

BSES Limited



**REVIEW OF THE GREEN GRASSY SHOOT DISEASE (GGSD) SITUATION IN
NGHE AN PROVINCE, VIETNAM 16-26 APRIL 2009**

by

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SR09002

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PROJECT LED BY PROFESSOR LESTER BURGESS, SYDNEY UNIVERSITY, NSW**

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SUMMARY

- I was invited to Nghe An Province by Professor Lester Burgess (Sydney University) and the Plant Protection Sub-Department of the Ministry of Agriculture (PPSD), Vinh City, Nghe An Province to review the sugarcane green grassy shoot disease (GGSD) situation in the Province. The trip was funded by the ATSE Crawford Fund.
- Green grassy shoot disease (GGSD) is having a drastic effect on sugarcane production in the NAT&L Quy Hop sugar factory area, contributing to a reduction in the total crop delivered to the factory by an estimated 50% in the 2008-2009 crop (0.6 versus 1.2 Mt of cane in 2007-2008).
- Valuable knowledge of GGSD and important contacts were made during the visit.
- The NAT&L sugar factory has been very innovative, especially in the GGSD extension program.
- The main contacts in Vietnam are the NAT&L sugar factory, PPRI, PPSD and Nghe An MARD.
- Strategic meetings held during the visit led to key agencies in Nghe An Province agreeing on urgent initiatives to bring the disease under control.
- The most immediate action required is to terminate badly affected crops and to replant with disease-free planting material. This issue was addressed during the visit.
- A R,D&E project proposal was developed in collaboration with the NAT&L sugar factory, Quy Hop, for potential ACIAR funding. This project will have very significant benefits for the Vietnam and Australian sugarcane industries and will lead to the long-term sustained control of GGSD in Vietnam. It would also prepare the Australian sugarcane industry for a disease incursion by GGSD, grassy shoot disease (GSD) or white leaf disease (WLD).
- Some training of young scientists from Vietnam and Laos in pathogen isolation and symptom recognition occurred during my visit.

1.0 BACKGROUND

Green grassy shoot disease (GGSD) has been rapidly escalating in the Quy Hop district of Nghe An Province, Vietnam. Details of the geography and location of the Quy Hop district are given in Appendix 1. The disease has very close similarity to grassy shoot disease (GSD), a disease known from south Asia and parts of SE Asia. GGSD is characterised by the production of very small grassy tillers during the growth of the crop; so many may be produced that the number of normal, high-yielding stalks becomes a very small proportion of the commercial crop. In these instances, yields have commonly progressed from 60-70 tonnes cane / ha in plant cane to 15 t/ ha in the first ratoon and zero commercial yield in the second ratoon.

My visit resulted from an invitation by Professor Lester Burgess, Sydney University, who has, and has had, ACIAR-funded projects in Nghe An Province since 1993. These projects have focussed on a range of disease issues in many crops and have also involved the training of local Vietnamese scientists in disease techniques and management. Some have undertaken external studies and postgraduate degrees in Australia. Funding was provided by the ATSE Crawford Fund. Prof. Burgess was seeking sugarcane pathology expertise with a rapidly expanding problem in the Vietnam sugarcane industry. It is worth noting that a former BSES Extension Officer, Peter Nielsen, spent over seven years in the area either as the General Manager of the Quy Hop sugar factory, or as a consultant (after his retirement) to the factory. His feedback on the disease situation has been invaluable.

My time in Vietnam involved several field visits to Quy Hop, consisting of a field visit to become more familiar with the disease, a second visit to present a sugarcane diseases workshop, and a third visit to view novel GGSD extension methods being used by the Quy Hop sugar factory. Other meetings included teaching sessions on sugarcane diseases for the office of the Plant Protection Sub-Department of the Ministry of Agriculture (PPSD), Vinh City, Vietnam. There remains a need for urgent targeted research into GGSD; this research will assist the Vietnamese farmers to survive the course of the GGSD epidemic and at the same time allow the Australian sugarcane industry to prepare for a very important disease, should an incursion occur. Details of a potential ACIAR-funded project are included in Appendix 2.

2.0 PRE-VIETNAM INTERACTIONS

PowerPoint presentations on important sugarcane diseases in SE Asia were prepared and sent to Prof Burgess; these were translated into Vietnamese before the start of my visit. A teleconference was also established between Prof Burgess, Peter Nielsen and myself to provide the best pre-visit understanding of the disease situation and local contacts before our visit. Peter's first-hand experience of the disease and the local area was very helpful and assisted with

visit planning. Notes taken on information supplied by Peter are included in Appendix 3.

