Nitrogen for smallholders and cereal crops in Myanmar: economic and social dimensions for fertility decisions

Bob Farquharson [a*], Thiagarajah Ramilan [a,b], So Pyay Thar [a,c], Shwe Mar Than [d], and Nay Myo Aung [d]

University of Melbourne, Australia
Massey University, New Zealand
PhD student
Yezin Agricultural University, Myanmar

* Corresponding author bob.farquharson@unimelb.edu.au

Contributed presentation at the 61st AARES Annual Conference,
Brisbane, Australia, 7-10 February 2017

Copyright 2017 by Author(s). All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Nitrogen for smallholders and cereal crops in Myanmar: economic and social dimensions for fertility decisions

Bob Farquharson [a*], Thiagarajah Ramilan [a,b], So Pyay Thar [a,c], Shwe Mar Than [d], and Nay Myo Aung [d]

University of Melbourne, Australia
Massey University, New Zealand
PhD student
Yezin Agricultural University, Myanmar

* Corresponding author bob.farquharson@unimelb.edu.au

Abstract

The underperformance of cereal crops in Myanmar is closely related to inadequate supply of nutrients, particularly nitrogen (N). Although other crop management practices can limit crop yields, management of nutrients for crop production is an important contemporary issue. Myanmar rice growers have changed from being mainly subsistence to semi-subsistence, and there are also good prospects for increasing rice exports. Therefore there are incentives to improve rice yields and profits. Similarly for maize, as a higher value crop, there is a strong incentive to improve production and profits.

But smallholder options to increase crop fertility must be considered in the social and economic context of their farming systems and village livelihoods. With small farm sizes, indebtedness, potentially high borrowing costs, and aversion to risk, their personal perspectives must be identified, discussed and incorporated into development activities. The decision to use more fertiliser is an investment with potential benefits and costs, which must be considered in the family and village contexts in which the decision is made. Smallholder personal (subjective) beliefs about crop yield improvements from added fertiliser are important in considering such decisions.

An economic framework is available for evaluating such decisions (marginal analysis of returns from incremental N applications with a high target rate of investment return), which can be used in conjunction with field demonstrations of crop yield responses to fertiliser. But further study of social aspects such as understanding smallholder perspectives, motivations and limits to action will be undertaken in conjunction with agronomic and economic assessments.

Key words: Nitrogen, cereal crops, smallholders, Myanmar, economic, social

Contributed paper to the 61st Annual Conference of the Australian Agricultural and Resource Economics Society, Brisbane, 7-10 February 2016

Nitrogen for smallholders and cereal crops in Myanmar: Economic and social dimensions for fertility decisions

1. Introduction

Observations of low cereal yields and perceptions of poor crop management have raised questions about an 'agricultural problem' in many developing countries, especially when allied with low farm incomes and concomitant problems associated with family health, education and welfare.

But smallholder farmers have their own good reasons for 'doing what they do', which might not be immediately apparent to an outsider looking in. If there is a concern for crop productivity and a desire to improve management for farm family livelihoods, then any planned research and/or management interventions must be considered in the context that is relevant to the farmers.

In developing countries the farm family focus has moved from subsistence to a semi-subsistence or semi-commercial basis. In this changed mode the need for income from crop (and other farm) sales has focussed farm management on improved crop inputs and outputs, and the associated prices. Agricultural profits provide an important source of income for the farm family.

Many agricultural Research and Development (R&D) funding agencies invest in projects with the overarching aim of reducing poverty and improving food security. Often this is done by focussing on generating improved agricultural technologies, management methods or farming systems for adoption by smallholder farmers. Projects may be able to investigate and develop such technologies, methods or systems, but are these adopted by many smallholders and do they make a widespread impact on poverty or food security? The step or process of 'Extending' the R&D into RD&E is one that may be left by researchers to others, especially if the research is seen to be different to extension. Sometimes project research includes development of Decision Support Systems as a way of extending the research results to enable adoption.

If the aim of projects is to reduce poverty and improve food security, then a funded project should consider the whole RD&E process. That is, projects should at least be developed and conducted with an eye to adoption of beneficial improvements as part of the project objective. In this light, consideration of economic and social contexts and imperatives should be part of agricultural development projects for smallholders, lest the R&D for improved technologies, methods and systems be misplaced by focussing on things that are not likely to be adopted.

