

# ***Darwin Initiative for the Survival of Species***

## ***Final Report***

### **1. Darwin Project Information**

Project title:	Training of Vietnamese Scientists in Tree Seed Science and Technology
Country	Vietnam
Contractor	Department of Agriculture, The University of Reading (Project leader: Professor Richard H. Ellis)
Project Reference No.	162/10/029
Grant Value	£65,322
Starting/Finishing dates	1 April 2001 – 31 March 2003

### **2. Project Background/Rationale**

The University of Agriculture and Forestry (UAF) of Ho Chi Minh City (HCMC) was the principal partner institution in Vietnam and co-ordinated the project within Vietnam.

Staff there had identified a lack of knowledge of seed science and technology, as a result of isolation, and the need for such knowledge to reverse forest decline and consequent loss of biodiversity.

In 1943, Vietnam had about 20 million hectares of forest, covering 44% of the country but this was reduced to 23% by 1983. Decades of war, intensive exploitation, fire, and conversion to agriculture destroyed two thirds of Vietnam's natural forests. The actual total area of good quality forest is about 7 million hectares (1994), while a total of 13 million hectares (or 40% of the country) is classed as bare land. Vietnam was rated as the 16<sup>th</sup> most biologically diverse country in the world with about 12,000 species of

higher plants, of which about 5,000 are endemic and found only in Vietnam. It was reported that about 300 tree species endemic to Vietnam are vulnerable to extinction. An end to both the degradation of natural forests and to the introduction of exotic species is therefore central to Darwin Project objectives. Our project addressed the development of Vietnamese scientists' skills and knowledge in tree seed science and technology and its application to the supply of local tree seeds (endemic species and local provenance) to forest regeneration and to reforestation (in place of imported exotic tree seeds).

Dr T.D. Hong has a lifetime of links with Vietnam. The project evolved from: an initial visit to Vietnam in 1996 by Dr Hong (funded by The University of Reading) to assess training needs; subsequent visits to the UAF; subsequent correspondence; and visits by several UAF staff to Reading. The SSL at Reading provided training to Dr Le Quang Hung of the UAF for one year (travel and subsistence funded by The Royal Society).

Vietnam is engaged in a struggle to restore forest. A new ambitious forest planting project aims to raise forest cover to 40% by 2010. The results of the reforestation programme over the previous decade in Vietnam were mostly disappointing. Furthermore the exotic forest species introduced were not well-adapted locally. On the other hand, endemic species are difficult to propagate on a large scale, and seldom regenerate naturally when disturbed extensively. These problems required greater understanding of seed science and technology and a detailed knowledge of the seed physiology of these endemics. Seed science had not been taught in Vietnamese universities. UAF had recognised this deficiency, but had no means of remedying it, despite an enthusiastic staff, because there was no base of expertise to build upon: no research institute or seed science laboratory in Vietnam had the expertise to deal with training and research in this

field. UAF therefore identified the need to draw on UK expertise in seed science for *ex situ* plant diversity conservation to train Vietnamese scientists in the basic and applied science, and also for assistance in problem-solving right through the application of the knowledge obtained in order to provide good quality seed of endemic for forest planting.

### **3. Project Summary**

Purpose and Objectives.

(i) To train a cadre of Vietnamese scientists selected from several universities and research institutes in Vietnam in Tree Seed Science for *ex situ* biodiversity conservation to a sufficient level of practical competence and scientific understanding in order that they can themselves research and train future generations of conservationists.

(ii) To help those scientists to carry out research on tree seed in order to develop the practical competence and confidence in research applied to solve practical problems in seed science for biodiversity conservation

For further information, see Annex 1: Logical framework

Original objectives were maintained and achieved in the light of progress being more rapid than planned and email communications more effective than expected, thus making the final visit unnecessary.

The Article under the Convention on Biological Diversity (CBD) which best describes the project is Article 12, Research and training

This two-year project was much more successful than originally proposed in meeting objectives:

1. Training: Three training courses (one more than the two proposed) to a total of 65 persons (36 more than the 29 trainees proposed). In the second year, an additional dissemination seminar was provided with the attendance of 28 scientists, and nine lectures provided to a total of 209 attendants in Vietnam. This was beyond the proposal in terms of both activities and the rate of progress. It was made possible by the rapid impact of the training courses and subsequent email support from The University of Reading on the ability of participants to develop new and relevant knowledge of endemic species' seed physiology from their investigations.
2. A seed science laboratory was established at UAF, the first such university laboratory for Vietnam.
3. A syllabus for the undergraduate teaching of Seed Science and Technology was introduced at UAF, the first teaching in this topic for a Vietnamese university. Teaching to the first cohort of undergraduates began in Academic Year 2001-2002.
4. Research in forest tree seeds, comprising about 52 endemic species, was carried out at UAF, SOFSE and Reading.
5. The media, in Vietnam and worldwide (principally BBC World Service), gave considerable attention to this Darwin Initiative Project.

