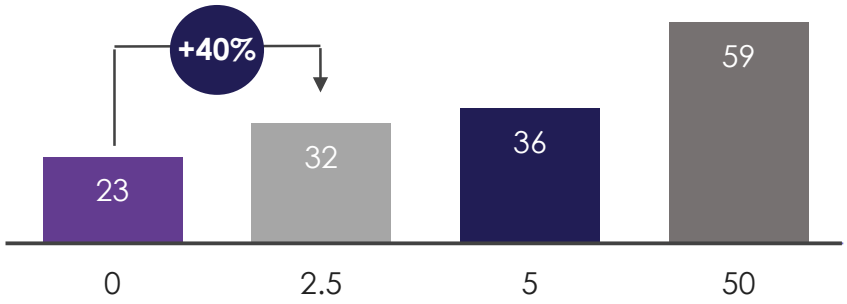


Notes: 1) Based on Wang Zhanli. 2000. Analysis affecting factors of soil erosion and its harming in China. Transactions of the CASE 16 (4):32-36.

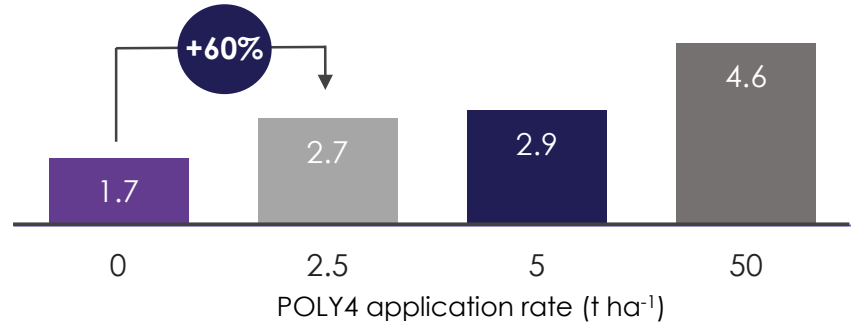
SOIL STABILISATION

- Research into calcium effects, commonly supplied by gypsum, shows evidence of improving soil structure
- POLY4 contains calcium that should provide a benefit to soil structure whilst being used as a fertilizer
- A laboratory trial was conducted with the University of Aberdeen, ranked number 1 for soil science in the UK
- Improvement in tensile strength is indicative of preventing soil movement and erosion
- Higher resilience to compact ensures water infiltrates rather than running off and creating erosion

Soil tensile strength (kPa)[2]



Soil resilience to compaction (Young's Modulus MPa)[2,3]



Notes: 1) Soil type was a sandy loam; 2) GENSTAT means ; 3) Young's Modulus is a measurement of the elasticity of solid materials.
Source: University of Aberdeen (2015) 34000-UOA-34010-15

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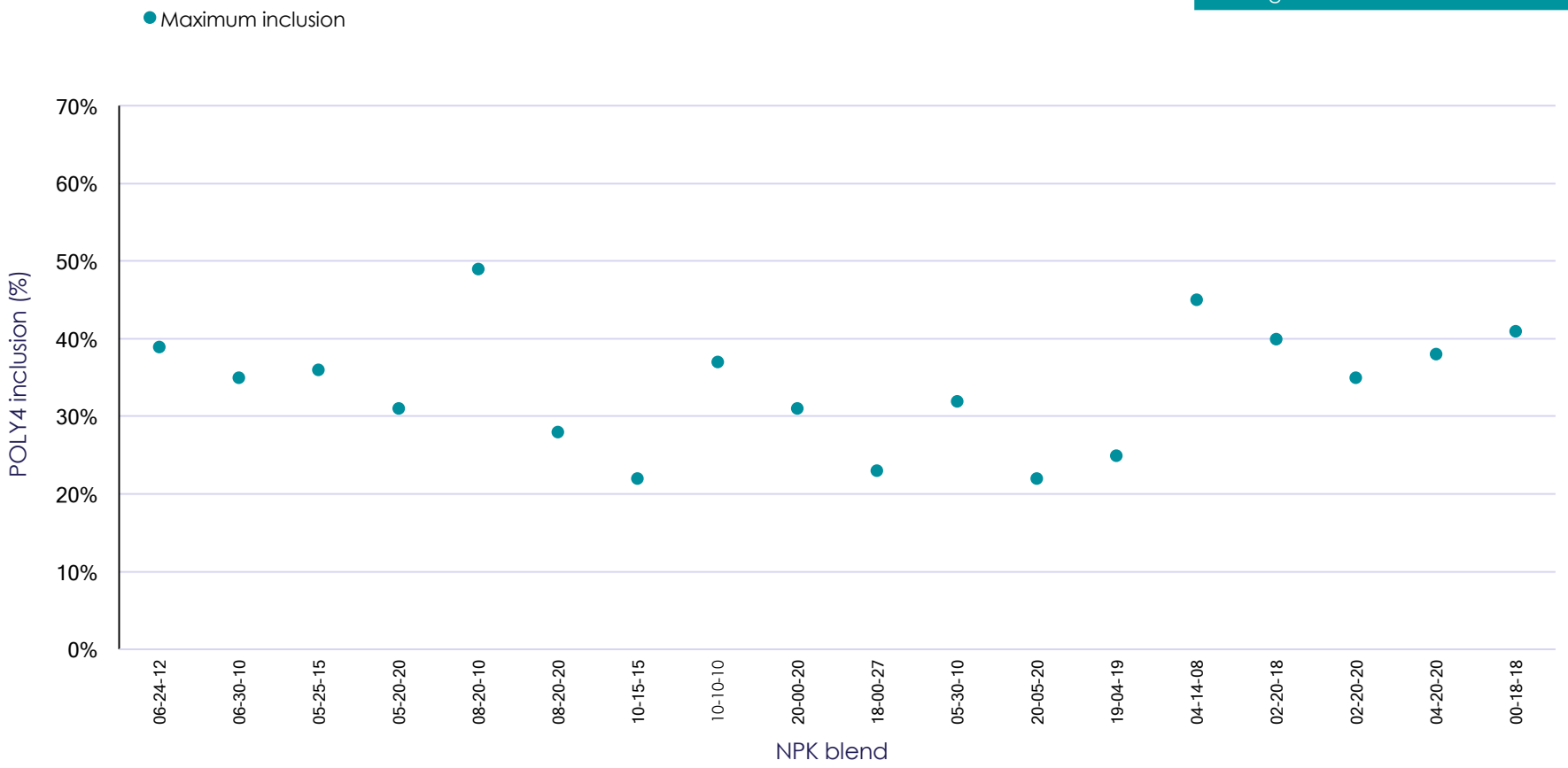
POLY4 – A FERTILIZER INPUT