A project titled 'Management of nutrients for improved profitability and sustainability of crop production in Central Myanmar' is being conducted in Myanmar, and this project is funded by the Australian Centre for International Agricultural Research (ACIAR). In this paper we discuss the economic and social dimensions of a 'new technology' (improved N fertility for cereal crops in central Myanmar) with the aim of enhancing adoption of improved crop fertility management and farm family income.

Fertiliser consumption by country in South-East Asia is shown in Figure 1 (International Rice Research Institute (IRRI) (Undated)). Myanmar has comparatively low levels of fertiliser use compared to other nearby countries.

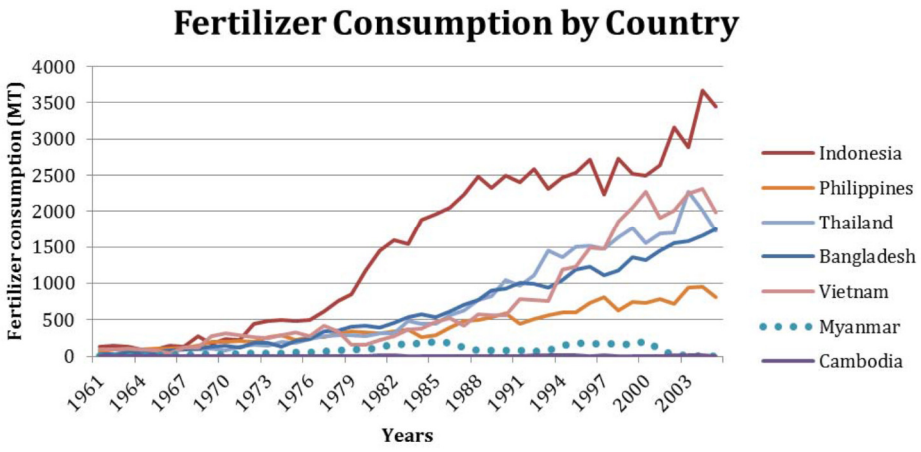

Figure 1. Total fertilizer consumption from chemical sources ('000 MT)

1.1 Myanmar country context

Myanmar (formerly Burma) has had a varied political and governance history since independence from the British in 1948. Rule by the Myanmar military forces was enforced from 1962 until 2010, which restrained social and economic development. Myanmar is one of the least developed countries in the world (Wikipedia). Sanctions from western countries were lifted in 2012 (the US) and 2013 (the EU). The National League for Democracy was elected to Government in 2015 with a super majority. Unfortunately the Myanmar Government is dealing with a very long-running civil war.

1.2 Natural resources

Myanmar is relatively rich in natural resources. The ratio of renewable water resources per head of population is higher than any other Asian country (Food and Agriculture Organisation of the United Nations 2012). For land, the ratio of land area per head of population is very high and half of the arable land is still fallow (unused) (Myanmar Department of Settlement and Land Records 2012). Soil resources vary for regions within the country (Baroang 2013). For labour the national unemployment rate is 4% (Myanmar Central Statistics Office 2012), and unemployment in rural areas is considered to enable provision of labour for agriculture, although the issues of rural wages rates and use of non-farm work and remittances will be assessed. In other South-East Asian countries there is demand for mechanisation to help with agricultural production processes and substitute for relatively high-priced and short-supply labour that has traditionally been available.

1.3 An ACIAR project

The ACIAR-funded project ("Management of nutrients for improved profitability and sustainability of crop production in Central Myanmar") has commenced with collaboration between the University of Melbourne and the Yezin Agricultural University (YAU).

The project is multi-disciplinary with two major components – bio-physical and socio-economic. The bio-physical sub-project will establish the soil-crop basis for appropriate fertiliser use for rice and maize crops in central Myanmar, and the socio-economic sub-project will determine and address economic and policy related constraints to adoption of improved rice and maize production by fertilisation. The project will also build capacity for the long-term improved nutrient management at

the farm level, through training of YAU staff, and develop decision support systems for rice and maize in central Myanmar.

Four trial sites are planned within the Tatkon, Zeyarthiri and Taungoo Townships of central Myanmar, see Figure 2. The sites are a Department of Agricultural Research (DAR) research farm (Tatkon), a farmer field at Lay Thar and the YAU farm (Zeyarthiri), and a rice farm (Taungoo).