#### 4. Scientific, Training, and Technical Assessment

In order to transfer UK expertise to Vietnam, Dr Hong provided training courses, seminars and other presentations.

**Training.** Training was carried out in Vietnam and the UK:

21 May – 01 June 2001. A two-week training workshop, “*Ex situ* seed conservation of tree genetic resources for Vietnam”, was held at the University of Agriculture and Forestry of Ho Chi Minh City (UAF), Vietnam. Twenty six scientists selected from five universities and thirteen research institutes of the southern part of Vietnam participated. The selection criteria were academic qualifications, relevant experience, motivation and enthusiasm. In addition, care was taken to ensure as wide a range of institutions and locations within the region as possible. The training course was delivered in Vietnamese and English and comprised seventeen topics covering basic knowledge of seed science and technology regarding *ex situ* seed conservation (Annex 2, Part 2). The participants were tested prior to the training course and achieved a mean mark of 17.8%. At the end of the course, a similar test gave a mean mark of 83.3% (with five trainees obtaining 100%). Further information on the training workshop’s programme, selection criteria, list of participants, assessment, etc. is provided in Annex 3.

02 July– 29 October 2001. Laboratory training was provided at the Seed Science Laboratory, The University of Reading. The selection of four candidates for this intensive training at Reading was based on the following criteria.

1. Satisfactory completion (high test mark, well motivated, competent, good communicators) of the two-week training workshop
2. Previous experience with tree seeds

3. Institute should have facilities suitable for tree seed research
4. Permission and guarantee from his/her employer for his/her pursuit of tree seed research upon his/her return to Vietnam.
5. Adequate documentation to enable permits to leave Vietnam and visas to enter the UK to be issued.
6. Moderate English language skills (reading and writing) to enable library use, etc.

Four candidates met these criteria:

1. Mr Nguyen Duc Xuan Chuong, aged 24, Lecturer Assistant, UAF.
2. Ms Truong Mai Hong, aged 45, Lecturer, UAF.
3. Ms Banh Ngoc Tam, aged 43, Deputy Director, Southern Forest Seed Enterprise.
4. Ms Vo Thi Le Tam, aged 41, Southern Forest Seed Enterprise.

All four arrived at Reading on 02 July 2001 and returned to Vietnam on 29 October 2001.

During the four months at the Seed Science Laboratory, Reading, the principal activities were as follows.

- Training. They were trained in seed laboratory techniques and taught seed physiology theory related to such practice.
- Research. The students began research in seed desiccation tolerance, seed storage behaviour, appropriate seed germination environments, etc. with seeds of several endemic species of trees from Vietnam. This research formed a part of the learning through experience (“hands on”) component of the training course.

But in addition, it also enabled investigational protocols to be developed for subsequent application in Vietnam and generated new knowledge on these species. A total of 29 indigenous tree species' seeds from Vietnam were brought to Reading for the students' research.

- Visits. Apart from local visits to several other laboratories at The University of Reading, three whole day visits were made to other institutes in Southern England by the four participants.

- \* 7 August 2001. Visit to Botanic Garden Conservation International (BGCI) and the Royal Botanic Gardens, Kew, Richmond, Surrey.

- \* 4 September 2001. Visit to the Millenium Seed Bank of the Royal Botanic Gardens, Kew, at Wakehurst Place, Ardingly, West Sussex.

- \* 25 September 2001. Visit to the Forestry Commission Research Station, Alice Holt, Surrey (including the UK Official Seed Testing Station for Tree Seeds).

By this means, the four trainees were introduced to a large number of potentially useful UK contacts for subsequent collaboration beyond this Darwin Project.

3 and 6 June 2002. Training on tree seed research at UAF. Advanced and "reminder" training was provided to UAF's six seed researchers (Dr Le Quang Hung, Nguyen Duc Xuan Chuong and Mr Tran Thanh Tan of the Department of Agronomy; Ms Truong Mai Hong, Mr Nguyen Kim Loi and Mr Tran The Phong of the Department of Forestry).

5 June 2002. Training in tree seed science and seed research to 10 undergraduate students of UAF who carried out research projects with forest tree seeds under Ms Mai

Hong's supervision (Annex 4, Figure 5).