EXISTING FIT – POLY4

POLY4 inclusion into popular grades

Average maximum POLY4 inclusion	34%



KEY TAKEAWAY: **POLY4 INCLUSION IN NPK BLENDS**

Notes: 1) Includes 15 popular Brazilian NPK blends for key crops; soybean, corn, cotton, coffee & sugarcane. NPK blends based on regional price references, quoted CPT basis. July 2018; MOP bulk cif Rondonopolis-Sorriso US$417/t, TSP cif Rondonopolis-Sorriso US$441/t, SSP 19-21pc P_2O_5 cif Rondonopolis-Sorriso US$258/t, MAP 11-52 cif Rondonopolis-Sorriso US$537/t, Urea granular cif Rondonopolis-Sorriso US$377/t, ammonium sulphate granular cif Rondonopolis-Sorriso US$282/t. Optimum POLY4 inclusion is based on the inclusion required to create the best margin whilst still meeting the blend K_2O requirement.

NPK CHEMICAL COMPATIBILITY IFDC TESTING MATRIX

DETERMINE THE CHEMICAL COMPATIBILITY WHEN PRODUCING THE FOLLOWING GRADES

Option 1

with urea-DAP-KCl-POLY4:

- 27.3 – 13.6 – 13.6 with 0% POLY4
- 24.4 – 12.2 – 12.2 with 14% POLY4
- 19.7 – 9.9 – 9.9 with 36% POLY4
- 16.5 – 8.3 – 8.3 with 51% POLY4

Nutrient ratio	Grade	Material (g)			
		Urea	DAP	KCl	POLY4
2:1:1	27.3-13.6-13.6	47.57	29.51	22.92	0.00
	24.4-12.2-12.2	42.49	26.36	17.34	13.81
	19.7-9.9-9.9	34.39	21.34	8.44	35.83
	16.5-8.3-8.3	28.86	17.91	2.36	50.87

Option 2

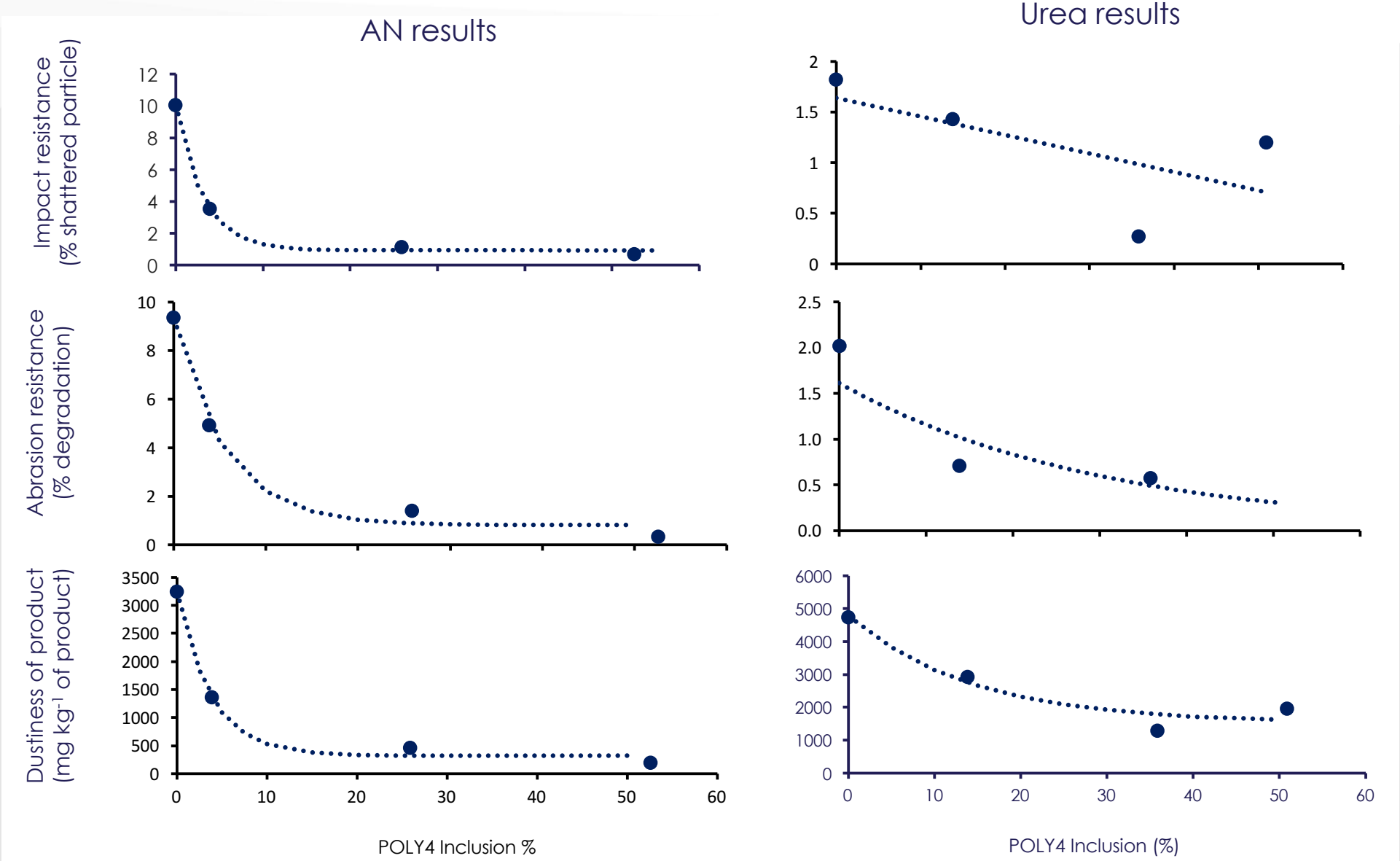
with AN-phosphate rock-KCl-POLY4:

- 12.5 – 12.5 – 12.5 with 0% POLY4
- 12.1 – 12.1 – 12.1 with 4% POLY4
- 10.0 – 10.0 – 10.0 with 26% POLY4
- 7.4 – 7.4 – 7.4 with 53% POLY4

Nutrient ratio	Grade	Material (g)			
		AN	Phosphate rock	KCl	POLY4
1:1:1	12.5-12.5-12.5	36.80	42.29	20.91	0.00
	12.1-12.1-12.1	35.68	41.00	19.38	3.95
	10.0-10.0-10.0	29.44	33.83	10.85	25.88
	7.4-7.4-7.4	21.83	25.08	0.46	52.63

Sources: 66000-IFDC- 60010-17

NPK COMPOUNDS – STEAM GRANULATION

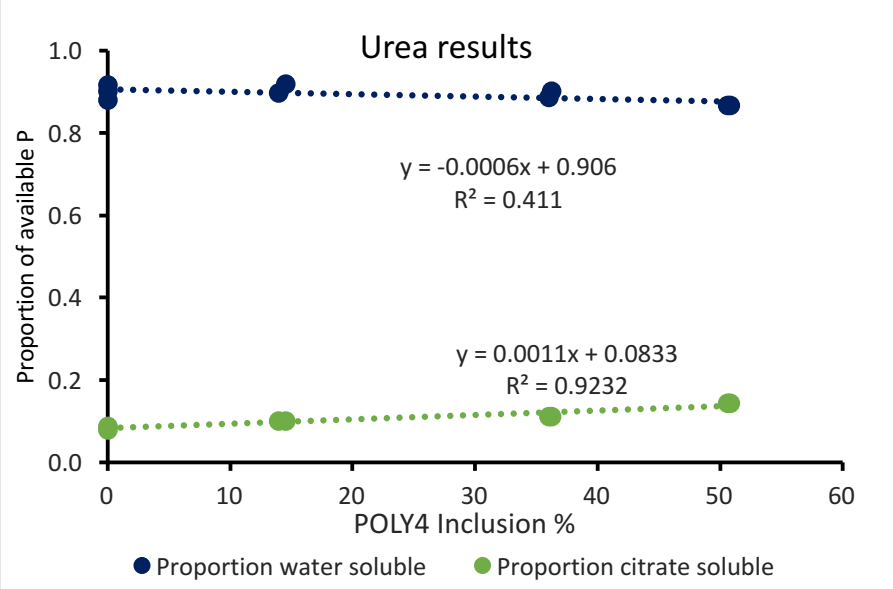


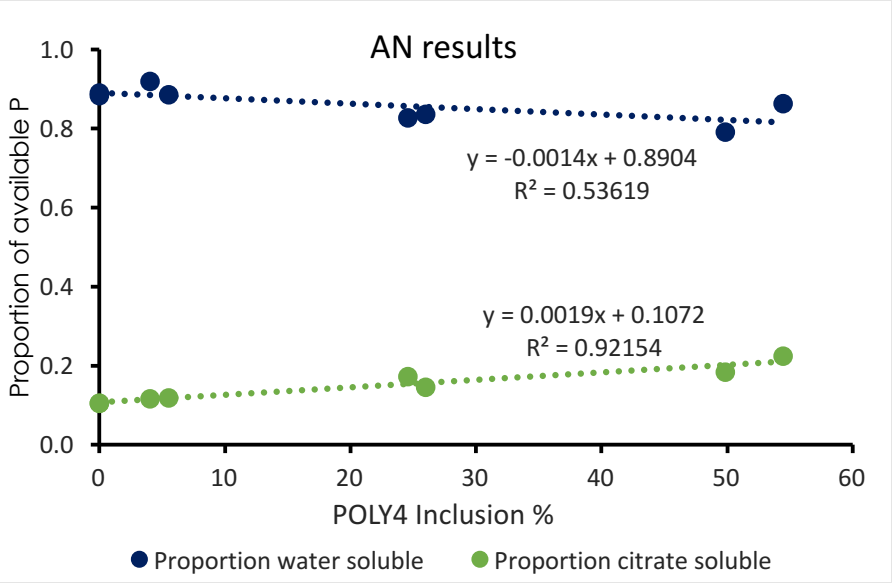
Notes: 1) Impact resistance testing procedure (IFDC S-118),Abrasion resistance testing procedure (IFDC S-116) and dustiness testing procedure (IFDC-S122) described in Manual for Determining Physical Properties of Fertilizer (IFDC—R-10).Sources: IFDC (2017) 66000-IFDC-60010-17

STEAM GRANULATION – NPK COMPOUND RESULTS

PHOSPHORUS AVAILABILITY

- Inclusion of POLY4 in steam granulated NPK compounds puts calcium and phosphorus together
- Water soluble P is marginally decreased
- Citrate soluble P is marginally increased