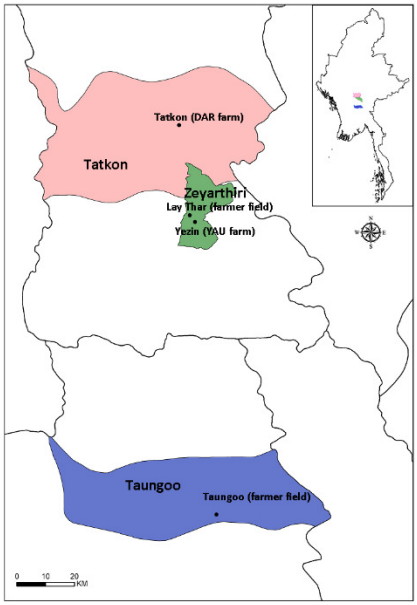

Figure 2. Project trail sites in the Tatkon, Zeyarthiri and Taungoo regions

1.4 The Green Revolution: High-yielding varieties and fertiliser management

In general the Green Revolution (GR) consisted of developing high-yielding crop varieties (HYVs) of irrigated rice and applying high rates of fertiliser to these varieties (de Janvry et al. (2016)). These 'agricultural technologies' have been widely adopted in irrigated areas but not in rainfed regions. de Janvry et al. (2016) considered that for rainfed regions in African and other developing countries the lack of adoption of HYVs is the problem, and low use of fertiliser is a symptom of that problem. Hence an important question for a project such as this is 'what crop (rice and maize) varieties do the local farmers use'? Perhaps the smallholders are using low fertiliser levels because they use low-yielding or outdated crop varieties. If this is the case then they may be considered 'poor but efficient' (Schultz 1964).

A hypothesis of low fertiliser use because of a low possibility for crop yield increases with traditional crop varieties is shown in Figure 3. Use of a HYV could provide greater potential for increased yields.

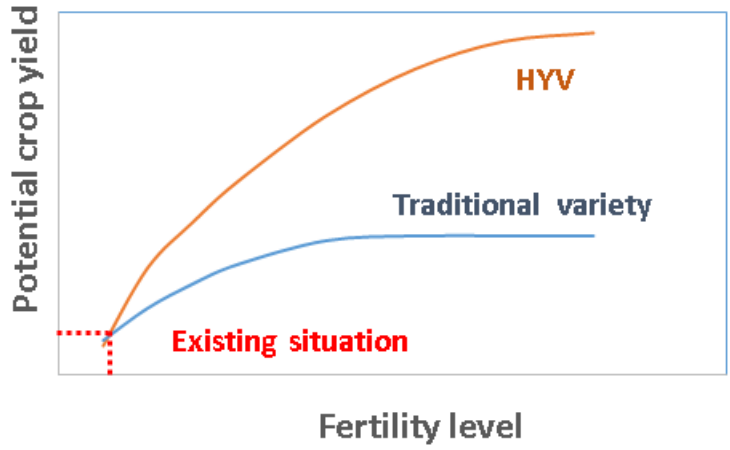

Figure 3. Potential yield improvements from traditional and high-yielding varieties

1.5 This paper

In this paper the aim is to review relevant literature, consider the important focus issues for the project, and develop questions for further project research which can be used as a basis for developing focus group discussion and a baseline survey to get to know the smallholder population.

2. Cereal crop issues in Myanmar

There is an apparent low use of fertiliser in Myanmar (Figure 1). Casual observation of cereal crops in Central Myanmar (principally rice and maize) shows that crops are underperforming (Prof. David Herridge, University of New England, personal communication). Substantial yellowing of rice is evident, indicating underuse of nutrients, especially Nitrogen (N).

Myanmar rice growers have changed from being mainly subsistence to semi-subsistence or semi-commercial, hence there are incentives to improve crop yields and profits. Similarly for maize, there is an apparent incentive to improve crop yields and farm-level profits. Typically, smallholders in developing countries have relatively small farm sizes and are poor, indebted, have poor access to credit and may have poor management skills. Myanmar smallholders now grow a range of crops on the rainfed lowland areas of the central Zone.