7 June 2002. Training on tree seed research to 10 research staff of the Forest Science Sub-Institute of South Vietnam, HCM City at an advanced level (Annex 4, Figure 6).

10 June 2002. Training in tree seed research to 8 undergraduate students of the Open University of Vietnam towards their BSc dissertations (under Dr Le Quang Hung's supervision).

14 June 2002. Training in tree seed research and general advice to Ms Vo Le Tam and Ms Banh Ngoc Tam at the Southern Forest Seed Enterprise (SOFSE).

For this training series, Dr Hong prepared a ten-page handout for the course in Vietnamese with two topics; (i) research on seed development and maturation; and (ii) a protocol to determine seed storage behaviour (Annex 2, Part 3). The objectives of this training course was to provide guidelines for tree seed research aimed at solving problems in providing good quality tree seeds for planting.

**Seminar.** Vietnam's first seminar on Seed Technology for Biodiversity Conservation was held at UAF on 11 June 2002. Ten organizations from Vietnam took part (four universities, three institutes and three seed companies). Fourteen topics were presented in two sessions; five on Plant Genetic Resources Conservation; and nine on Seed Storage and Germination. Photographs of this seminar are shown in Annex 4 (Figures 7 and 8). The programme, abstracts, and list of participants are presented in Annex 5.

**Lectures.** In order to raise awareness of Seed Science and Technology, Plant Genetic Resources and Biodiversity Conservation, Dr Hong delivered a total of nine lectures in



Vietnam during January 2002. This series of lectures arose out of diverse invitations/requested following the original training course in May – June 2001 which had been heavily reported in the media within the region.

1. 11 January 2002, Southern Seed Company (282 Le Van Sy, HCM City): “Seed science and technology applied to crops and vegetables in Vietnam” (3 hours, 15 research staff).
2. 14 January 2002, UAF (morning): “Seed science and technology applied to crops, weed control and genetic resources conservation” (3 hours; 23 participants including lecturers and post-graduate students)
3. 14 January 2002, UAF (afternoon): “Development and validation of a predictive storage model for *Metarhizium* and *Beauveria* conidia” (2 hours; 15 participants including lecturers and post-graduate students).
4. 15 January 2002, Saigon Seed Enterprise, HCM City: “Seed science and technology applied to crops and vegetables in Vietnam” (3 hours; 10 research staff).
5. 18 January 2002, Saigon Botanic Garden (2 Nguyen Binh Khiem HCM City): “*In situ* and *ex situ* conservation of tree genetic resources for Vietnam” (3 hours; 12 participants).
6. 23 January 2002, Southern Fruit Tree Research Institute (SOFRI) at Long Dinh, My Tho (70 km from HCM City): “Conservation of fruit tree genetic resources for the Mekong Delta” (3 hours; about 20 research staff).
7. 24 January 2002, Mekong University at Vinh Long (130 km from HCM City): “Application of seed science and technology in crop production and seed storage at the farmer level” (90 minutes). About 80 participants including lecturers, undergraduate students and local agriculturists (Annex 4, Figure 9).
8. 25 January 2002, Can Tho University (CTU), at Can Tho City (180 km from HCM City): “Seed science and technology applied in crop production, seed storage, weed

control and genetic resources conservation” (6 hours; 20 participants including lecturers and post-graduate students).

9. 28 January 2002, Institute of Agricultural Sciences of South Vietnam (IAS) (121 Nguyen Binh Khiem, HCM City) “Seed science and technology applied in crop production, seed storage, weed control and genetic resources conservation” (3 hours, 14 research staff).

## **Research**

Research on Vietnamese tree seeds at Seed Science Laboratory, Reading began in July 2001, when the four Vietnamese scientists (Ms Truong Mai Hong, Ms Banh Ngoc Tam, Ms Vo Le Tam and Mr Nguyen Duc Xuan Chuong) participated in the training course at this laboratory (2 July 2002 – 30 October 2001). Research in Vietnam, at UAF and SOFSE, began in November 2002 after their return to Vietnam together with that by Dr Le Quang Hung. Fifty two species of forest tree seeds (Annex 6, Part 1; Annex 4, Figure 10) have been investigated since July 2001. The objectives of the investigations were to determine (i) seed storage behaviour, (ii) optimal environments for seed germination, and (iii) seed development and maturation to determine optimal time of seed harvest.

