Office Use Only	
Project Code	
Project Type	

FINAL REPORT 2022

Applicants must read the *SAGIT Project Funding Guidelines* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be submitted by email to admin@sagit.com.au as a Microsoft Word document in the format shown **within two months** after the completion of the Project Term.

PROJECT CODE	**UNF117**
PROJECT TITLE (10 words maximum)	
Increasing the knowledge and understanding of micronutrient deficiency in the UN	

PROJECT DURATION *These dates **must** be the same as those stated in the Funding Agreement.*				
Project start date	**1/07/2017**			
Project end date	**30/06/2021**			
SAGIT Funding	**2018**	**2019**	**2020**	**2021**

PROJECT SUPERVISOR CONTACT DETAILS *(responsible for the overall project)*		
Title:	**First Name:**	**Surname:**
Miss	Jade	Rose
Organisation	Upper North Farming Systems – Research Coordinator	
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Mailing address:	PO Box 323, Jamestown 5491	
Telephone:		**Email:**

ADMINISTRATION CONTACT DETAILS *(responsible for all administrative matters relating to project)*		
Title:	**First Name:**	**Surname:**
Mrs	Kristina	Mudge
Organisation:	Upper North Farming Systems – Administration/Finance Officer	
Mailing address:	PO Box 323, Jamestown 5491	
Telephone:		**Email:**

PROJECT REPORT: *Please provide a clear description for each of the following:*

Executive Summary (200 words maximum):

This project highlighted the need for better understanding of micronutrients in our region's advisors and consultants, as those partnered with for this project are the key advisors in this space. The lack of clarity in the results reflects the knowledge gaps in the region. The three trial seasons (2017 was Literature Review only) 2018, 2019 and 2020, exposed the annual trials to a wide variety of growing conditions. In 2018 there was significantly below average rainfall and very dry conditions in 2019. The growing season conditions in 2020 were more typical for average rainfall, however, unfortunately included low stored soil moisture to depth for the duration of the growing season.

Key outcomes

- 2018, there were no significant differences in grain yield between the micronutrient treatments at each of the three selected trial sites from either micronutrient treatments or product types.
- 2019, results from both wheat micronutrient trials presented no significant results in yield or plant tissue tests at the trial sites. The pulse trial site at Booleroo indicated a trend in increased molybdenum levels in plant tissue tests. Unfortunately, the trial site was unable to be harvested due to persistent and terminal drought conditions.
- 2020, results from the cereal micronutrient trial at Booleroo Centre indicated no significant response in yield to any of the treatments applied at this site. Results from the cereal micronutrient trial at Mambray Creek determined a rate response in yield with higher rate or dual applications of zinc, resulting in higher yields. Application of molybdenum resulted in the highest yield (4.24 t/ha) this was also apparent in the tissue test results which showed this treatment had the highest level of molybdenum present across the trial site. Results from the pulse micronutrient trial at Mambray Creek indicated no differences in lentil grain yield from applied micronutrients for all treatments. Results from the pulse micronutrient trial at Booleroo indicated there were clear trends in increased zinc and molybdenum levels assessed across the treatments.

Project objectives: *A concise statement of the aims of the project in outcome terms should be provided.*

The UNFS Micronutrient Project pursued four distinct functional aims:

- The identification of soil types in the upper North that are responsive to micronutrient application.
- The demonstration of different methods of application of micronutrients.
- An increase in the knowledge of farmers in the Upper North in relation to micronutrients and their roles in plant development and yield potential.
- An increase in Upper North farmers' understanding of soil types and their inherent and seasonally dynamic potential for micronutrient tie-up or deficiencies.

The core objectives of the UNFS Micronutrient project were to:

- Demonstrate for Upper North a post emergent micronutrient strategy predetermined by available legacy data sets to determine micronutrient type, form, volume and application timing
- Determine most cost-effective micronutrient strategies for use in the Upper North based on mid-season plant tissue uptake and end of season yield and grain quality parameters.
- Identify the optimal micronutrient use strategy for cropping systems managed within the typical annual seasonal constraints experienced in the Upper North.
- Identify management guidelines for micronutrient application and use based on soil condition and type and plant assessment for the primary cropping cultivars / varieties grown in the Upper North.