3.0 STAFF INVOLVED IN VIETNAM MEETINGS

Participants (April 16-26, 2009)

BSES Limited

Dr RC Magarey - Principal Plant Pathologist, BSES Limited

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Ms Nguyen Thi Minh Thu

Ms Le Thi Minh Thu

Mr Pham Thanh Long

Mrs Pham Thi Tien

Mr Nguyen Van Khuong (Driver)

NAT&L Sugar Factory, Quy Hop

Mr Ngo Van Tu - Email: tu.ngovan@natl.com.vn

Nghe An MARDI (Department of Agriculture equivalent)

Mr. Nguyen Tho Canh (Director or D-G)

Nghe An PPC (Provincial People Party – Communist Party)

Mr Nguyen Van Lap (Agronomy Specialist)

Nghiadan District

Mr Le Hong Son (Vice-Chairman)

4.0 TRAVEL

Travel was via Brisbane, Singapore, Ho Chi Minh City, to Vinh City, Nghe An Province. Travel to Quy Hop was by car. The itinerary for the visit is in Table 1.

Table 1 Itinerary for the Nghe An Province visit in April 2009.

Date	Travel
16-17 April	Travel to Vietnam
18 April	Visit to NAT&L Quy Hop sugar factory area to see GGSD
19 April	Preparation of PowerPoint presentations for extension training (including checking of Vietnamese translations)
20 April	Presentation to NAT&L, Quy Hop factory staff, Quy Hop sugar factory
21 April	Presentation to PPRI, PPSD and Quy Hop factory leaders, Vinh City
22 April	Morning at PPSD; afternoon seminar at Provincial office, Department of Agriculture (Nghe An MARD) on GGSD
23 April	Meeting at Nghe An MARD, including officials from all departments and Quy Hop sugar factory, to discuss the GGSD response and application for Government funding for eradication of heavily diseased areas
24 April	Field trip NAT&L, Quy Hop sugar factory to observe novel GGSD extension techniques.
25-26 April	Travel back to Australia

5.0 FIRST VISIT TO NAT&L QUY HOP SUGAR FACTORY AREA (GGSD), 18 APRIL

A two and a half hour car trip on Saturday 18 April was via the number 1 Vietnam highway linking the south with Hanoi, then travel west into more hilly/mountainous country where sugarcane is grown. Other crops seen along the way were rice, corn, peanuts, cassava and several tree crops (mango, long-an, citrus). The Quy Hop sugar factory produces around 1.0 Mt of sugarcane with 24,000 farmers supplying sugarcane from around 1 ha each. Average yield is 60-70 t/ha with rendement (CCS) approximately 8-9 %.

Five sites were inspected during the visit; we were accompanied by Mr Tiao, a Quy Hop sugar factory agronomist (Figure 1). There were some difficulties with translation making it slightly more difficult to find out information. Severe symptoms of the disease were seen in first ratoon crops of the variety MY55-14; this is not the most susceptible variety to GGSD but still suffers badly from the disease. The most pronounced symptoms (Figures 2-7) were very small and profuse grassy tillers at the base of affected stools; generally there was no leaf chlorosis, though we did find a few in one specimen, and stool death resulting in greatly reduced yields. Chlorosis symptoms were seen in a side-shoot in a

mature stool and these did not appear to be caused by leaf scald. Many of the axillary buds had germinated and some of these were completely chlorotic. From ad hoc evidence it appears that cool conditions in Quy Hop may favour chlorosis, though this needs to be substantiated. The result of high disease severity in a crop was the presence of long sequences of row with whole stools consisting of only very small (10-20 cm high) profuse tillers. In these crops, yield losses are substantial, while in subsequent ratoons, many stools die leading to complete yield loss.



Figure 1 Members of the PPSD inspection team and the Quy Hop Sugar mill inspecting sugarcane near the NAT&L Quy Hop sugar mill (from left: Mr Ta Dinh Tro – factory agronomist; Rob Magarey, Mr Lam, Miss Vinh, Mr Long – all PPSD staff)



Figure 2 Typical small green grassy shoots of green grassy shoot disease (GGSD) in a crop of MY55-14 in Quy Hop Sugar mill.



Figure 3 Small green shoots, typical of GGSD, at the base of a stool of a mature cane stool which are often the first symptoms (above); and as young ratoon shoots in MY55-14 in Quy Hop sugar mill (below).



Figure 4 Normal ratoon shoots (at left of foreground) and green grassy shoots (right foreground) in MY55-14 in Quy Hop sugar mill area, Nghe An Province.



Figure 5 ROC10 is not as badly affected as MY55-14. Slightly stunted ratoon shoots can be seen next to a normal ratoon shoot in Quy Hop.



Figure 6 Side-shooting and chlorotic shoots were seen on one stalk in a mature crop of MY55-14. Leaf scald symptoms (such as pencil lines) were not seen. There is some potential variation in symptoms of GGSD (which may include chlorosis).



Figure 7 Chlorosis was seen in another mature stool that also showed typical very small grassy tillers at the stool base. Slicing of this stalk failed to show any evidence of internal reddening associated with leaf scald.