1. **At SSL, Reading.** Dr Hong (i) continued the ongoing research on all species in the laboratory at Reading by the four trainees after their return to Vietnam, (ii) complemented the research begun subsequently at UAF and SOFSE using equipment and facilities available at Reading but not available at UAF and SOFSE.
2. **At UAF.** Many topics have been researched by Dr Le Quang Hung, Ms Truong Mai Hong, Mr Nguyen Duc Xuan Chuong, Mr Tran Thanh Tan and fifteen

students.

3. **At SOFSE.** Several experiments have been carried out by Ms Banh Ngoc Tam and Ms Vo Le Tam:

Lists of species, research members and students' research topics are given in Annex 6.

After 18 months (July 2001 – March 2003) of intensive research at SSL (Reading), UAF and SOFSE (Vietnam), the trainees have begun to obtain good results for publications (see Appendix III).

## **5. Project Impacts**

Apart from our achievements in training and research (cited above) we have also achieved the following.

1. Establishment of a seed laboratory at UAF. In May 2001, a seed laboratory began operating at UAF. With monies provided by the Darwin Project (£4,000), one four-decimal place balance, one constant temperature incubator (0 to 50°C), one domestic refrigerator, one deep freeze, one seed grinder, one heat sealing machine (for laminated aluminium foil packets), several electronic thermo-hygrometers, and a quantity of laboratory consumables (Petri dishes, germination test papers, germination boxes, silica gel, laminated aluminium foil packets, etc.) were purchased. With monies provided by UAF, one oven, several desiccators and two desk top computers with a printer were purchased. The new laboratory and its activities are shown in Annex 4, Figures 11 and 12.
2. New syllabus at UAF. A new syllabus for Seed Science and Technology was approved by the Ministry of Education and Training of Vietnam for teaching at undergraduate and postgraduate levels at UAF beginning in Academic Year 2001-2002.

This course comprises 45 contact hours (30 hours for theory, and 15 hours for practical) and is taught by Dr Le Quang Hung. In December 2002, twelve BSc students (8 from UAF and 4 from Vietnam's Open University) graduated with Dissertations on Seed Science and Technology.

Many Vietnamese institutions and their staff and/or students have benefited from this training project. The training project has provided high-quality instruction directly and indirectly to a diverse range of young and mid-career professionals, and relevant problem – solving research is now well underway at several institutions. All these outputs will provide the resources, expertise and motivation to enable Vietnam to better meet its obligations under the CBD.

#### UAF

\* Following training at the Seed Science Laboratory of The University of Reading (funded by The Royal Society in 2000) and then at UAF (within the current Darwin project), Dr Le Quang Hung was invited to give an oral presentation in an international workshop on Seed Technology in Taiwan in July 2001. (Hung, L.Q. 2001. Seed longevity of tomato and eggplant of Vietnam under different temperature conditions. *Workshop on seed and seedling science & technology, Taichung, Taiwan, ROC, 11-15 June 2001*, 1-8).

\* Training future generations of conservationists. For the first time in Vietnam, 20 undergraduate students and one post graduate student were involved in research related to tree seed science and technology and conservation (Annex 6, parts 2 and 3).

\* Two undergraduate students (Tran Thi Kim Thoa and Le Thanh Quang) who carried out research on seed storage of *Dipterocarpus chartaceus* and *Hopea odorata* (Annex 6, part 3) won a third prize of Science Research with this research topic in a

national competition among students of 70 universities of Vietnam in December 2002 (Annex 4, Figure 13).

\* New activities in the Department of Reforestation and Urban Regreening of the Faculty of Forestry have been supplemented recently in the pursuit of training, research, and conservation of plant genetic resources in forests. Ms Truong Mai Hong (Darwin trainee) is Head of this Department (details in Section 8).

\* Dr Fanch Le Hir, a conservationist from the Botanic Garden of Brest, France, met Ms Truong Mai Hong twice (July 2002 and February 2003) at UAF to develop a proposal for a conservation project of rare forest tree species endemic to Vietnam. Dr Hong will continue to provide technical advice to Ms Mai Hong towards this project (if successful).

#### Southern Forest Seed Enterprise (SOFSE).

After the attendance at the training workshop held in May 2001, and the four-month training at SSL Reading (July – October 2001), Ms Banh Ngoc Tam (Deputy Director) has extended storage life of forest seeds in the company seed store using new concepts learnt during her training. For example, previously forest tree seeds of all species after collection were always placed in a cold store (10-15°C), irrespective of differences in their seed storage behaviour. Now, forest seeds with orthodox seed storage behaviour are dried to low moisture contents before packing in sealed thick (0.2mm) polyethylene bags and then placed in the cold store. Such seeds can now survive for more than two years rather than only several months by the old method. Ms Vo Le Tam has also begun to identify seed storage behaviour and determine suitable methods of storage for several important forest tree species. For example, she found that *Anisoptera colchinchinensis*

and *Dipterocarpus alatus*, which are very short-lived in open storage, showed intermediate and orthodox seed storage behaviour, respectively. Hence, seed longevity of these species can now be extended considerably by providing suitable storage environments (but which differ between the two species). SOFSE has benefited from these findings, as have the growers who receive the seeds from SOFSE.