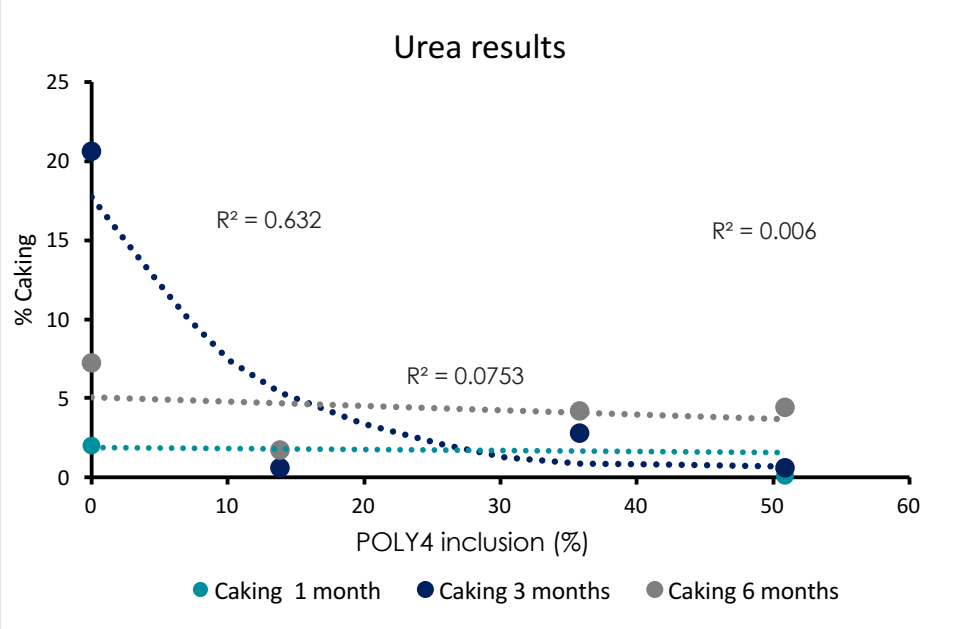
KEY TAKEAWAY: POLY4 INCLUSION HAS NEGLIGIBLE IMPACT ON WATER SOLUBLE PHOSPHORUS AVAILABILITY

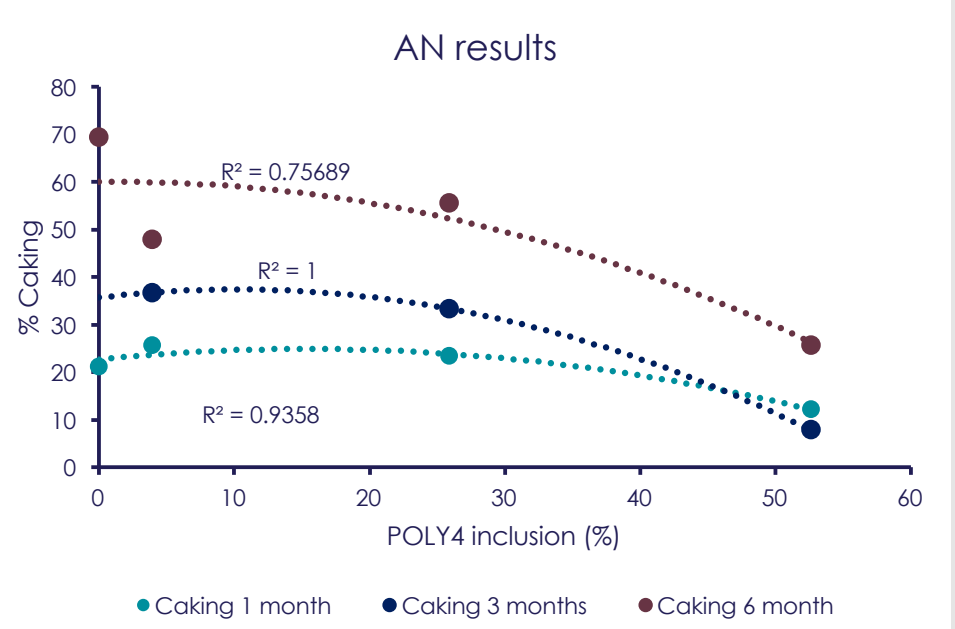
Notes: 1) Chemical analysis performed according to the AOAC International methods. Sources: IFDC (2017) 66000-IFDC-60010-17

STEAM GRANULATION – NPK COMPOUND RESULTS

CAKING PROPENSITY

- Inclusion of POLY4 in steam granulated NPK compounds reduces caking
- Improved caking resistance up to three months shelf life (small bag technique)



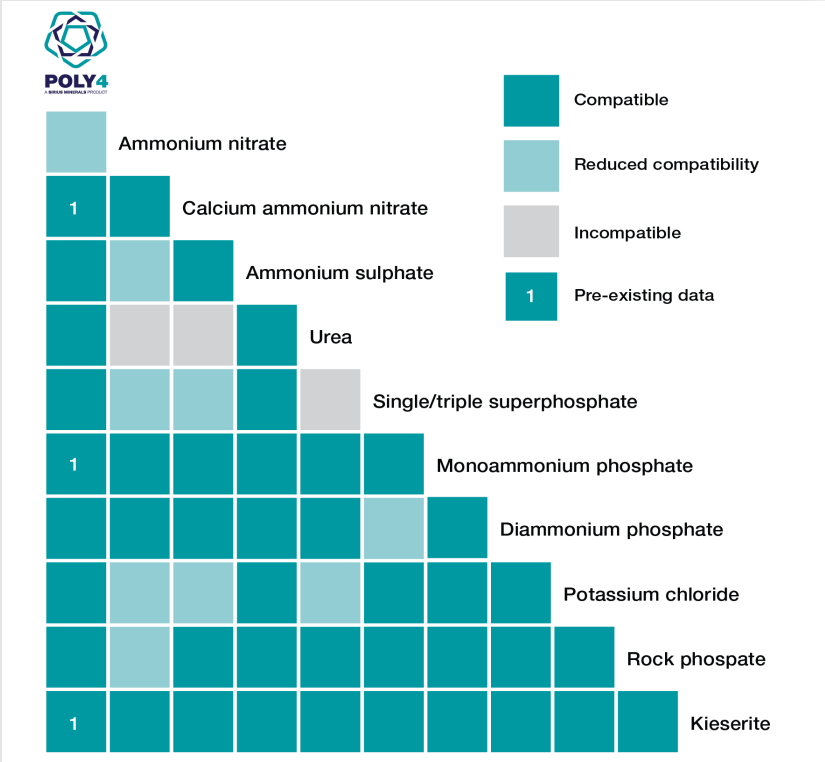


KEY TAKEAWAY: **POLY4 INCLUSION MINIMISES CAKING**

Notes: 1) Determined according to the procedure (IFDC S-106) described in Manual for Determining Physical Properties of Fertilizer (IFDC—R-10).
Sources: IFDC (2017) 66000-IFDC-60010-17