Overall Performance

A concise statement indicating the extent to which the project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

All project objectives were met despite challenging seasons which provided sub-optimal conditions for undertaking trials on this topic. Difficulties with drought conditions for harvesting affected trials in 2019. The trials were visited each year, excluding 2020 in which COVID19 and a lack of visual differences or data from historic years to report did not allow. Trial sites were open to visitation by the general public at all times. Project extension has been difficult due to the seasonal conditions and lack of clear messaging from data obtained.

The UNFS micronutrient trial sites were on multiple landholder's properties including Carey, McCallum, Koch, Catford, and Mudge Operations. The trial site locations were selected on paddocks with known micronutrient deficiencies. Trial sites were managed by Jonathon Mudge, YPAG (Western Trial Sites) and Matt Foulis and Andrew Catford, Northern Ag (Eastern Trial Sites). The project was managed by Hannah Mikajlo (UNFS Project Officer) and Jana Dixon (Rural Directions) in 2018, Ruth Sommerville (UNFS Executive Officer) and Jamie Wilson (UNFS Project Officer) in 2019-2020 and Jade Rose (UNFS Research Coordinator) in Mid 2020-2021. This inconsistency of project management has been a downfall of the project and is something UNFS is working to ensure does not happen in future with its new staffing structure.

The final project review summary was developed by Michael Eyres of Field Systems. This is attached, yet will not be circulated in its current format. Final edits required before publishing. Feedback welcome.

KEY PERFORMANCE INDICATORS (KPI)

*Please indicate whether KPIs were achieved. The KPIs **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	Achieved	If not achieved, please state reason.
Literature review complete	Yes ☒ No ☐	
Workshop on soil parameters, micronutrient availability and role in plant development	Yes ☒ No ☐	
Trial plan for Years 2 and 3 developed	Yes ☒ No ☐	
Sites established as per trial plan	Yes ☒ No ☐	
Results Reported in UNFS Annual Compendium	Yes ☒ No ☐	
Sites established as per trial plan	Yes ☒ No ☐	
3 Site visits to trial sites by members	Yes ☒ No ☐	
Results Reported in UNFS Annual Compendium	Yes ☒ No ☐	
Project Variation – Four micronutrient trials, results reported in UNFS Annual Compendium 2021	Yes ☒ No ☐	

TECHNICAL INFORMATION (Not to exceed **three** pages)
Provide sufficient data and short clear statements of outcomes.

2018

The 2018 trial involved the foliar application of two micronutrients (zinc and copper) at two wheat (cereal) trial sites (Carey and McCallum), and two micronutrients (zinc and molybdenum) at one lentil (legume) trial site (Koch). These micronutrients were applied as a range of selected products, to compare both the performance and the field response of commercially available foliar micronutrient treatments on crop yield and plant nutrition.
There was no significant difference in grain yield between the micronutrient treatments at each of the three selected trial sites. Both the wheat, and the one lentil trial site (Koch) were under significant moisture stress for most of the 2018 growing season. There was no significant difference between each of the micronutrient treatments for zinc or copper levels in the wheat tissue samples at the McCallum trial site. This indicates that none of the micronutrient treatments or products influenced wheat nutrition at this particular site in 2018.

Plant tissue samples were also taken on 3/7/18 on the wheat at the McCallum site, prior to any foliar micronutrient applications. The samples were taken of the youngest emerged leaf blade (YEB) at the early to late tillering growth stage. Results indicated sufficient levels of zinc at 32 mg/kg, sufficient levels of copper at 9.9mg/kg, and sufficient levels of phosphorus (0.33%) and nitrogen (5.2%). This suggests that the plants were not experiencing any micronutrient deficiencies or were phosphorus or nitrogen deficient prior to the foliar applications in late July. This is an important point in relation to establishing general soil available nutrient fertility estimates.

Whilst there was no difference in zinc levels between treatments, it is noted that all of the wheat tissue samples indicated marginal levels of zinc. The topsoil (0-10cm) tests at the Carey trial site also indicated a defined zinc deficiency. This supports the basis of this trial indicating zinc to be a micronutrient likely to be deficient in this district. Copper levels in the plant tissue tests also didn't present any difference between the treatments or products and was present at an adequate level in the wheat tissue samples.