2.1 Farming systems in Central Myanmar

The presumed farming systems to be investigated at the project trial sites are shown in Table 1. However, other crop combinations or sequences are possible. Ramilan et al. (2017) investigated typical farming systems in central Myanmar. The types of farming systems and crop sequences, the use of inputs and technology, and the level of management will be determined by Focus Group Workshops and a Baseline Survey.

Table 1. Farming systems at experimental sites

Farming system	Type of site	
	Experimental farm	*Farmer field*
Rice – rice	YAU farm, Yezin	Taungoo
Maize - legume	Tutkone DAR farm	Lay Thar

2.2 Factors and determinants of technology adoption

A schematic of the possible determinants of technology adoption from de Janvry et al. (2016) is shown in Figure 4. Following a comprehensive review of literature these authors considered that the demand for new technology can be influenced by smallholder management skills and capacity to discern the potential changes required on their own part. The supply of new technology is importantly affected by whether a suitable technology actually exists, whether there is information about the technology, and whether it is locally available. Between the demand and supply of a new technology are mediating factors associated with institutions (e.g. credit), markets and policies. If all these factors are in accord then the behavioural response of adoption may occur. But there are many factors associated with successful development and adoption of a new technology. These authors concluded that in Africa and other places rainfed agriculture suffers from ineffective supply of suitable crop varieties, which constrains adoption and results in low fertiliser use.

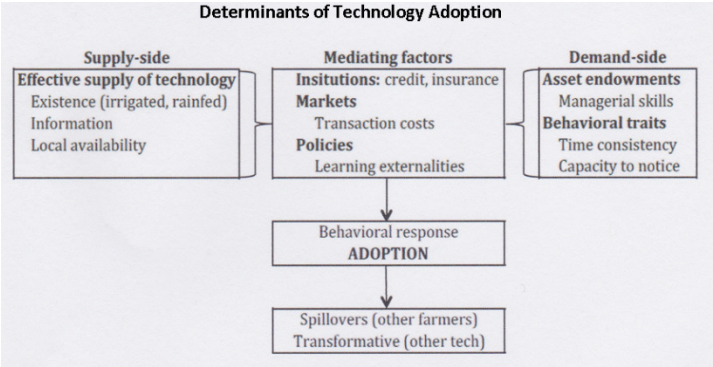

Figure 4. Determinants of technology adoption (after de Janvry et al. (2016))

If this conclusion holds more generally, then an important question for cereal production in central Myanmar relates to the varieties of rice and maize that smallholders currently use. If the varieties (and associated management such as use of certified seeds and weed control) are inadequate to allow full expression of crop yield in response to improved fertiliser management (Figure 3) then focussing on improved fertiliser management may be inefficient, it may be addressing a symptom rather than a cause of a low crop-productivity problem.

A recent observation in Myanmar is that smallholders are using the maize variety CP808. This is a hybrid variety but not a modern variety. Further assessment of this variety in terms of the crop yield potential is necessary.

3. Agro-ecological regions

de Janvry et al. (2016) proposed 3 categories in rainfed agricultural regions:

- Good potential – low risk (technology for irrigated agriculture applies)
- Good potential – risky (varieties resilient to droughts/floods are necessary)
- Low potential – solutions are not achieved through varieties.

The categories of good or low potential can relate to the natural soil characteristics or capacity and associated climate, and also to the crop varieties available, i.e. are HYVs available? The classification of regions and districts in Central Myanmar according to soil suitability for agriculture is being conducted by another ACIAR project.

Risk can relate to the inherent variability in climate and whether the crop varieties are adversely affected by low rainfall (drought) years. For rainfed regions the question of crop variety performance in drought years is important in assessing potential adoption. If there is substantial downside yield risk then a crop variety may be considered highly risky and therefore not suited for adoption by risk-averse farmers.

Classification of the villages and village tracts surrounding the trial sites according to types of information is being conducted using GIS mapping.

4. Supply-side characteristics of new technologies

The issue of whether suitable crop technologies exist, or are available, leads to questions of desirable traits for technologies to enhance adoption. CIMMYT (1988) and de Janvry et al. (2016) considered that a new technology should:

- Be simple to adopt and use (i.e. being closely related to existing management is desirable). Increased fertiliser rates may easier to adopt if farmers already use fertiliser;
- Exhibit large potential economic gains (a benefit: cost ratio of >2: 1 is considered desirable in a developing country context);
- Be transformative in inducing other behavioural change; and
- Reduce the income riskiness of agricultural production.