SUMMARY OF FINDINGS

STEAM GRANULATED NPK COMPOUND	Influence up to 50% (w/w) POLY4 composition	
	AN-RP-KCl-POLY	Urea-DAP-KCl-POLY4
CRUSH STRENGTH	Improved	Improved
IMPACT RESISTANCE	Improved	Improved
ABRASION RESISTANCE	Improved	Improved
CRH	~	~
DUST GENERATION	Improved	Improved
CAKING	Improved	Improved



KEY TAKEAWAY: POLY4 HAS A POSITIVE IMPACT ON DRY BLENDS, COMPACTED AND STEAM-GRANULATED COMPLEXES

IFDC methodology ratifies methods of Walker et al (1998) and published findings of Albadarin et al (2017).
Sources: 66000-IFDC-66010-17

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POLY4 AGRONOMY IN CHINA

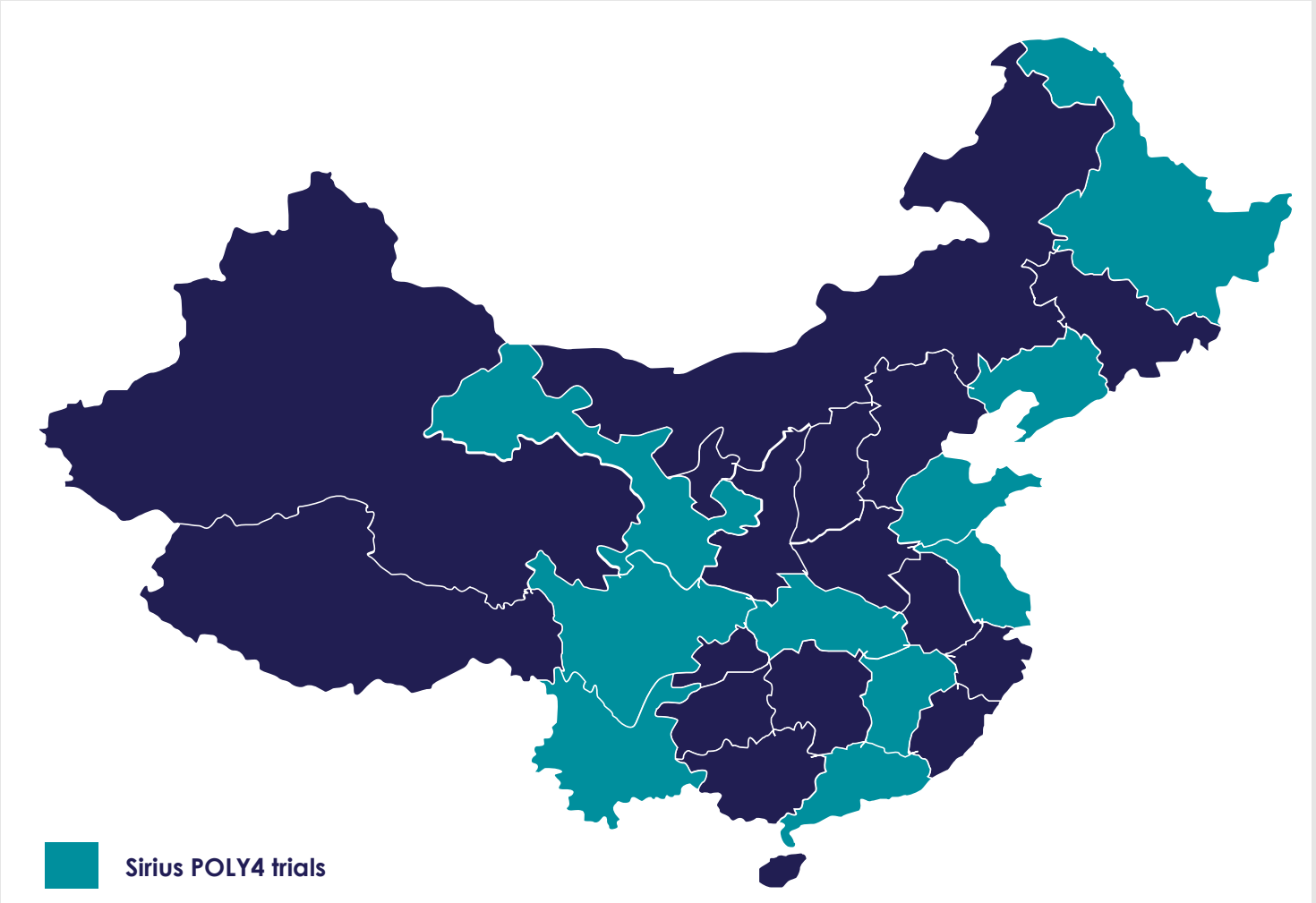
R&D PROGRAMME - CHINA

Current activities

- Rice
- Corn
- Wheat
- Potatoes
- Tea
- Tobacco
- Citrus
- Peony
- Sugarcane
- Oilseed rape
- Coffee