The soil tests taken on the Koch property trial site indicate adequate zinc levels in the topsoil. As zinc is relatively immobile in the soil, and becomes less available in cold, dry conditions, it is anticipated that poor uptake could be a potential reason behind the deficient tissue sample results. This is an important factor in understanding nutrient uptake potential. Simply because it is in the soil test or has been applied does not necessarily mean that the element is available to the crop.

The 2018 season was a Decile 1 rainfall year in the Upper North region, with both wheat and lentil yields in the district being well below average due to moisture stress and severe frost damage. Water was the prevalent limiting factor for yield in both wheat and lentils, it is not unexpected that there was no response to the micronutrient treatments presented in the yield data.

2019

The 2019 trials involved the same treatments as 2018, however there were two wheat trial sites (Booleroo and Mambray Creek) and one pulse trial site (Booleroo). Results from both wheat micronutrient trials indicated no significant results in yield or plant tissue tests. There was no significant response to any applied treatment at these sites. This included formulation type, rate of product and timing of the copper chelate application. Unfortunately, 2019 was an extremely dry season with terminal spring conditions significantly reducing all crop yields. This is the second trial to have netted similar results in consecutive seasons in this region, both being exposed to terminal spring conditions (2018 and 2019). The pulse trial site at Booleroo presented a trend in increased molybdenum levels in plant tissue tests. Unfortunately, the trial

site was unable to be harvested due to persistent and terminal drought conditions. Further trial work therefore for 2020 was suggested to include the use of molybdenum with the same treatments. Molybdenum is seen as important in the plant for nitrogen pathways and could assist with increased nitrogen use efficiency. During an average season, it was then expected to show increased results with a greater plant biomass and more rapid plant growth requiring a greater amount of micronutrients.

2020

The 2020 trials involved the foliar application of two micronutrients (zinc and copper) at two wheat trial sites (Booleroo and Mambray Creek) and two micronutrients (zinc and molybdenum) at two lentil sites (Booleroo and Mambray Creek). These micronutrients were applied as various products at different rates and timings. Results from the 2020 cereal micronutrient trial at Booleroo Centre indicated no significant response in yield to any of the treatments applied at this site (Figure 1). The trial also showed no effect from treatments of copper, zinc or molybdenum in the plant tissue tests. The trial did determine a trend where molybdenum levels increased in the plant tissue test when molybdenum was applied. Again, crop growth in the Upper North region was limited by low moisture throughout the growing season.

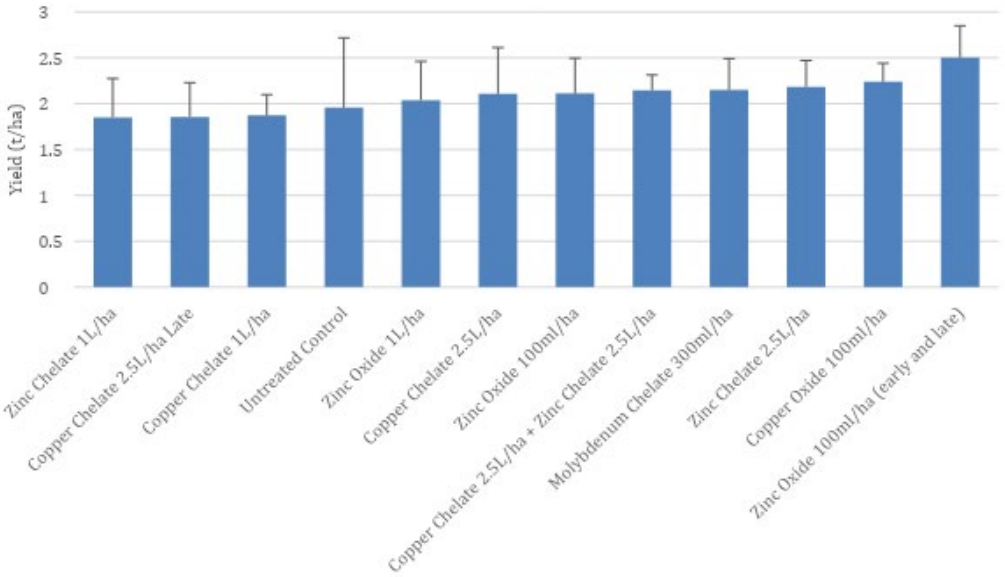

Figure 1. Booleroo site: Cereal - Yield harvest data (t/ha) for each of the treatments on the cereal micronutrients site at Booleroo 2020. Error bars represent standard deviation.