Disease data collected by the sugar factory suggests that GGSD is spreading rapidly, via the planting of diseased planting material and most likely also via an insect vector. Older texts suggest GSD has no insect vector, although a 2006 paper (shown to us while in Vietnam) attributes a leafhopper vector to GSD. Vietnam observations suggest that GGSD has an insect vector too.

There remains an urgent need to undertake immediate research and extension to limit the spread of the disease in Nghe An Province – and lead to minimally diseased cropping areas. Unless this is achieved, farmers with no alternative potential cash crops will lose subsistence income, while the sugar factory will face hard economic circumstances. The involvement of Australian scientists will not only provide significant benefit in establishing the necessary skills and knowledge needed to combat the disease in Vietnam, but their experience will equip the Australian sugarcane industry for a GGSD disease incursion.

A potential research project plan for an Australian-led project (perhaps suitable for ACIAR funding) is attached in Appendix 2. Key elements are:

1. Survey to assess the extent of the phytoplasma disease problem (specimen archive) in Vietnam and close neighbouring countries where GSD, WLD and GGSD occur.
2. Full description of disease symptoms.
3. Specimen assay for pathogen(s) using known phytoplasma primers.
4. Development of specific primers and ability to distinguish between phytoplasma diseases with similar symptoms.

5. Research to identify vector(s) and vector population dynamics and controls.
6. Research to identify hot-water treatments that eliminate the disease to provide healthy plant sources.
7. Development of resistance screening test (with standards) and arrangements for importation of other germplasm into Vietnam.
8. Development of a suitable Integrated Disease Management (IDM) program
9. Suitable extension and training programs to ensure good disease management is extended to farmers.

6.0 WORKSHOP / SEMINARS AT NAT&L SUGAR FACTORY, QUY HOP (SECOND VISIT), 20 APRIL

A series of seminars was organised for over 40 NAT&L Sugar Factory staff members to discuss phytoplasmas and green grassy shoot disease (GGSD) in particular. The staff (Figure 8) who attended are regularly in the field conversing with sugarcane farmers. Three seminars were presented, with PowerPoint presentations in both Vietnamese and English (two computers); these addressed the following topics:

- i. introduction to phytoplasmas by Prof. Lester Burgess,
- ii. green grassy shoot and other phytoplasma diseases in sugarcane by Rob Magarey, and
- iii. other significant sugarcane diseases in Vietnam by Rob Magarey.

The PPSD staff members translated the PowerPoint presentations, whilst Mr Tu, NAT&L Sugar Factory, translated the verbal presentations.



Figure 8 Professor Burgess (Sydney University) and Mr Tu (NAT&L Quy Hop sugar mill) (left) and the attendees at the Quy Hop sugar factory staff seminar where phytoplasma diseases were explained to factory field staff and important field observations on GGSD sourced.

The staff provided some very important feedback on GGSD and the other diseases. Some points to note were:

- GGSD production effects: Factory staff suggested that the total factory crop amounted to 1,200,000 t in 2007-08, but only 600,000 t in 2008-09; the main factor was GGSD. If this is the case, a 50% crop loss must challenge the economics of the entire factory operation.
- Varieties: the worst affected varieties are MY55-14 and ROC10, while the lesser affected are ROC16 and KK2 (a Thailand variety). Highly resistant varieties are unavailable. Unfortunately, MY55-14 and ROC10 comprise around 80% of the current cropping area.
- Effect of sugarcane cultivation: the factory advisory staff from badly affected districts within the mill area (about one quarter of the production area) suggested that sugarcane cropping within this part of the mill area would fall by between 10-50%. This will greatly challenge sugarcane production economics at the sugar factory.
- GGSD transmission: most felt that the speed of GGSD transmission suggested that an insect vector must be involved. An example was recounted where a geographically isolated area quickly acquired the disease, even though no planting material was introduced (as far as was known).
- White (chlorotic) leaves: A significant number of staff suggested that white leaves had been seen accompanying some GGSD symptoms. While leaf scald in some cases may have resulted in these observations, the sighting of white leaves could suggest that other phytoplasmas (GSD or WLD) may be present or that there is variation in the symptoms produced by GGSD.
- GGSD: There was very clear acknowledgement that although symptoms of the disease affecting crops in Quy Hop may vary, GGSD symptoms (with no chlorosis) form the basis of the disease epidemic.
- History: Mill staff (Mr Tu in particular) provided important information, suggesting that 5-15 years ago, mill staff imported a number of varieties from around Nghe An (and other countries) and established a nursery plot not far from the Sugar Factory. It is in this region that the current GGSD epidemic is affecting crops. It is quite possible that the disease was introduced at that time and that the epidemic has radiated since then.
- Other diseases:
 - RSD: When asked about their knowledge of RSD, staff indicated they had some knowledge and that they remembered Barry Croft's (BSES) previous visit. Unfortunately, it appears that few RSD controls have been put in place. Some disturbing information was that a couple of demonstration plots failed to show differences in yield between healthy and diseased cane; this may have resulted for a number of reasons (perhaps diseased 'healthy' cane was used, or a tolerant variety; weather conditions in that year may have mitigated yield responses etc). It is highly likely that Quy Hop Sugar Factory is also experiencing an unseen RSD epidemic and that yields are suffering because of this disease as well.
 - Smut and leaf scald: both diseases were recognised and interestingly smut was not seen as a major problem, nor had staff seen major yield effects from the disease.