Technical

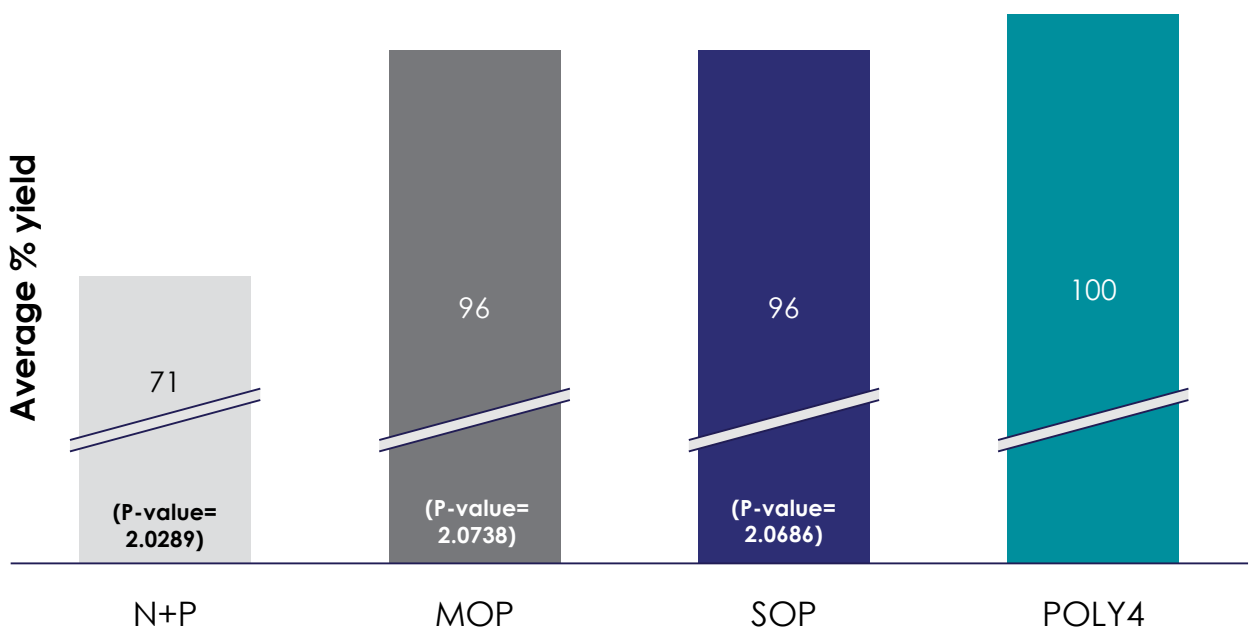
- App'n timing
- SOP substitution
- Crop programmes
- FMP replacement
- Soil effects
- Soil microbiology
- S F stn demos



POLY4 PERFORMANCE COMPARED TO POTASH SOURCES

YIELD RESULTS FROM 30 STRAIGHT TRIALS IN CHINA GENERATE POWERFUL CONCLUSIONS

Average POLY4 performance against other K sources[1,2]



Initial soil analysis

Soil measurement	Value
P (mg kg^{-1})	17
K (mg kg^{-1})	98
Mg (mg kg^{-1})	125
Ca (mg kg^{-1})	1329
S (mg kg^{-1})	57
OM (g kg^{-1})	21
pH	6

KEY TAKEAWAY: POLY4 OUTPERFORMED MOP AND SOP AND VALIDATE THE SIGNIFICANT PRODUCT VALUE FOR FARMERS

Notes: 1) Average performance based on straight trial results at recommended K_2O application rates; 2) Data covers broad acre (rice, corn, oilseed rape and) and high value crops (Chilli peppers, tobacco, tea and cotton. Source: Sirius Minerals

SUSTAINED MACRO-NUTRIENT DELIVERY

MACRO-NUTRIENT UPTAKE RESULTS FROM CHINESE TRIALS

Improvements in macro-nutrient uptake compared to MOP[1]

Initial soil analysis[1]

Soil measurement	Value
P (mg kg^{-1})	20
K (mg kg^{-1})	124
Mg (mg kg^{-1})	159
Ca (mg kg^{-1})	1047
S (mg kg^{-1})	61
OM (g kg^{-1})	21
pH	5.9