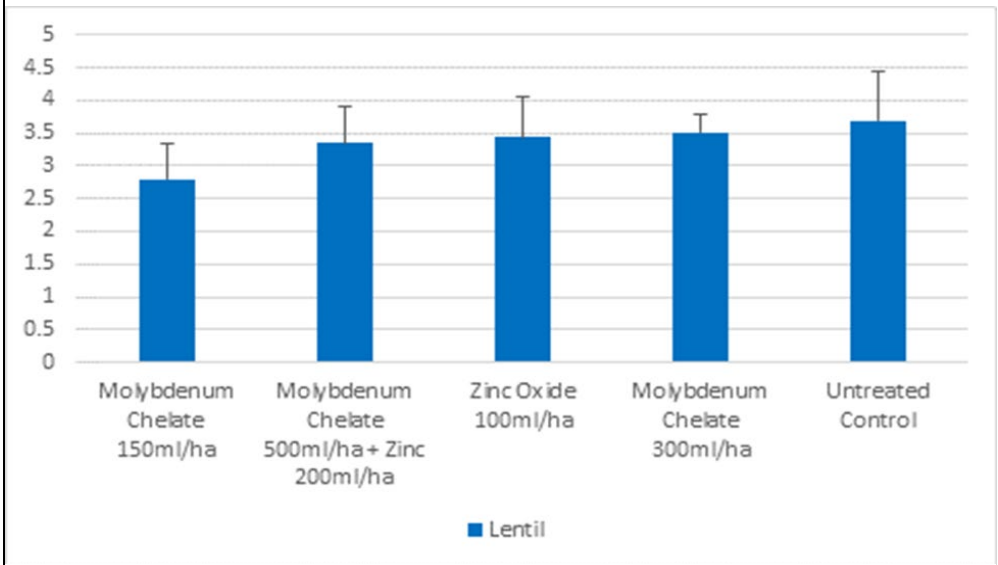

Figure 2. Booleroo site: Pulse. Yield harvest data (t/ha) for each of the treatments on the pulse micronutrients site at Booleroo 2020. Error bars represent standard deviation.

Results from the 2020 cereal micronutrient trial at Mambray Creek illustrated a rate response in yield with higher rate or dual applications of zinc, resulting in higher yields. Application of molybdenum resulted in the highest yield (4.24 t/ha) (Figure 3) this was also apparent in the tissue test results which determined this treatment had the highest level of molybdenum present across the trial site (Appendix).

Results from the 2020 pulse micronutrient trial at Booleroo indicated there were clear trends in increased zinc and molybdenum levels assessed across the treatments (Figure 2). All other nutrients analysed in the tissue samples did not show any relevant responses to treatments. Lentil grain tests determined statistically significant increase in molybdenum as a result of a foliar treatment of molybdenum chelate. Other nutrient and grain quality data and grain yield collected from the trial site did not indicate any significant differences between the treatments.