- Pineapple sett rot: it was obvious from discussions with the factory staff that poor germination of planting material was an issue for crop production. We viewed a field trial where both fungicide (propiconazole) and insecticide (chlorpyrifos) had been applied to setts at planting. There were very large differences in germination; when setts that had failed to germinate were excavated, there were obvious pineapple sett rot symptoms. Isolations were attempted at the PPSD laboratory and *Ceratocystis paradoxa* recovered. Planting-material diseases are likely to form another significant disease issue for the factory but pales into relative insignificance (except when attempting to maximise GGSD-free planting material multiplication) when compared to GGSD.
- Soil health: general observations of cultivated soils used for watermelon, sugarcane and other crops suggests that soil physical, chemical and biological parameters are in decline due to the farming systems used. Poor soil structure and soil erosion were very obvious in cropped fields (sugarcane and watermelons). Soil cultivation and a lack of organic matter incorporation are two key issues.

7.0 ATSE CRAWFORD FUND WORKSHOP; SUGARCANE DISEASES, VINH CITY, 21 APRIL

This workshop involved PPRI staff (Plant Protection Research Institute, based in Hanoi), PPSD (Plant Protection Sub-District, based at Vinh City), Quy Hop sugar factory (Mr Tu and several others), Professor Burgess and myself, and was directed specifically at the GGSD situation. Prof Burgess again spoke on phytoplasmas, while I presented on GGSD, GSD, and other diseases present in Vietnam (Figure 9). Approximately 30 people attended. The objective of the meeting was to ensure all Government staff were aware of the sugarcane disease epidemic and to focus on a co-ordinated response to ensure yield losses, and economic effects on farmers, is kept to a minimum. Three key immediate disease control strategies were emphasised:

- i. very large-scale supply of disease-free planting material,
- ii. termination of badly infested crops,
- iii. maintaining planting material free of leafhoppers.

Preventative measures for pineapple disease control are also needed to ensure the efficient utilisation of GGSD disease-free planting material. There are obvious factors that need to be considered in an epidemic management strategy, and these were raised: quality control of the planting material, ensuring that the disease-free material brought in from other districts is not infested with other serious pests or diseases, incentives for smaller farmers to terminate their badly infested crops (and ensuring they don't lose out financially) and very good collaboration between Government, Sugar Factory and farmers.



Figure 9 Attendees at the ATSE Crawford fund seminar on GGSD held at Vinh City; staff came from the PPRI, PPSD and the Quy Hop sugar factory (left); Prof Burgess and Mr Tu (Sugar Factory Management) at right.

Mr Tu presented an overview of the GGSD sugar factory strategy control program; the greatest emphasis is on the following activities:

1. Provision of disease-free planting material: some material is being sourced from lesser affected areas. The scale of this operation and the quality control on disease-free material is unclear.
2. Incentives to terminate heavily diseased crops. These were initially made available to farmers who destroyed crops and replanted with healthy seed cane in areas >5 ha, but after discussions with farmers this has since been reduced to 2.0 ha. Currently in the 2009 crop, 500 ha are badly diseased with GGSD (yet to be terminated), while 1,700 ha remains lightly diseased. Pressure is being applied by both the sugar factory and local communes to local farmers to terminate infested crops.
3. Farmer training: although not spoken about extensively, it is clear that the Factory is attempting to train farmers on the benefits of controlling GGSD and using novel techniques (for instance TV games to illustrate management principles).

Mr Tu also mentioned that woolly aphids have been attacking sugarcane and reducing rendement (CCS) by around two units; an insecticide spray program has been used to keep populations low and this strategy may influence leafhopper populations.

During the presentation it was identified by the staff present that leafhoppers had been caught in light traps, but it was not known if these had originated on sugarcane. An entomologist had observed leafhoppers on cane but failed to catch any.

Dr Vien, Head, PPRI, Hanoi, suggested the following issues are where outside help is needed:

- i. diagnostic tests for disease pathogen,
- ii. identification of associated vector(s),
- iii. disease-free planting material,
- iv. development of a resistance screening test,
- v. access to resistant varieties,
- vi. farmer training, including extension assistance,
- vii. training staff in laboratory diagnostics.