In rainfed regions do the currently used varieties have substantial downside risk, and will an improved variety reduce that riskiness (i.e. in drought years)? Associated with risk is the question of variability in soil conditions across a landscape, i.e. if there is variability in crop yield response due to soil variability then a single message about increased fertiliser use may be inappropriate for different locations or regions. And if there is variance in farmer characteristics in responses then this must also be considered.

Pannell et al. (2006) considered adoptability of conservation practices by farmers. Desirable characteristics of a new technology include relative advantage, trialability, and observability. Farquharson et al. (2013) assessed the adoptability of rhizobium inoculation of legume seeds for upland crops in Cambodia using these characteristics. They found that relative advantage and, to a lesser extent, observability were the most important technology traits explaining farmer intentions to adopt rhizobium inoculation.

5. Learning and information for adoption

How do farmers in Central Myanmar think and learn about farming issues that are important to them? This is important question for agricultural development projects concerned with adoption and practice change. Projects should address issues that farmers themselves consider to be important. And the projects should develop their activities to fit in with how farmers learn about crop management and potential changes. The motivations of farmers and their trusted sources of information need to be included in project activities and methods. Two issues arise from these observations – focus group workshops and running field trials.

5.1 Focus group workshops

It is important to determine the issues and problems that farmers themselves consider to be important. Rather than researchers assuming they know what is important, they should first ask

farmers about what they consider to be important. This can include what are considered to be valuable and trusted sources of information, which can shed light on the process of how farmers learn.

The question of who farmers look to and trust for information about farm management was assessed by Farquharson and Cook (2015) in upland Cambodia. They found that the actors who could potentially influence Cambodian farmers (small, medium and large in farm size) include experts (foreign and Cambodian), Non-Government Organisations (NGOs), donors, the Cambodian and foreign governments, and commercial suppliers of farm inputs (Figure 5). These authors found that in upland Cambodia farmers overwhelmingly nominated commercial actors as the primary source of information, credit and supplies. There seemed to be a disconnection between farmers and other individuals or groups seeking to expand and support farmers, including extension services.

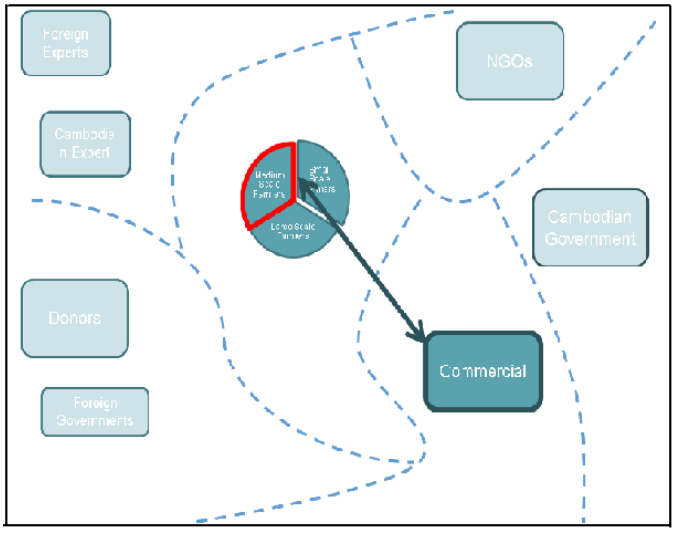

Figure 5. Sources of information for farmers in upland Cambodia

5.2 Conduct of field trials

Second, and leading on from the first issue, it is important to consider the conduct of field activities, i.e. planning and managing the project trial sites, and running field days for farmer groups. Three possibilities are for the trial sites to be managed by YAU researchers, by Department of Agricultural Research (DAR) or Department of Agriculture (DOA) extension officers, or by local farmers. These can be classified as agency managed (YAU/DAR/DOA) or farmer managed. Ideally in a field-based project the demonstration of new technologies or improved management in field trials will be managed in the same way that farmers operate to produce their crops, at least as the base case or counterfactual. Field trials, farmer demonstrations and farmer field days are valuable in the demonstration and adoption process. The management choice can be between agency- and farmer-managed trials, but there are trade-offs in this decision.

