Expanding production and use of legume inoculants in Myanmar and Vietnam

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Abstract

For different reasons, inoculation of legumes with rhizobia is not widely practiced in Myanmar and Vietnam, although both countries are major legume producers. In Myanmar, there are problems in the whole supply chain from production and quality assurance (QA) to distribution to demand, whilst in Vietnam farmers have little knowledge of inoculants and routinely fertilise legumes with N. In both countries, widespread adoption of legume inoculation, using high-quality inoculants, could add in the order of A$100 million annually to farmer incomes. This report provides details of projects, funded by ACIAR in Myanmar and AusAID in Vietnam, and which commenced in 2007, that aim to expand production and use of inoculants in those countries through R&D, training, infrastructure development and technology transfer.

Key Words

Rhizobia, farmer surveys, nodulation, capacity building, training, extension

Introduction

Legumes are major crops in Myanmar and Vietnam. In Myanmar, about 3.3 Mt grain are produced annually from 3.3 Mha with projections of 4.5 Mha by 2010. Principal species are pigeonpea (*Cajanus cajan*), green gram (*Vigna radiata*), black gram (*Vigna mungo*), chickpea (*Cicer arietinum*) and groundnut (*Arachis hypogaea*). The crops are primarily grown by small-holder farmers with minimal inputs of fertilisers, pesticides and herbicides. Yields are low because of the lack of nutrient inputs, improved high-yielding varieties and limited options for pest and disease management. Experimental and anecdotal evidence suggests also that productivity and yield may be further diminished because of poor nodulation resulting in crop nitrogen (N) deficiencies. Myanmar farmers have used, and continue to use, rhizobial inoculants when sowing legumes, but the practice is currently not widespread. The Department of Agricultural Research (DAR), Yezin, is responsible for producing inoculants in Myanmar and, together with the Myanmar Agricultural Service (MAS), for their distribution to farmers. Production by DAR peaked during the 1980s at 600–700,000 packets annually. Current production is <100,000 packets, due to limitations in the whole supply chain from production and quality assurance (QA) to distribution to demand. Myanmar farmers use nitrogenous (N) fertilisers sparingly, particularly on legume crops. Thus, low-nodulation induced N deficiencies of the legumes are not remedied by inputs of fertiliser N and the value of lost production could exceed $100 million annually.

The situation is somewhat similar in Vietnam. Groundnut and soybean (*Glycine max*) are the principal legume crops. The Vietnamese government, through the Ministries of Industry (MOI) and Agriculture &

Rural Development (MARD), has plans to expand the current 0.8 million ha of legumes in the country to >1 million ha by 2010. Unlike the situation in Myanmar, farmers in Vietnam fertilise legume crops at rates of 30–150 kg N/ha, rather than inoculate. Thus, grain yields are not compromised but the cost of fertiliser N adds substantially to the cost of production, in the order of $100 million annually.

By way of contrast, Australian farmers have long embraced the practice of legume inoculation. The soils that they first farmed were generally low in mineral N and use of fertiliser N was not an affordable option. Thus, the legumes grown, mainly pasture and forage species, had to supply N for themselves; that is they had to be capable of effective N_2 fixation. In 1896, the famous agricultural chemist, FB (Frederick) Guthrie, wrote about legume N_2 fixation in the *Agricultural Gazette of New South Wales* saying that '…it will prove to be one of the most valuable contributions ever made by science to practical agriculture. It is of special interest to us in Australia….' (Guthrie 1896). Guthrie showed remarkable foresight because now, more than 100 years later, Australian farmers inoculate about 2.5 million ha or 50% of the legumes sown annually. Essentially all of the 3–4 million tonnes of nitrogen fixed annually by legumes growing on about 25 million ha of land can be attributed to either current or past inoculation (Brockwell 2004; Herridge, unpublished).

At the outset, the program teams at the Australian Centre for International Agricultural Research (ACIAR) recognised the intrinsic value of legume N_2 fixation to agricultural systems and, at the same time, the body of expertise that existed within Australia that could be mobilised for collaborative research in mandate countries. Between 1984 and 2001, ACIAR funded 6 projects on rhizobia and inoculation in a suite of countries – Malaysia, Thailand, Indonesia, the Philippines, China, Jordan, Vietnam – as well as a number of other projects on legume N_2 fixation and legumes in farming systems (Herridge 2006). This report chronicles the latest in the series of international projects on rhizobia and inoculation, located in Myanmar and Vietnam and funded by ACIAR and AusAID, respectively.