The one-day meeting also involved informal discussions between key leaders, including Dr Vien, Head, PPRI, Mr. Thieu, Head, Vinh City PPSD, Mr. Tu, Quy Hop sugar factory, Prof Burgess and myself.

8.0 MEETING AT MARDI, NGHE AN, WEDNESDAY 23 APRIL

A result of the workshop on the 22 April was a call by the Director of the Nghe An MARDI (equivalent to the Department of Agriculture) who wanted to be briefed on the disease situation. Prof Burgess and I attended and presented again our Vietnamese PowerPoint presentations on phytoplasmas and GGSD. We were asked several questions and the urgent nature of the disease epidemic was clearly proposed to the Director. We were then invited to join with the Director at a hurriedly-organised meeting for the following morning where all relevant parties (Government, Sugar Factory and Provincial People's Party) were invited. There seemed to be a cascade of responses to the sugarcane diseases workshop presented on Tuesday 21 April.

9.0 COMBINED MEETING – GOVERNMENT AND PRIVATE STAFF: NGHE AN MARDI OFFICE, THURSDAY 23 APRIL

Prof Burgess and I attended this meeting and answered questions as requested (Figure 10). Much of what was presented came from Mr Cahn, Chairman, MARDI, Nghe An. He recommended that any remaining heavily infested crops be terminated as soon as possible (one of our recommendations). The Quy Hop sugar factory had already set several management options in place; these included:

- i. Termination of the worst affected areas,
- ii. Subsidy paid to farmers who terminated >2.0 ha diseased fields,
- iii. Extension concerning the need to terminate badly diseased crops and emphasising the need to replant with healthy planting material. The Mill was assisting in identifying good plant sources.

However, they did not intend to pay small farmers to terminate crops <2.0 ha.

The meeting agreed that:

- i. the Provincial Government be approached to assist with funding (herbicide and labour costs) for terminating and replanting affected crops <2.0 ha.
- ii. the PPSD assist with producing information on spraying out crops to farmers.
- iii. the television media be employed to broadcast the need to terminate diseased crops
- iv. technical assistance for this technology be sought urgently from BSES Limited

In informal talks with Mr Tu, Quy Hop sugar factory, it was clear that the sugar factory has already trialled the use of glyphosate to eliminate cane; their preference was for farmers to cultivate out established diseased crops. Further communication is necessary between all parties.



Figure 10 Mr Canh addressing heads of key agencies on the needed immediate actions to control GGSD in Quy Hop (left) and some of the participants (right).

10.0 NAT&L SUGAR FACTORY, QUY HOP, GGSD EXTENSION MEETING, FRIDAY 24 APRIL

We travelled back to the NAT&L Sugar Factory at Quy Hop and attended an extension meeting at one of the local communes; at least three sugar factory staff were in attendance and they ran a very impressive extension program on GGSD and its control. Approximately 60 local farmers (mainly women) were in attendance and the program was based on a popular TV game show (Figure 11). A PowerPoint program included 30 multiple point questions which two teams had to try and answer. A score was kept of the number of correct answers and the team that answered the most correctly won prizes (small bags of sugar). There was a tremendous sense of fun amongst the participants and the presentation obviously enraptured the local commune population. Our attendance also

generated much interest, particularly our (my) height! Pamphlets on GGSD were given to each attendee afterwards. The amazing thing was that out of 30 questions on key points about GGSD, the two teams of local farmers answered 23 and 27 correctly! The extension program went for about 1.5 hours.

When quizzed more particularly about the program, Mr Tu explained that the sugar factory had five sets of data projectors, sound systems and laptops and these were used continually in the extension program (there are 24,000 farmers supplying the Quy Hop factory). The factory had presented at 175 commune GGSD extension meetings (using the game show format) since the start of 2009! Mr Tu will provide digital copies of the GGSD game show and of some video taken at the meeting.



Figure 11 The NAT&L sugar factory commune extension program held on Friday 24th April near Quy Hop; many of the participants were women (previous page). The program is based on a popular TV game show and there was much enthusiasm from all those attending. PowerPoint slides with one of the multiple choice questions (left) and a diagram of a phytospasma-infected leafhopper (right).

A short field visit was made to a site where hot water treatments were being tested by the PPRI, Hanoi. During the visit, questions were asked of key agencies and individuals about sightings of a potential leafhopper vector, with no success. During our visit to this experimental site, and though the sugarcane was still young (waist high crop), we sighted at least two species of leafhopper. There will be further collections by Prof. Burgess and PPSD staff next week and it is hoped to send these to Australia for identification.

A further visit was then made to the Sugar Factory again where we discussed the key components of a potential ACIAR-funded project. These are listed in Appendix 2. We identified key primary contacts for each part of the program:

- Survey: various institutions
- Molecular / conventional diagnostics: PPRI / PPSD
- Vectors: PPRI / PPSD
- Disease-free seedcane: Sugar Factory / PPRI
- Resistant varieties and screening: Sugar Factory
- Training: Sugar Factory and others

It was decided that the lead Vietnamese would best be the NAT&L Sugar Factory at Quy Hop. Prof. Burgess is to speak to the PPRI in Hanoi and the Australian Ambassador to Vietnam about these proposals next week.