Forest Science Sub-Institute of South Vietnam (FSSISV), HCM City.

After the attendance at the training workshop held in May 2001, Ms Nguyen Hai Hong has contributed a great deal in research at FSSISV. With Dr Hong's advice, she carried out research on melaleuca seeds (see topic 7 of Annex 5, Seminar). So far, she has given presentations at two conferences in Vietnam; (i) Conservation of tree genetic resources of Vietnam, and (ii) Development of reforestation methods for the acid soils of the Mekong Delta. Both practical biodiversity conservation topics are related directly to her research on melaleuca seeds.

Can Tho University (CTU)

After the attendance by two lecturers (Ms Phan Thi Thanh Thuy and Ms Phan Thi Truc Linh) at the workshop held in May 2001, Seed Science and Technology has been included as an additional topic in the existing Post-harvest and Plant Breeding course for MSc students. Dr Hong provided advice on instruments and equipment for the planned establishment of a seed science laboratory (costing about US\$ 10,000), and on a syllabus for Seed Science and Technology teaching at CTU. These proposals are expected to be approved by the Ministry of Education and Training of Vietnam for Academic Year 2003-2004. Research in seed science has also begun recently at CTU. CTU is situated in the centre of the Mekong Delta (without upland forest), its research therefore

concentrated in crop (mainly rice and soyabean) and fruit tree genetic conservation programmes. Its main task was to solve the problem of low viability of soyabean seeds in the Mekong Delta. With Dr Hong's advice, storage of soyabean seeds at low moisture contents has begun recently. Ms Phan Thi Thanh Thuy (Darwin trainee) reported to Dr Hong that after 9 month storage at ambient temperature, soyabean viability remained >95%, while in the normal method of seed storage (open storage in the ambient environment) no soyabean seeds survived beyond six months. Research on storage of rice and other crop seeds are underway.

#### Agricultural Experiment Station of Hung Loc

After the attendance at the training workshop held in May 2001, Mr Nguyen Thanh Binh, Manager in charge of Cashew Project for Vietnam, has contributed a great deal to the subsequent success of this project in Vietnam. Because of the falling price of coffee in the international market, Vietnamese authorities recommended that cashew be grown in place of coffee. But the main difficulty in achieving this goal was the shortage of a sufficient supply of good quality seeds; in their normal method of seed storage (open storage in the ambient environment), no cashew seeds survived beyond six months, while the suitable time for sowing is nine months after the cashew seeds have been harvested. After the workshop, he carried out a small experiment on low moisture content seed storage. Seed moisture content was reduced from 12-13% (present storage method) to 7-8% moisture content using repeated sun drying (7 times). He found that no loss of viability had occurred after nine months of subsequent storage in sealed 0.2 mm-thick polyethylene bags at ambient temperature. He recently emailed to report to Dr Hong that this sowing season (November and December 2002), there was no shortage of good cashew seeds following the improvement of seed storage practices. This "low moisture

content seed storage” technique has now been disseminated to farmers in Vietnam.

Apart from Article 12 (Research and training) achieved as proposed, we also achieved Article 13 (Public Education and Awareness), and Article 16 (Access to and transfer of Technology). See Appendix I.

## **6. Project Outputs**

Project outputs using the coding and format of the Darwin Initiative Standard Output Measures were as follows.

2001: at UAF: 4B= 2 weeks; 4C = 26 persons; 4D= 52 person weeks

at Reading: 4B = 16 weeks; 4C= 4 persons; 4D= 64 person weeks

2002: at UAF: 4B= 0.4 weeks (i.e. 2 days); 4C= 19; 4D= 7.6 person weeks

at FSSI: 4B= 0.2 weeks (i.e. 1 day); 4C= 10; 4D= 2 person weeks

Total: 4B= 18.6 weeks; 4C= 49; 4D= 125.6 person weeks

Output in the agreed schedule = 114 person weeks

We achieved an additional 11.6 person weeks (125.6 – 114).

For more detailed information, see Appendix II.

Appendix III lists all publications and material that can be publicly accessed.