KEY TAKEAWAY: POLY4 OUTPERFORMED MOP IN MACRO-NUTRIENT UPTAKE

Notes: 1) The results are based on 9 trials in China.
Source: Sirius Minerals

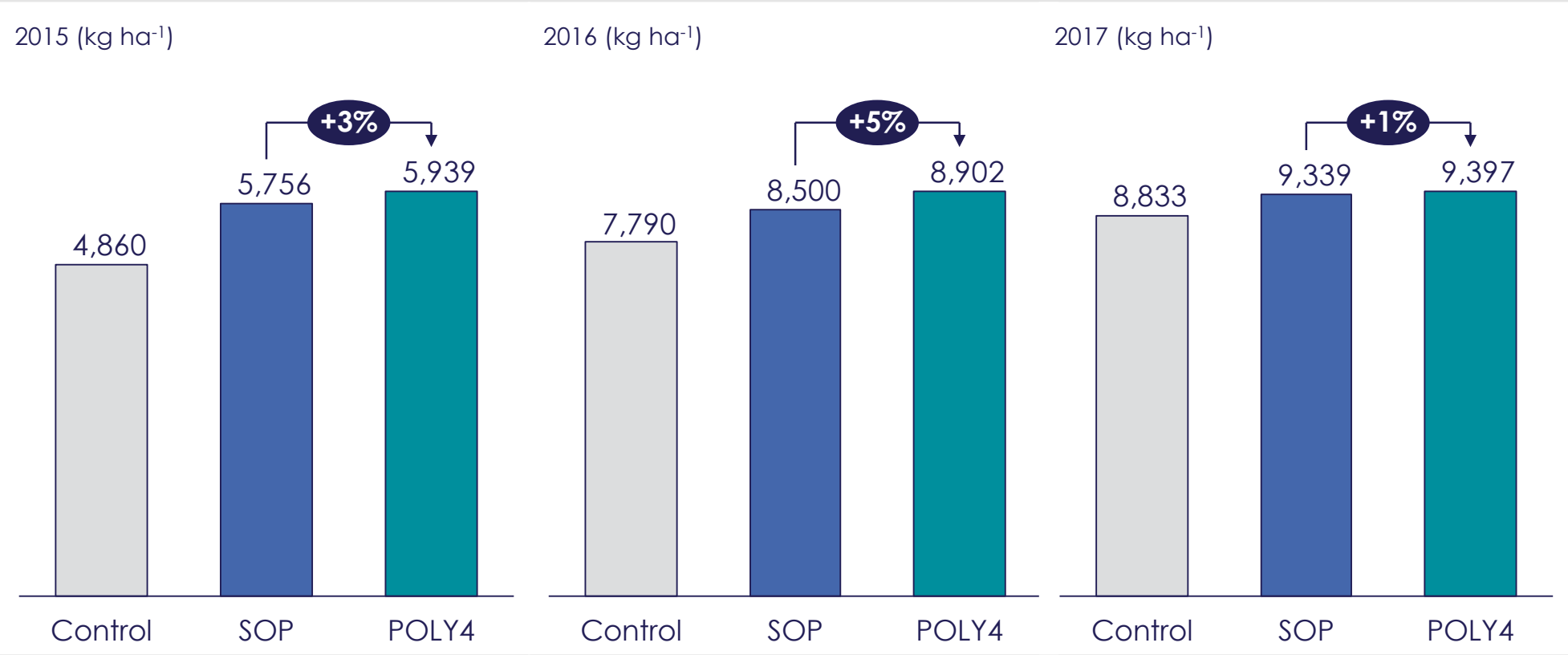
YUNNAN TEA

Treatment	Nutrients applied (kg ha^{-1})			
	K_2O	CaO	MgO	S
CK	0	0	0	0
POLY4	56	67	24	76
POLY4	84	100	36	114
POLY4	112	133	48	153
POLY4	168	200	72	229
SOP	56	0	0	20
SOP	84	0	0	30
SOP	112	0	0	40
SOP	168	0	0	60

Field experiment site: the tea garden of Tea Research Institute, Menghai, Xishuangbanna, Yunnan, 2014-2017
Tea variety: YunKang10
N and P_2O_5 were applied at local recommended rates.

Notes: Initial soil analysis : pH 5.2; organic matter 0.03%; 199.8 mg N kg^{-1} 5.5 mg P kg^{-1} 89.5 mg K kg.$^{-1}$
Source: Yunnan University (21000-YAU-21011-14;21000-YAU-21014-15; 21000-YAU-21017-16)

YUNNAN TEA – TOTAL YIELD

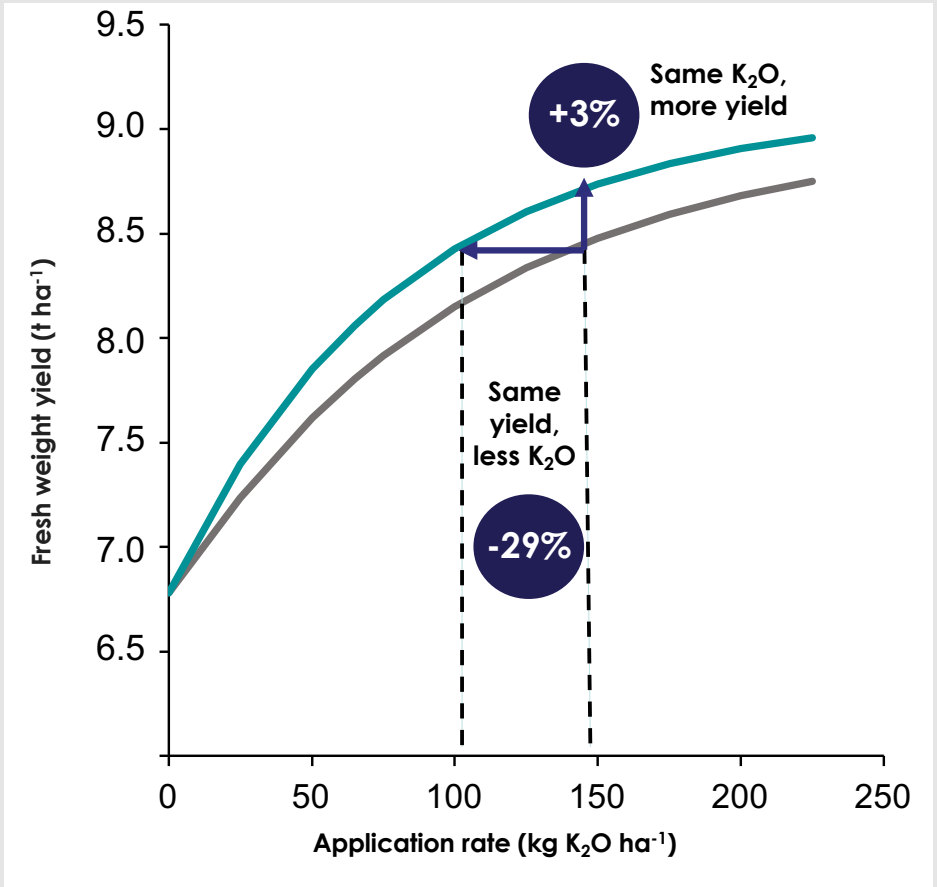


KEY TAKEAWAY: TOTAL TEA YIELD WAS CONSISTENTLY IMPROVED WITH POLY4 COMPARED TO SOP

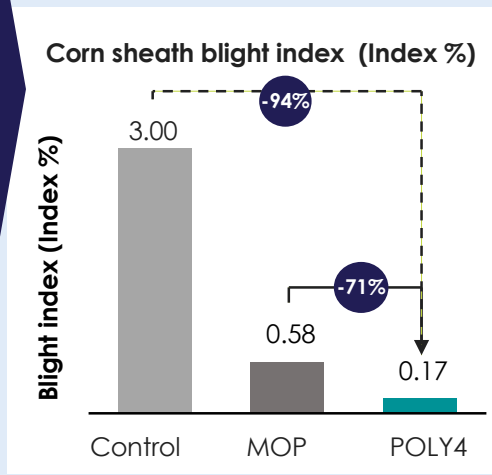
Notes: 1) Combined spring, summer and autumn yield. Initial soil analysis : pH 5.2; organic matter 0.03%; 199.8 mg N kg^{-1}, 5.5 mg P kg^{-1}, 89.5 mg Kkg^{-1}.
Source: Yunnan University (21000-YAU-21011-14;21000-YAU-21014-15; 21000-YAU-21017-16).