Following this meeting our group travelled back to Vinh City via the Ho Chi Minh highway. We stopped and made observations in a very badly smut-affected sugarcane crop – there were whips everywhere. In addition, severe leaf scald was observed in quite a few stools and samples were taken for isolation later in the evening. Other crops (tea etc) with diseases were also observed.

11.0 DISCUSSION

There is a severe green grassy shoot epidemic developing in sugarcane in the NAT&L Sugar Factory area at Quy Hop, Vietnam. This is threatening yields and is likely to be spreading to other sugarcane cropping areas in Vietnam. It is also likely to be present in Laos and perhaps other neighbouring countries (apart from Thailand where it was first observed). The NAT&L factory is taking the epidemic very seriously and has developed very effective extension programs to transfer key messages to the 24,000 cane farmers supplying the factory. The Factory, plus other research and extension institutions in Vietnam, are also seeking the assistance of BSES to help ensure the economic effects of the disease are restricted. Without further research and extension assistance, GGSD has great potential to cripple production in Vietnam.

My visit, funded by the ATSE Crawford Fund, proved very valuable. A great deal of new information was obtained on GGSD and about the agencies addressing the issue within Vietnam. Several key meetings were attended and a proposal was developed to submit to ACIAR for funding consideration. It appeared that the visit by Prof Burgess and myself precipitated the gathering of key Vietnamese

research, extension and governing agencies – who then made some very important decisions regarding the control of GGSD. Without our visit, it seemed likely these actions would not have occurred.

There is now a key draft document ready to submit to a potential funding agency (ACIAR, see Appendix 2). The NAT&L sugar factory appears to be happy with this proposal, but further agreement with the factory and the other agencies will be needed with submission of the proposal to ACIAR. BSES management will need to consider whether this proposal is appropriate and can be populated by appropriate staff. By undertaking the project, I see the following advantages:

- i. Diagnostics for potential new Australian sugarcane pathogens (for use in exotic disease incursions) will be developed. This will be essential to properly deal with an incursion of a phytoplasma in the Australian industry.
- ii. Our expertise with phytoplasmas will be greatly enhanced.
- iii. Our scientists will further develop their expertise, particularly some of the lesser experienced staff.
- iv. We will be able to test our varieties for resistance to GGSD, GSD and perhaps WLD and, therefore, be in a position to consider our vulnerability (and risk factors) related to phytoplasma diseases.
- v. We will develop much better scientific contacts in this part of S.E. Asia.
- vi. Funding for several key staff and activities may be provided by the funding agency.

A very obvious feature of my time in Vietnam was the poor condition of the cropping soils. Many (cassava, sugarcane, tea, corn, beans, etc) were growing in a farming system that incorporated a bare soil surface; these soils appeared to have very low levels of organic matter. It was difficult to find organic matter mulch anywhere. The vulnerability of the soils to erosion and the likely poor CEC, biological buffering and nutrient and moisture retention capacities are only a few of the probable outcomes from this situation.

12.0 CONCLUSIONS

1. The visit provided first hand knowledge of green grassy shoot disease (GGSD). The disease is having a very serious effect on sugarcane production in the biggest sugarcane production area of Nghe An Province (NAT&L sugar factory).
2. The visit facilitated key decision-making within lead Vietnamese agencies for implementation of the most urgent control options.
3. The visit led to the development of a draft R, D and E project proposal for potential submission to ACIAR for funding. There was general agreement on the content from the NAT&L sugar factory.
4. Potential outcomes from the proposed R, D and E will be of very significant benefit to both the Vietnam and Australian sugarcane industries.

13.0 ACKNOWLEDGEMENTS

I thank the ATSE Crawford Fund, and Prof Burgess, for facilitating this visit.

APPENDIX 1: GENERAL PHYSICAL FEATURES OF NGHE AN

Area: 16,487 sq km

Population: 3,002,298 inhabitants

Provincial Town: Vinh City

Provincial Communes: Cua Lo Town, Thai Hoa Town and communes: Dien Chau, Quynh Luu, Yen Thanh, Do Luong, Nghi Loc, Hung Nguyen, Nam Dan, Thanh Chuong, Tan Ky, Anh Son, Con Cuong, Nghia Dan, Quy Hop, Quy Chau, Que Phong, Tuong Duong, Ky Son.