The principal project outputs have been the numbers of individuals trained. Information relating to the fact that training occurred, and the objectives of the training towards the CBD, was disseminated via the media within Vietnam. The less direct outputs of the project will be outputs from the research stimulated by, and to some extent a component



of, the Darwin-funded training. An initial report on the training and early research outputs from the trainees in the context of the CBD and the Darwin Initiative for the Survival of Species was provided in a lecture by Professor R.H. Ellis to the UK's annual Seed Biology meeting (reference to abstract in Appendix III) in April 2002.

Subsequently, a greater range of training and research outputs were disseminated within Vietnam by the seminar held at UAF on 11 June 2002.

The tree seed research has progressed well at Reading, SOFSE and particularly UAF given the participation of many students (see Annex 6). The majority of experiments require 12 to 24 months or more to obtain adequate results. The results of several of the initial experiments which began in July – November 2001 have now been obtained, analysed and prepared for publication. While this is a collaborative venture, Dr Hong has played a substantial role in the latter activities, and several manuscripts have been submitted for publication. Many of the experiments which this project has stimulated will not be completed for some considerable time. Hence, the preparation of manuscripts for publication will continue well after project completion (see Appendix III). The Department of Agriculture, The University of Reading, will continue its role and will also bear the cost of further information dissemination through refereed journal publications, etc.

## **7. Project Expenditure**

Please note that these are not the audited accounts and are the best estimates of financial information available to the researchers at this time. The University of Reading Finance Department will provide audited accounts in due course.

Expenditure details	Total Expenditure	Budget

\*Expenditure on laboratory consumables was higher than proposed because of support to research at Reading, UAF and SOFSE in chemicals and seed collection charges – principally as a consequence of greater experimental work than estimated. Savings were made from Travel, to avoid an overspend, by reducing the number of visits to Vietnam.

### **8. Project Operation and Partnerships:**

UAF has been the principal partner of this project in Vietnam. Dr Le Quang Hung and Ms Truong Mai Hong have been very active. Dr Le Quang Hung, Dean of the Faculty of Agronomy, is the main lecturer in Seed Science and Technology for BSc and MSc course. He supervised eleven students (10 undergraduates and one MSc) for seed research in 2002-2003 (Annex 6). In May 2003, six undergraduates and two Ph.D students will be recruited in seed science. The Seed Science Laboratory, located temporarily in Dr Hung’s office, will be moved to a larger apartment when a new building is completed. Dr Hung also has had some links with several agriculture and forestry institutes in South Vietnam for research in crop, horticulture, and industrial species’ seeds.

Ms Truong Mai Hong, Head of the Department of Reforestation and Urban Re-greening, is a principal lecturer in seed science in the Faculty of Forestry of the UAF. In the 2002-2003 academic year, she supervised ten students for forest seed research (Annex 6). She has begun to set up a net work of forest seeds (mainly seed collection throughout Vietnam for research) among her classmates, as far as to the northern Vietnam.

Ms Banh Ngoc Tam, Deputy Director of the SOFSE (which is a state-own forest seed company), is in charge of the technical activity of the company (vegetative propagation via tissue culture, nursery, seed collection and distribution) for the reforestation programmes in South Vietnam. She is also in charge of two programmes of reforestation with indigenous species; at Cat Tien National Park and Binh Thuan Province.

Ms Vo Le Tam of SOFSE is in charge of forest tree research (tissue culture and seed storage research). She is very active in research. So far, she has given two presentations on seed storage behaviour of (i) *Avicennia alba* and (ii) *Anisoptera colchinchinensis* and *Dipterocarpus alatus* at the Central Forest Seed Enterprise of Hanoi, Vietnam. Her future research will concentrate on seed storage behaviour of species within Dipterocarpaceae and Meliaceae, which provide precious timbers of Vietnam.

Ms Nguyen Hai Hong (Darwin trainee, see Section 5), a unique seed researcher of the Forest Science Sub-Institute of South Vietnam (FSSISV), is also very active in forest tree seed research. She is now specialised in melaleuca species endemic to Vietnam dealing with phenology, seed production, storage, dormancy and germination, planting and field establishment.