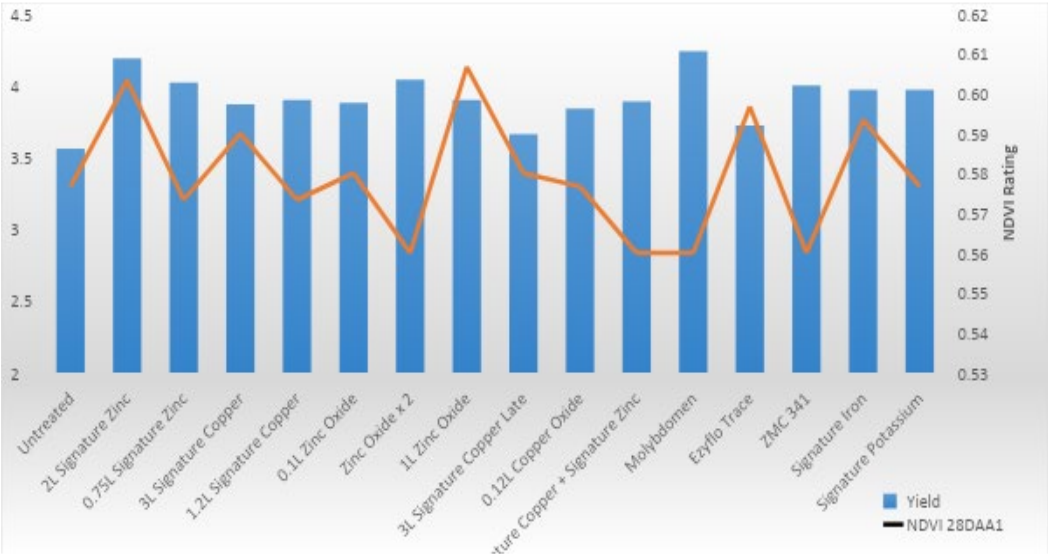

Figure 3. Mambray Creek Site: Cereal 2020 - Yield (t/ha) and Normalised Difference Vegetation Index (NDVI) assessment chart for each treatment.

Results from the 2020 pulse micronutrient trial at Baroota indicated no differences in lentil grain yield from applied micronutrients for all treatments (Figure 4). Nodule counts show variation across treatments, however, there is no difference between molybdenum treatments, which suggests there was no response in nodulation by the time the assessments were taken in this trial. The protein results analysed from grain samples signify no trends for molybdenum or zinc applications to protein content. The tissue test results suggest that there is a definite response of nitrogen uptake by the plant following a molybdenum application as well as the increased level of molybdenum itself in these treatments. These results also present an apparent response to various other nutrients when Zinc was applied including Iron, Aluminium and Cobalt.

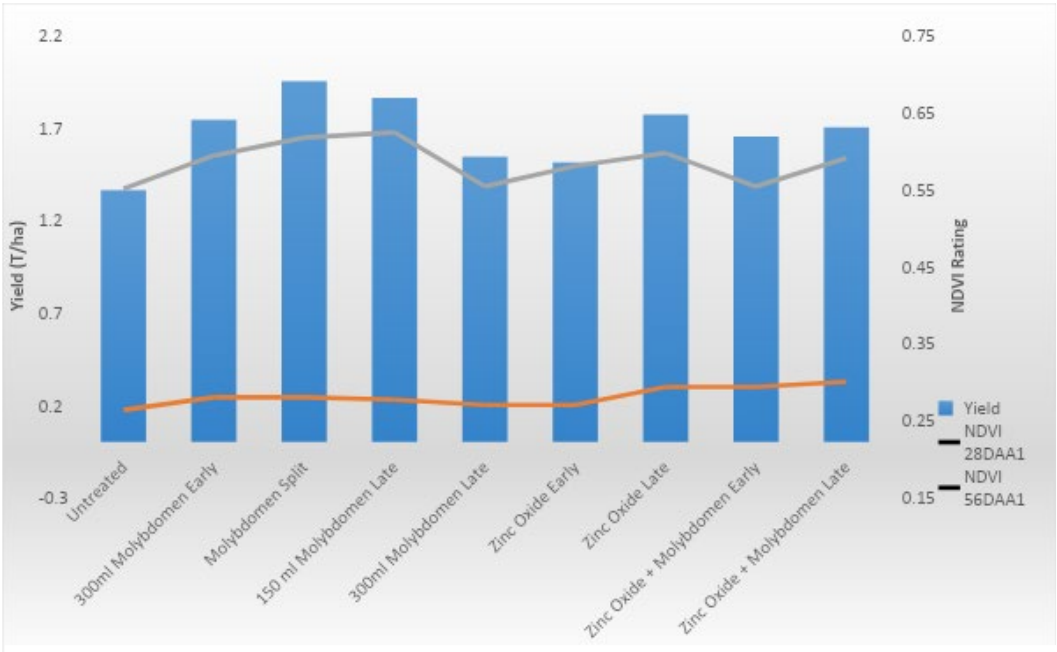

Figure 4. Baroota Site: Pulse - Yield (t/ha) and NDVI assessment chart for each treatment for the pulse micronutrient trial at Baroota 2020.

CONCLUSIONS REACHED &/OR DISCOVERIES MADE (Not to exceed one page)

Please provide concise statement of any conclusions reached &/or discoveries made.