Nghe An Administrative Map

Geography

Nghe An is a north central province of Vietnam. It is situated from the longitude 18°33'10" to 19°24'43" north, and from the latitude 103°52'53" to 105°45'50" east. Nghe An borders Thanh Hoa in the north with a 196,13km borderline. It borders Ha Tinh to the south with a 92.6 km borderline. Laos to the west with a 419km frontier and faces the East Sea in the east with a 82km long-coastline. Nghe An covers a total area of 1,648,729 ha.

Topography

Nghe An Province lies on the north east of Truong Son Mountain Range. The topography is complicated and separated by the mountains and hills, rivers and streams with the descending slope from the north - west to the south-east. The most highest peak is Pulaileng (2,711 m high) in Ky Son District, the lower is the plains of Quynh Luu, Dien Chau, Yen Thanh districts. At these places Quynh Thanh Commune in Quynh Luu District is only 0.2 m high above the sea level. The mountains and hills occupy 83% area of the natural land of the province.

The system of rivers is dense. The total length of the running rivers and streams are 9,828 km, with the average density is 0.7 km/sqkm. The biggest river is Ca (Lam) originates from Muong Pec District in Xieng Khoang (Laos) with 532 km long. The coastline is 82 km with 6 watercourse- mouths which are convenient for sea transportation, and developing sea port: Cua Lo Sea Port.

Climate

Nghe An lies in the tropics and temperate zone, and is influenced directly by hot and dry of wind (from April to August) and cold north east wind (from November to the March next year).

APPENDIX 2: POTENTIAL GREEN GRASSY SHOOT PROJECT FOR ACIAR FUNDING

Introduction

Green grassy shoot disease (GGSD) is escalating rapidly in the Quy Hop area affecting over 6,000ha of sugarcane crops to a varied degree; it threatens a much greater area. Affected crops yield very poorly; healthy crops within a year decrease in yield potential from 60-70 tonnes biomass / ha to 15 tonnes / ha. The disease is still spreading and threatens both a much larger proportion of the NAT&L sugar factory production area in Quy Hop, and sugarcane factories in other parts of Vietnam. On this visit, funded by the Crawford fund and hosted by the Vinh PPSD, an assessment was made of the disease situation and the actions needed to bring the epidemic under control. Listed below are some actions needed and potential work that I suggest should be considered for ACIAR funding.

Key project elements

- 1. Survey to assess the extent of the phytoplasma disease problem (specimen archive)**
 - Including the sugarcane-producing Provinces of Vietnam, Thailand and India (some specimens may be submitted by researchers in the latter countries, though it is important that key project staff view the white leaf (WLD) and grassy shoot (GSD) in the field).
 - Specimens to be preserved to allow for molecular assay development and testing.
- 2. Full description of disease symptoms**
 - Defining the extent of symptom variation with each disease – coupled with molecular assay.
 - Defining in more detail symptoms for each disease
- 3. Specimen assay for pathogen(s) using known primers**
 - BSES staff at Indooroopilly to test specified primers for WLD, GSD and GGSD at Indooroopilly with known samples of each disease. A Vietnam laboratory to work in partnership to learn assay procedures and ensure molecular skills are developed.
- 4. Development of specific primers and ability to distinguish phytoplasma diseases**
 - Further molecular assay development will ensue if current primers for each disease (WLD, GSD and GGSD) are unsatisfactory. This will ensure the Australian sugarcane industry is in a position to assay for a phytoplasma disease, should a disease incursion occur.
- 5. Research to identify vector(s).**
 - An Australian entomologist would be included to assist with transmission studies in Vietnam to determine the vector of GGSD. This will involve: -

- Surveys of affected fields to determine the potential vectors present and their population dynamics (peak population times)
- Cage experiments with possible vectors as a follow up to population studies in the field
- Potential soft pesticides or biocontrols that may minimise vectors within disease-free plant sources.

6. Research to identify HWTs that eliminate the disease

- Simple experiments will be conducted on a small-scale to determine thresholds for eliminating GGSD from planting material.
- The potential for increasing the number of HWT tanks within the local industry will be scoped as well as the costs of manufacturing accurate units at a minimum cost.
- The potential for establishing disease-free nurseries and running a disease-free nursery program will also be examined.

7. Develop resistance screening test (with standards) and arrange for importation of other germplasm into Vietnam

- Using field observations determine the level of resistance to GGSD in varieties in Vietnam
- If there is sufficient resistance, select a set of potential 'standard' varieties and begin screening development in a badly-infested area
- Arrange further variety imports to identify other resistant varieties (on-going) in germplasm from overseas or from other SE Asian countries (such as Thailand).

8. Development of IDM

- Including: -
- Disease-free planting material and nursery plots
- Resistant varieties
- Vector controls, either biocontrols or soft pesticides (short-term control).
- Demonstrated through 'model' farms or key local area farmers.

9. Extension and training

- Training workshops: continue the successful training workshops / master-classes to teach industry staff the needed GGSD management program
- Develop a GGSD manual as developed for other diseases by Prof Burgess
- Develop a Vietnamese Field Guide for use by factory staff, PPSR staff and other extension personnel.
- Continue close associations with sugar factory management and staff.