SUMMARY OF CORN TRIAL

POLY4 DELIVERS BALANCED FERTILIZATION TO CORN



Added value K sources

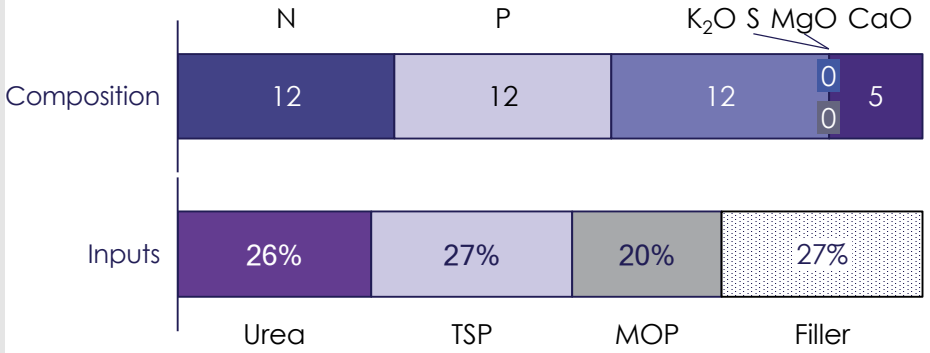


- Taller crop
- Significantly higher biomass
- Reduced sheath blight
- Reduced numbers of yellowing leaves

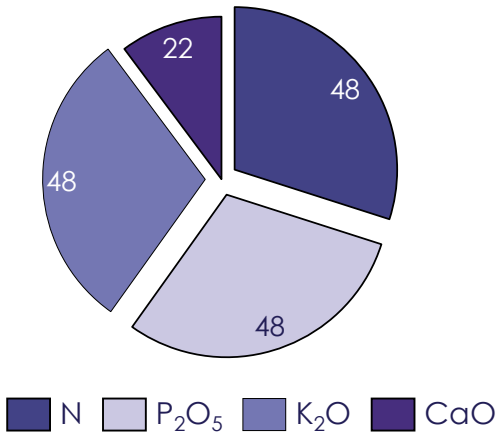
Notes: 1) Genstat exponential regression based on preliminary findings; Initial soil analysis pH 5.64, P mg/kg, 43 mg K kg^{-1}, 107 mg Mg kg^{-1}, 2128 mg Ca kg^{-1}, 27 mg S kg^{-1}.
Sources: Sichuan Academy of Agricultural Science (19000 -SAAS-19012-14).

POLY4 NPK BASED BLENDS FOR CEREALS

Traditional 12:12:12 NPK composition[1]

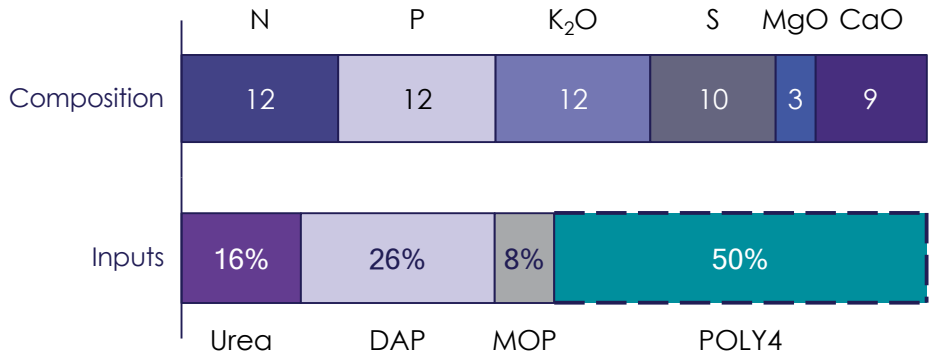


Transformation nutrient recommendation (kg nutrient)[1]

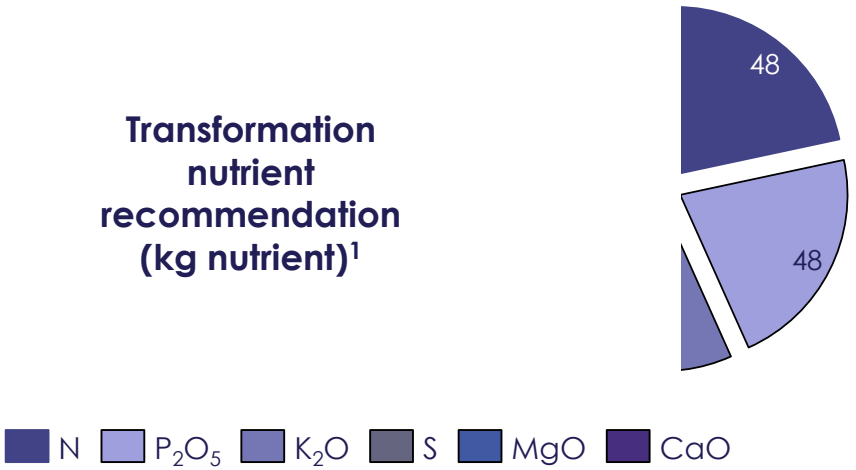


Zero Growth Transition

POLY4 12:12:12 NPK composition[1]



Transformation nutrient recommendation (kg nutrient)[1]



KEY TAKEAWAY: INCLUSION OF POLY4 LOWERS CHEMICAL BLEND APPLICATION

Notes: 1) Calculations based on application of 400 kg of blend.
Sources: Sirius Minerals , FAO.

SUMMARY

- POLY4 is a natural multi-nutrient fertilizer containing K, S, Mg and Ca
- POLY4 handles, spreads and stores effectively
- Granulation with a range of nutrient sources is validated
- Sirius's global agronomy programme demonstrates agronomic value
- China's drive towards sustainable agriculture fits with POLY4

2011 - 2015
Resource definition, minerals rights and approvals

Nov 2016
Stage 1 financing complete

2017 – 2021
Construction and development

2021
First polyhalite

2024
10 Mtpa ramp up

Sustaining the future.

SIRIUS MINERALS PLC

THANK YOU

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