There is no similar project in Southern Vietnam. We have contacted the Forest Science Sub-Institute of South Vietnam at HCM City where only *in situ* biodiversity conservation has been realised (see Annex 5, topic 2). In North Vietnam, DANIDA has had a training and forest tree seed research at the Research Centre for Forest Tree Improvement (RCFTI) of the Forest Science Institute of Vietnam (FSIV) at Hanoi. It seems that their activity was restricted to FSIV staff, particularly in Hanoi and surroundings, while the Darwin Project was broadened, not only to FSIV (such as Forest Science Sub-Institute of South Vietnam, Institute of Forest Research at Trang Bom, Institute of Forest Management) but also to five universities (Hue, Ban Ma Thuot, Can Tho and two of HCM City) and ten other research institutes and seed companies of the southern part of Vietnam (Annex 3, Part 3). Second, the DANIDA training programme was somewhat practical and simple to enable Vietnamese scientists to carry out some pre-designed research, while the Darwin Project aimed to broaden basic and advanced knowledge of seed science in order that they can themselves research, solve practical problems and train future generations of conservationists. Third, the Darwin project aimed to train not only scientists in forestry, but also crop, plantation and horticulture in an integrated strategy of biodiversity conservation.

In September 2001, Dr Hong contacted by email with the Director of the Research Centre for Forest Tree Improvement (RCFTI) of the Forest Science Institute of Vietnam at Hanoi for a planned visit to this centre in January 2002. Dr Hong also suggested that he was willing to give a lecture on Tree Seed Physiology for one day (6 hours). A reply letter from the Director of RCFTI said that he would welcome Dr Hong's visit and lecture, but in late November 2001 when Dr Hong arranged the date of the visit and lecture, no reply was made.

With the Seed Science Laboratory established, in a three-year programme (2002-2005) the Department of Reforestation and Urban Re-greening (Ms Truong Mai Hong) of UAF has committed itself to:

- recruit five young research assistants;
- continue to carry research on forest tree seeds regarding seed storage behaviour and germination;
- carry out research on vegetative multiplication for species suitable for both the urban re-greening and the reforestation programmes;
- provide short training courses in biodiversity conservation to provincial agro-forestry cadres.

In addition, the Faculty of Agronomy (Dr Le Quang Hung) will recruit two young scientists regarding research in genetic conservation for fruit and industrial tree species. Dr Hung has also contacted with several provincial organisations for the applied research in crop (mainly rice and maize) and fruit tree (citrus seeds for rootstock) seed storage.

The Southern Forest Seed Enterprise (Ms Banh Ngoc Tam and Ms Vo Thi Le Tam) and the Forest Science Sub-Institute of South Vietnam (Ms Nguyen Hai Hong) will remain active after the end of the project, of course. They will continue to work with foresters and their capacity to regenerate natural forests and to reforest with endemic species has been greatly enhanced as a result of this Darwin Project.

## 9. Monitoring and Evaluation, Lesson learning

For the training programme, we (i) tested trainees before and after training. See the test content in Annex 2, Part 1, and the test results in Annex 3, Part 5; and (ii) rated the value of the training by feed back (Annex 3, Part 6). The pre-training mean mark of the class was 17.8%, with extreme marks of -9% (two trainees) and 61% (one trainee). At the end of the workshop, the mean mark was 83.3% with extremes of 41% (one trainee) and 100% (five trainees). The results of the feed back showed that (i) the content of the training was regarded as very good (19 of 24 participants), (ii) the effectiveness of the instructor was very high (15 participants), and (iii) the importance of the workshop training to the trainee's career was very high (12 participants), where very good/high was the maximum mark possible.

For the research programme, quarterly interim reports were made in order to monitor the progress. Progress was better than planned and no feedback to collaborators was required to correct deficiencies.

Towards the end of the funded project (February 2003), we received 12 feedback forms from an email survey of 18 Vietnamese scientists (who have email address among 26 participants of the training workshop held in May 2001). In general, the training course in May 2001 was said to have improved participants' knowledge of seed science (12 participants), 9 participants have applied the new knowledge in their careers, while three reported that their current careers are no longer to seed science and conservation. Examples of impacts are shown in Section 5 (Project Impacts).

Dr Jan Dick, Centre for Ecology & Hydrology, Edinburgh, conducted a review of this project in Vietnam from 21 October to 26 October 2002 on behalf of the Darwin

Initiative. We believe that her evaluation was positive and look forward to receiving it in due course should the Darwin Initiative make it available to us.

During this project in Vietnam, we observed that: (i) young scientists were very enthusiastic to be involved in the project; (ii) lower rank staff were more active than higher rank staff; (iii) the Vietnamese university attitudes were very open and willing to cooperate, while the governmental institutes were more diplomatic but less active in real collaboration and participation; and hence (iv) to achieve project goals aid and support, equipment, materials, etc, were directed towards the active staff in the universities.