GREEN GRASSY SHOOT DISEASE

Fact Sheet

APPENDIX 3: GREEN GRASSY SHOOT DISEASE (GGSD) FACT SHEET

Introduction

Green grassy shoot disease (GGSD) was only recognized for the first time in the mid-1990s in Thailand. Caused by a phytoplasma, a very small organism that lives in the phloem of the vascular bundles, the disease has caused serious yield losses in Thailand. GGSD has very close similarity to grassy shoot disease (GSD) a disease first seen in India in the 1940s. In 2006, GGSD was recognized for the first time in Vietnam and is currently causing a major disease epidemic in that country, particularly in the Nghe An Province. GGSD, if it was introduced to Australia could cause spectacular yield losses in the Australian sugarcane industry. Issues such as diagnostic techniques, resistant varieties and alternative hosts remain to be researched.

Causal organism

The disease is caused by a phytoplasma; these organisms infest the phloem tissues in the sugarcane vascular bundles. The phytoplasma is difficult to detect, not only because of its small size (requiring an electron microscope) but because of the limited occurrence of the phytoplasma within the tissues.

Symptoms

The main symptoms of GGSD are small, green, and profuse tillering at the base of the mature sugarcane stool. These tillers do not show any white leaves, as is the case with grassy shoot disease (GSD).

When the crop is ratooned, emerging shoots (if there are any) consist of very small, green profuse tillers which fail to develop into mature stalks. Advanced infestations are characterized by very gappy crops and greatly reduced yields. Crops in Vietnam have decreased from 80 tonnes/ha in plant cane to 15 tonnes cane/ha in the first ratoon.

The differences between GGSD, GSD and white leaf disease (WLD) can be summarized as: i. GGSD does not show any white leaves, ii.



GSD has white leaves and grassy tillering, while iii. WLD has white leaves but not a grassy growth habit.

Currently in Vietnam, the main symptoms of the prevalent disease are consistent with GGSD.

White leaves have been observed on a very limited basis in the Quy Hop factory area, perhaps suggesting that GSD or WLD may also be present in a few locations. This needs to be further investigated.





Comparison of grassy tillers with healthy shoots in fields of MY55-14 in the Quy Hop sugar factory area (earliest symptoms in mature cane top).

Yield loss

GGSD is capable of causing major yield losses in susceptible varieties. The production of very small multiple tillers, and the lack of mature harvestable stalks, means the disease has very serious consequences. Crop production at the NAT&L Quy Hop Sugar factory in Nghe An Province, Vietnam decreased from 1.2 m tonnes in 2007-2008 to 0.6m tonnes in 2008-2009 and a significant proportion of this decrease was due to severe GGSD.

Failed ratoons mean very severe financial losses for cane farmers and GGSD is a major disease by any measure for the Australian sugarcane industry.

Diagnosis

Phytoplasma diseases may be diagnosed using molecular tools. General assays for phytoplasmas have been developed and primers for GGSD. However more research is needed to ensure molecular assays are specific to GGSD (and assay results not confused by the presence of GSD or WLD); this work remains to be undertaken. In the field, the disease is diagnosed by the profuse grassy tillering with no leaf chlorosis (white leaves).

Spread

GGSD is spread principally through the planting of infested planting material. However, rapid spread in Vietnam is being interpreted as indicating a potential insect vector. Similar phytoplasma diseases are spread by leafhoppers; in Australia planthoppers are

responsible for spreading Fiji leaf gall, a viral disease in southern Queensland and northern New South Wales. The presence of a vector for GGSD has yet to be confirmed. The disease is not spread by cane juice – so machinery and knives do not spread the infection. Soil does not transmit GGSD either.

Alternative hosts

Little is known of alternative hosts for GGSD. If there are any, they are likely to be closely related grasses. Further research on GGSD hosts is needed.

Control

Planting of disease-free planting material is of prime importance. GSD and WLD are both largely eliminated from diseased planting material by hot water treatments (50C for 2-3 hours) and early work with GGSD suggests a similar result. As for RSD, there is a low level of ‘escapes’ – stalks where the pathogen is not completely eliminated, so care in the selection of disease-free, or minimally diseased planting material is important for subjecting to hot water treatment (to minimise the chance of an escape).

There appears to be a very limited source of resistance in commercial varieties in either Thailand or Vietnam. Further work into resistance, and resistance screening, in commercial varieties is needed.

The most important management options therefore are to eliminate badly diseased crops, replanting with disease-free planting material into fallow ground (no volunteers) and the selection of the most resistant varieties available.





Grassy tillers adjacent to ‘disease-free’ plants in the susceptible variety MY55-14 in the NAT&L Quy Hop sugar factory, Nghe An Province, Vietnam.