



Darwin Initiative for the Survival of Species

Final Report

**Framework for monitoring invasive tree species in
Ghana**

Project No. 162/9/019

01/10/00 to 30/06/03

Submitted by:

Centre for Natural Resources and Development, NatureBureau International

Environmental Change Institute, University of Oxford

Forestry Research Institute of Ghana

Ghana Organic Agriculture Network

Suntaa-Nuntaa Agroforestry

Acknowledgments

This report is an output of a project funded by the UK government's Darwin Initiative for the Survival of Species (Department for Environment, Food and Rural Affairs; Project No. 162/9/019).

Many individuals and organisations contributed to the project research and training activities and the views expressed in this report. In Ghana, thanks are due to the Dr J.R. Cobbinah and Mr Bright Kankam (Forestry Research Institute of Ghana); Mr Bob Loggah, Jen Russell, Jonas Kpierekoh and the staff at Suntaa-Nuntaa Agroforestry; the Ghana Organic Agriculture Network; the Nature Conservation Research Centre; and Wildlife Division staff at the Shai Hills Game Reserve. In the UK, thanks are due to Felicity Childs; Anna Lawrence and Sarah Gillett (Environmental Change Institute, University of Oxford); Paul Maiteny; and Laurie Strike and the staff of Naturebureau International.

JRC
November 2003

Darwin Initiative for the Survival of Species

Final Report

Contents

1.	Darwin Project Information	3
2.	Project Background/Rationale	3
3.	Project Summary	3
4.	Scientific, Training, and Technical Assessment	4
5.	Project Impacts	13
6.	Project Outputs	16
7.	Project Expenditure	16
8.	Project Operation and Partnerships	17
9.	Monitoring and Evaluation, Lesson learning	18
10.	Darwin Identity:	19
11.	Leverage	19
12.	Sustainability and Legacy	19
13.	Post-Project Follow up Activities	20
14.	Value for money	21
15.	Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)	22
16.	Appendix II Outputs	23
17.	Appendix III: Publications	25
18.	Appendix IV: Darwin Contacts	26

Darwin Initiative for the Survival of Species

Final Report

1. Darwin Project Information

Project title	Framework for monitoring invasive tree species in Ghana
Country	Ghana
Contractor	CNRD, Nature Bureau International
Project Reference No.	162/9/019
Grant Value	£93,793
Starting/Finishing dates	01/10/00 to 30/06/03

2. Project Background/Rationale

Concern was expressed over the invasiveness of exotic tree species, in particular neem (*Azadirachta indica*), in fallow agricultural land, dry forest and game reserves in Ghana. Invasive tree species appear to be disrupting the natural succession of savannah and dry forest, reducing the availability of agricultural land for farmers, contributing to the loss of rare tree species and reducing mammal biodiversity. This project aimed to provide a framework for the monitoring and evaluation of the impact of invasive tree species on biodiversity in participation with rural communities.

The problem was identified and the project conceived during the course of a DFID-funded project involving three of the project collaborators, the Centre for Natural Resources and Development (CNRD), the Ghana Organic Agriculture Network (GOAN) and Suntaa-Nuntaa Agroforestry (a member of the GOAN network). Demand for the project came from local communities working with GOAN, and concern expressed by the Wildlife Department over the invasiveness of neem in the Shai Hills Game Reserve. An additional partner, the Forest Research Institute of Ghana (FORIG), expressed an interest in carrying out a biological assessment of the problem in the Shai Hills.

3. Project Summary

3.1 Project Purpose & Objectives

The purpose of the project is to develop a framework for monitoring the impacts of invasive tree species on biodiversity in rural communities of Ghana.

Specific outputs include:

- A framework for the participatory monitoring of invasive tree species in Ghana
- The provision of training to governmental and non-governmental staff on how to monitor and ameliorate the effects of invasive tree species, and considerations for their introduction to new environments.
- The dissemination of research results through a wide variety of outputs.

No Logical Framework has been developed for this project.

The original Project Implementation Timetable was revised three times during the course of the project, in February 2001, July 2001 and September 2002. The first and third revisions of the Project Implementation Timetable were as a result of the Project Leaders maternity leave. This was discussed with the Darwin Secretariat on both occasions and resulted in two short project extensions with an additional budget allocation. The Project Implementation Timetable was developed further in terms of its detail in consultation with all project collaborators in July 2001. Minor changes were made, but the purpose and objectives remained the same.