These micronutrient trials have clarified the strengths and vulnerabilities of dryland nutrient management in a more marginal cropping climate in the Upper North. The results have proven that rainfall is critical and soil moisture is paramount to nutrient availability and uptake. Furthermore, soils may possibly have enough micronutrient capacity in low rainfall years but in more productive higher rainfall conditions then micronutrient use will be of greater importance for yield and crop risk management. Future focus from growers of the UN region to understand nutrient interactions and multiple use pathways (more comprehension of multiple nutrient effects) is necessary and will need to be adjusted to suit given seasonal conditions.

INTELLECTUAL PROPERTY

Please provide concise statement of any intellectual property generated and potential for commercialisation.

UNFS retains Intellectual Property of data collected, however asks only that appropriate acknowledgement of the source is made for the data to be used.

APPLICATION / COMMUNICATION OF RESULTS

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

*Key findings presented at top of report

During the last 20 months, there have been more limited opportunities to communicate project findings to UNFS members. Due to the restrictions and meeting limitations of COVID 19, our annual Members Expo for 2020 was cancelled. Smaller field trial walks were held in its place for relevant field trials. Due to the lack of defined results or visual differences from these trials during the 2020 season due to seasonal rainfall constraints, no event was held at a trial site in 2020. Final trial results from 2020 were analysed and collated in April and are available for review. The results from these trials have been published in the 2021 UNFS Annual Compendium. Further support has been provided by UNFS to extend the results, guidelines and message delivery to growers for cost effective micronutrient use in the UNFS. This will be achieved with grower information days, micronutrient management data sheets, UNFS zoom discussion forums and as selected webinar topics when suitable dates are organised for grower contribution and attendance.

Regular updates throughout the project were provided in the UNFS Newsletter, Twitter and Facebook platforms throughout the project and the results from 2018, 2019 and 2020 were published in the UNFS Annual Compendiums (available on the website).

A series of individual UNFS Hub meetings to discuss the Project results and more specific information on micronutrients and their relevance in the Upper North was organised for July and August 2021, including soil scientists and agronomists as key speakers. Due to Covid restrictions this was delayed. This September and October is now conducive to Covid safe provision of micronutrient information, and this will be done at 2 separate UNFS field days at Nelshaby and Booleroo in Spring of 2021 (End of September). The 2017-2021 Project Review and a Project Extension Summary incorporating these events that utilised project findings will

be published in the 2021 Annual Compendium (published 2022) and be available on the UNFS website.

POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

Further trial work in micronutrient deficiencies in the UN would be recommended due to three very dry and yield limiting seasons during this project. A summary of follow up grower questions and future work in this area of micronutrient use has been commenced by UNFS.

Key areas of interest for further work in the UN have been identified including:

Molybdenum on pulses - There were significantly different zinc and molybdenum tissue uptake results in lentils but no change in crop performance visually or in terms of yield in the first two trial years. Zinc oxide applied at a double rate (twice in growing season) was effective (500kg/Ha above control) in 2020 trials of Sceptre wheat at Mambray Creek as were the single application treatments of Iron Amino chelate and Potassium Amino in the same cultivar.

Other key micronutrients needed in the UN - Potassium and Iron were only considered in the final year of trials but have proved their worth based on the data. This warrants further investigation in relating macronutrient use to micronutrient performance.

The role of seed dressings - Need to consider seed applied micronutrient use as an adjunct to a foliar programme to keep micronutrients in a more available pool for crop to utilise for the entire growing season. Is it better to in future validate seed coatings or in furrow fertiliser options rather than using earlier foliars – target at least 50% soil coverage, or increase application rate relative to the limited leaf area?

Prevalence of alkaline soils in the region - High surface chloride levels in one of the alkaline soil trial sites (McCallum) may exaggerate phosphorus adsorption in soil and the crop may have been lacking enough P for its metabolism to be able to utilise any applied micronutrients, Zinc can be antagonistic to P in a plant or soil so it may be why zinc application may not have been an effective treatment despite low rainfall effect on crop growth?

Further extension - Workshops in the region specific to micronutrients and their role in broadacre cropping systems would be beneficial to improve knowledge on the signs of nutrient deficiencies in crops, timing of applications and understanding background micronutrient levels.