Myanmar

Project and project objectives

This 4-year project commenced in January 2007 with broad aims to improve productivity of pulse and oilseed legumes in Myanmar's Central Dry Zone (CDZ). The project has specific foci of plant varietal improvement and rhizobial inoculant technology. The objectives are to:

- Identify and distribute high-yielding chickpea, groundnut and pigeonpea cultivars adapted to the relevant cropping systems of the CDZ, using farmer participatory varietal selection
- Increase production of high-quality rhizobial inoculants in Myanmar through application of a cost-effective strategy involving equipment and procedural changes, QA, R&D and training
- Conduct training and extension programs on legume improvement and inoculant technology to enhance R,D&E capacity in these disciplines in Myanmar and to facilitate uptake of project outputs.

The CDZ is an area of about 10 million ha in the centre of the country defined by the 500-800 mm rainfall isohyets and lying between the mountain ranges to the north, east and west and the delta regions to the south. The project is led by Dr OP Rupela, ICRISAT, India, with collaboration from scientists and personnel of NSW Department of Primary Industries (NSWDPI), Australia, and DAR and MAS in Myanmar

Farmer surveys – knowledge of and attitudes to legume inoculation

In March 2007, a Participatory Rural Appraisal (PRA) was conducted involving 163 farmers in the Sagaing, Mandalay and Magway Divisions of Myanmar's CDZ. The PRA provided intelligence on farmer's preferred traits for legume varieties of chickpea, pigeonpea and groundnut, as well as current knowledge and practices relevant to the use of legume inoculants and legume production. The responses indicated that:

- 88% of farmers had heard of inoculants and understood something of what they did
- 75% of farmers use or had used inoculants, the major reason for non-use was non-availability. Use would increase with greater availability
- The MAS (extension service, sources inoculants from DAR) is currently the major supplier of inoculants and information on their use
- 49% of farmers currently apply fertiliser N to their legumes at average rates of <5 kg N/ha.

Current production of inoculants

Currently production of inoculants in Myanmar is <100,000 packets. Quality is low principally because of high levels of contaminants in the fermentation vessels. To counter this problem, large volume (100 L) fermentation has been replaced by small volume (1–2 L) fermentation, coupled with broth dilution and solid state fermentation. Effects of these changes on quality have yet to be determined.

Technical training

Four personnel from the *Rhizobium* group, DAR completed a 3-week training workshop during 4 – 22 June 2007 at the Suranaree University of Technology (SUT), Thailand, with Prof. Nantakorn Boonkerd. Training focussed on inoculant production and fermentation technologies and involved lectures, laboratory training and visits to commercial production facilities. A fifth scientist from the group, Daw Maw Maw Than, is currently at SUT for 4 months as part of her PhD program at Yezin Agricultural University. A sixth scientist, Daw Thi Thi Aung will hopefully embark on a 3-year PhD program at SUT within two months.

Infrastructure development

A substantial amount of project and institutional funds have been used for purchase of laboratory equipment and development of facilities at DAR. One such facility is an air-conditioned plant growth room. New equipment has been commissioned and production and QA protocols modified as a result.

Experimental/extension program

During 2007–08, a total of 63 field trials were conducted in farmers' fields (26 for groundnut, 19 for pigeonpea and 18 for chickpea) with two treatments (+ inoculation and no inoculation). Observations were made on nodulation and plant colour. The results suggested responses to inoculation at many sites and marginal improvements in crop colour that, at face value, are very promising. No field trials are planned for 2008–09. Instead, all effort will be directed at improving the capacity of the DAR *Rhizobium* laboratory to produce inoculants and to implement an appropriate QA program.

Private sector involvement

Currently, there is no private sector involvement, but such involvement is envisaged in the long-term.

Vietnam

Project and project objectives

This 2-year project commenced in March 2007 with broad aims of replacing N fertilisation of soybean and groundnut with rhizobial inoculants. Key issues are inoculant production, quality, distribution and marketing and farmer education. Project plans include involvement of the private sector in both production and marketing to ensure long-term viability. Project objectives are to:

- Increase production of high-quality inoculants for soybean, groundnut and other legumes in Vietnam through enhancement of production capacity, implementation of QA, and increased inoculant R&D

- Increase farmer interest and use of inoculants in Vietnam through effective extension and training programs on inoculants and legume N_2 fixation
- Involve the private sector in the 'pilot production' of legume inoculants, with the aim that the private sector would progressively take over production.

The project is led by Ms Tran Yen Thao, Research Institute of Oil and Oil Plant (OPI), Vietnam, with collaboration from scientists of NSWDPI and the University of Sydney, Australia, and in Vietnam the Institute of Agricultural Science for South Vietnam (IAS), the Soils and Fertilisers Institute (SFI), the Institute of Agriculture and Forestry for Tay Nguyen, and the Agricultural Science Institute for Southern Coastal Vietnam. Three private sector companies are also involved – Komix, Humix and Cu Chi.