In demonstrating a crop yield response to added fertiliser an agency-managed trial will probably generate field plots and results that are clearer in terms of yield differences. But the downside is that farmers may not believe that they can achieve the results on their own farms. Davidson and Martin (1965) found that the likely yield reduction from a research station trial to a farmer field was 33%. If a local farmer manages the trials then the results are likely to be more believable to farmers, but the demonstration plots may not be so clear in differences.

6. Focus Group Workshops and Baseline Survey

A baseline survey and focus group workshop discussions with smallholders in villages surrounding the project sites will be conducted. The main information being collected includes:

- General interviewee Information
- Household information
- Farm decision making
- Individual Farm Information
    - Land Information
    - Soil Information
    - Crop Production
    - Rice/Maize/Black Gram production information
- Fertiliser Usage
- Crop Marketing
- Financing Information
- Constraints and Problems.

The CommCare system for field and other data collection and management is being developed for this survey. CommCare is a free open-source mobile platform that enables development of automated collection of data in the field. It was developed in 2007 by Dimagi, see http://www.dimagi.com/products/.

7. Conclusion

Farming systems throughout the world vary with location, climate, soil, topography, market and institutional or policy frameworks. Individual farmers use their own skills, resources and personal preferences to manage their farms.

In a project considering an apparent low use of fertiliser and low cereal crop yields in an under-studied region or country, initial questions must be answered about farmer objectives and motivations, about their resource and constraints to production, about market opportunities and prices, and about the policy and institutional framework in which they operate.

These understandings are essential for a project to focus on appropriate questions and to develop information that is useful for farm decisions and potential practice change.

References

Baroang, K. (2013). Background Paper No. 1 Myanmar Bio-Physical Characterisation: Summary findings and issues to explore, *retrieved from* *http://www.burmalibrary.org/docs22/Ref_Doc_Background_Paper_1_Myanmar_Bio-Physical_Characterization_May2013.pdf*.

CIMMYT (1988). From Agronomic Data to Farmer Recommendations: An Economics Training Manual, *Completely revised edition*, Mexico, D.F.

Davidson, B.R. and Martin, B.R. (1965). The relationship between yields on farms and in experiments, *Australian Journal of Agricultural Economics* 9, 129-140.

de Janvry, A., Emerick, Kyle, Sadoulet, Elisabeth, Dar, Manzoor (2016). The Agricultural Technology Adoption Puzzle: What Can We Learn From Field Experiments?, *FERDI Working paper 178 Policy Brief*. Fondation Pour Les Etudes et Recherges Sur Le Development International (FERDI).

Farquharson, R.J., Martin, R.J., McCorkell, B., Scott, J.F., El, S., Chan, P., Heng, S., Srey, S., Cheach, M., Svay, S. and Bo, S. (2013). Characteristics of an Agricultural Innovation and Incentives for Adoption: Rhizobium in Cambodia, *International Journal of Environment and Rural Development* 4, 44 - 49.

Food and Agriculture Organisation of the United Nations (2012). Myanmar: Country profile: AQUASTAT, *Retrieved from* *http://www.fao.org/nr/myanmar/aquastat-myanmar.pdf*.

International Rice Research Institute (Undated). IRRI World Rice Statistics, http://ricestat.irri.org:8080/wrs/.

Myanmar Central Statistics Office (2012). Statistical Yearbook, *Cenral Statistics Office*, Yangon.

Myanmar Department of Settlement and Land Records (2012). Settlement and Land, *Central Statistics Office (CSO)*.

Pannell, D.J., Marshall, Graham R., Barr, Neil., Curtis, Allan., Vanclay, Frank., Wilkinson, Roger (2006). Understanding and promoting adoption of conservation practices by rural landholders., *Australian Journal of Experimental Agriculture* 46, 1407-1424.

Ramilan, T., Farquharson, Bob, Thar, So Pyay, Than, Shwe Mar, Aung, Nay Myo (2017). Characterisation of farming systems in Central Myanmar, *61st Annual Conference of the Australian Agricultural & Resource Economics Society*, Brisbane, 8-10 February.

Schultz, T.W. (1964). *Transforming Traditional Agriculture*. Yale University Press, New Haven and London.