Our most difficult organisational problems resulted from having many of our milestones within the first nine months of the project. This was necessary because we had to begin with the training elements of the project. Delays in formal project approval beyond the nominal start date were disruptive to the organisation of the initial training course in Vietnam and we also failed to take into account the very long period normally required to obtain UK visas for the trainees who subsequently came to Reading. That said, the former problem was solved by good will and hard work on both sides, and the latter by assistance from UK civil servants in Vietnam. We could have avoided the problems by being less ambitious over milestones and by taking 3 years rather than 2 for the project.

## **10. Darwin Identity**

All letters, application forms, teaching materials (manuals and Powerpoint slides), certificate of attendance, banderols, etc. always bore the Darwin name and logo (see all Annexes and figures within).

All publications, in English and Vietnamese, always acknowledged the Darwin Initiative for the Survival of Species.

Local and national media which publicised the training course and published interviews with Dr Hong all cited the Darwin Initiative as sponsor (Annex 7). For example, Figure 14 Annex 7 provides the evidence of Darwin's role in training Vietnamese scientists and the subsequent research programme in Vietnam. The television broadcast on 21 May 2001 (Annex 7, Figure 24) on HTV Channel of HCM City to about 10 million viewers concentrated on Mr Adrian Stephens's (Consul General, British Consulate) speech on the role of Darwin Initiative projects in Vietnam. Within the cohort of people we met, the UK-Darwin-Biodiversity-Conservation links were all made.

This Darwin project has acted a catalyst to strengthen the skills bases of the staff of UAF, who continue to train subsequent generations of conservationists. The prospect of this project is clear; UAF has plans to continue with its own budget. It is acknowledged that the wider issues of the forest protection and regeneration in Vietnam over 40% of its land area dwarfs this particular project. Nevertheless, we believe that this small project will have a significant impact and legacy in the wider national scheme.

## **11. Leverage**

UAF funded improvements to its seed science laboratory and to the Department of Reforestation and Urban Regreening.

Dr Hong helped UAF to apply for funds from international organisations, e.g. International Society of Arboriculture and Botanic Garden of Brest, France.



## **12. Sustainability and Legacy**

Dr Hong (Reading), Dr Le Quang Hung and Ms Truong Mai Hong (UAF), Ms Banh Ngoc Tam and Ms Vo Thi Le Tam (SOFSE) will continue to collaborate. The most obvious form of this continuation will be the preparation of manuscripts for publication. This will continue until at least summer 2004. Publication charges will be met by The University of Reading.

One lasting legacy will be provided by the positive outcome of the training project for the careers of individuals - and the fact that they will thereby be in a position to influence future policy and associated resources for biodiversity conservation in Vietnam.

Five recent promotions or awards are particularly noteworthy in this respect.

1. Dr Le Quang Hung, coordinator in Vietnam, was promoted in March 2003 to Associated Professor (from Senior Lecturer), and Dean of the Faculty of Agronomy (from Deputy Dean) - UAF.
2. Ms Truong Mai Hong was promoted in March 2003 to Head of the Department of Reforestation and Urban Regreening - UAF.
1. Ms Banh Ngoc Tam was promoted in April 2003 to Director of Southern Forest Seed Enterprise (from Deputy Director).
2. Mr Nguyen Duc Xuan Chuong (Darwin trainee at Reading) has been successfully nominated by UAF for a postgraduate scholarship in seed science at The University of Reading funded by the Vietnamese government.
3. Ms Nguyen Hai Hong of the Forest Science Sub-Institute of South Vietnam was awarded a post graduate scholarship by the Vietnamese government, and she will attend an MSc course in the Netherlands this October.

The research carried out in this project is very practical, and some of the outputs have been applied already in seed storage and nursery practice in Vietnam (see Section 5 Project Impacts).

Not by The University of Reading. UAF is trying to obtain small grants from the government for continuing research.

### **13. Value for money**

We do believe that our project has been successful in meeting its original proposed objectives in a very short period of time. With only £ 63,000 funded by the Darwin Initiative, and after only two years, UAF is now itself training subsequent generations of conservationists at the provincial level, and carrying out research to solve problems facing biodiversity conservation in the region. The tree seed companies have changed their practices, resulting in an improved (quality and quantity) seed supply.

We would argue that in terms of value for money this project has been particularly successful: the funding would have been sufficient for one International Higher Degree by Research Student, who would not have completed their thesis until 3.5 to 4.0 years after commencing. This project has benefited 65 researchers directly, and many more indirectly, and will result in a greater number published outputs than a typical Ph.D. student. Moreover, dissemination has occurred simultaneously and the research has already impacted positively on forest tree seed supply in the region.