Farmer surveys – knowledge of and attitudes to legume inoculation

The survey of 281 farmers and 44 extension officers was conducted during August-December 2007. Of the 281 farmers, 153 (54%) grew groundnut and 168 (60%) grew soybean. The responses indicated that:

- only 15% of farmers had heard of inoculants and understood what they did,
- 99% of farmers did not use inoculants principally because they knew nothing about them. Those that did have knowledge of inoculants did not use them because they were not available in the market place
- 99% of farmers would use them if they could purchase them, based on the belief in new technology bringing yield and economic benefits (85% and 94% of farmers). There was little interest in possible environmental benefits (19% of farmers)
- 95% of farmers currently apply fertiliser N to groundnut and soybean at average rates of 25–80 kg N/ha.

Responses of extension officers indicated that, while they had more knowledge of inoculants than farmers (almost 70% had heard of inoculants and understood what they did), almost none used inoculants in their trials because of lack of availability in the marketplace.

Current production of inoculants

Current production of inoculants in Vietnam is in the order of 1,000–2,000 packets annually. As far as we are aware, there is currently no commercial production of rhizobial inoculants in Vietnam. Quality of inoculants produced at IAS, OPI and SFI were evaluated on three occasions during 2007. The variation in rhizobial counts and levels of contaminants for the different batches resulted from differences in procedures and expertise amongst the three laboratories, effects of peat moisture content, and probable effects of the different sources of peat. The inconsistencies in inoculant quality indicate that improvements are still required, although the testing data indicated a general improvement in quality during 2007. The quality assessment process at OPI worked well, suggesting the foundation has been laid for an effective QA program in Vietnam to underpin proposed expansion of inoculant production.

Technical training

Two training programs have now been completed. The first, in Ho Chi Minh City during 26 Feb – 9 March 2007, focussed on QA and was based on Australian protocols. There were 17 participants, drawn from the collaborating government and private sector institutions. Workshop participants gained practical experience in QA procedures and worked towards defining a QA program for Vietnam. The workshop was designed and presented by Elizabeth Hartley (NSWDPI), Greg Gemell (NSWDPI) and Rosalind Deaker (University of Sydney). The second training program (4 – 22 June 2007), at Thailand's SUT under the guidance of Prof. Nantakorn Boonkerd, focussed on inoculant production and fermentation technologies. Three Vietnamese scientists participated in this training together with the four technicians from Myanmar (see above).

Infrastructure development

Project funds are being used for laboratory operations at OPI, IAS and SFI and for field programs at all institutes. Upgrading of laboratory and plant growth facilities at OPI has also commenced. The plant growth room at OPI will be a key facility for inoculant QA.

Experimental/extension field program

The research focus during 2007–08 was on selecting highly effective rhizobial strains for soybean and groundnut. The Australian commercial strains CB1809 (soybean) and NC92 (groundnut) were found to be more effective than local Vietnamese strains at almost all of the 20 field sites for which data are available. The two Australian strains increased soybean and groundnut nodulation by an average of 62%, biomass yield by 34% and grain yield by 27%, relative to uninoculated plots and by 26%, 11% and 10%, relative to the local Vietnamese strains.

The extension-training program revolves around simple (+inoculation and –inoculation), multi-location, inoculation demonstrations with high-level farmer participation. Training courses are to be developed in association with the demonstrations. A total of 28 demonstration trials have now been conducted in 9 provinces with data available for 15 of the trials. Overall, inoculation of soybean and groundnut increased grain yield and potential farmer income by an average of 6% and 3.5000.000VNĐ/ha (A$230/ha). Most of the economic benefit came through reduced N fertiliser costs. Farmers were invited to the demonstration sites at least once and, in many fields they came for nodule and biomass samplings as well as at grain harvest time. Overall, there were a total of 600–800 person visits.

Private sector involvement

Private sector partners are critical for ensuring long-term production and distribution of high quality legume inoculants in Vietnam. A strategy has now been developed to transfer inoculant production technology from the institutes to the Komix company. Their facilities for microbiological fermentation are good and they have an extensive marketing network. The other companies in the project will be involved in marketing.

Conclusion

The projects in Myanmar and Vietnam are progressing well, although a number of challenges remain. In both countries, the greatest challenges are to dramatically improve the quality of inoculants through changes to production protocols, implementation of QA and development of efficient product distribution networks. Early involvement of the private sector in Vietnam has been positive with interest of at least one company in both inoculant production and marketing.

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