3.2 The Project and the CBD

The project is relevant to the conservation priorities of Ghana as outlined in its Environmental Action Plan, and will assist in meeting the country's obligations under Articles 7, 12, 13, 14 and 17 of the Biodiversity Convention. The article that best describes the project is Article 7. Identification and Monitoring:

*Identify and monitor components of biological diversity, particularly those requiring urgent conservation; **identify processes and activities which have adverse effects**; maintain and organise relevant data.*

3.3 Status of the project

The project has largely met its objectives:

1. A framework for the participatory monitoring of invasive tree species in Ghana.

Status: Achieved

2. The provision of training to governmental and non-governmental staff on how to monitor and ameliorate the effects of invasive tree species, and considerations for their introduction to new environments.

Status: Achieved

3. The dissemination of research results through a wide variety of outputs.

Status: Partly achieved

A detailed status of project activities against our agreed baseline timetable is shown in Annex 1.

4. Scientific, Training, and Technical Assessment

4.1 Research

Research work was carried out by GOAN, Suntaa-Nuntaa and FORIG with assistance from the UK partners. The following sections describe the work and findings of the respective partners.

4.1.1 Summary of research carried out by GOAN and Suntaa-Nuntaa

The general objective of GOAN's and Suntaa-Nuntaa's research was to *develop a participatory framework for monitoring invasive tree species*. The specific objectives were to:

- *Understand rural communities' perceptions of invasive tree species.*
- *Develop indicators of change*

Study sites

The participatory research was carried out on the Accra Plains and the Upper West Region, both areas where invasion by exotic trees was found to be causing problems. The Accra Plains form part of south-eastern Ghana lying between the Akwapim Range, the lower Volta River and the sea. It lies between 6°14'N and 5°29'N and 0°23'W and 0°41'E. Four communities were selected for study and included: Dodowa, Oyibi, Kordiabe and Old Ningo. The Upper West Region is found in the north west of Ghana, and lies between 9°40' and 11°N, and 2°50'E and 1°30' E. Five communities were selected for study and included: Busa, Goripie, Naaha, Dapuri and Tanchara. Three of these communities had invasive tree species, Naaha has a forest reserve and Goirpie was without forest resources or invasive trees.

Methods

Methods were selected from the PRA repertoire, but used specifically to focus on the research topics relevant to the project, i.e. **change** and **impact**. A basic list of tools were tested and evaluated for their suitability and the sequence in which they could be used. Tools included: maps, time-lines, trend diagrams, semi-structured interviews and problem trees, with impact diagrams to be used at a later stage in the participatory research. Initial work with communities has been undertaken and the results of the research analysed.

Results

Perceptions of invasive tree species

Upper West Region: Over 80% of the people in the sampled communities had increasingly felt the impacts of invasive trees and a reduction in biodiversity. Most people felt that invasiveness was a result of a poor level of awareness surrounding tree species, i.e. neem and leucaena, and dependence on natural resources for livelihoods, but with poor land management practices contributing to invasiveness, e.g. shifting cultivation, bushfires, etc. The communities sampled gave a number of reasons for the spread of invasive tree species that included the need for fodder and fuelwood, fewer native trees, incomplete information from over-enthusiastic extension workers, aggressive growth and the rapid spread of seeds. Positive and negative effects of these tree species were recognised and control measures were suggested.

Accra Plains: Communities in this region identified exotic tree species (predominantly neem and leucaena) as invasive due to their aggressive and rapid growth, and their ability to have detrimental effects on the surrounding native species. They perceived that invasiveness was a result of shifting cultivation, seed dispersal by birds and other mammals and bushfires. The speed of invasion was felt to be facilitated by the tree's ability to sprout easily after the cutting of stems and roots. The communities sampled felt that re-sprouts occurred more rapidly in clay soils than in sandy soils. The use of tractors for ploughing was also felt to contribute to invasiveness through the cutting of roots and disturbance of the top soil. As in the Upper West Region, both positive and negative effects of invasive trees were recognised, and control measures suggested.

Indicators of change

Indicators of the lessening negative impacts of invasive tree species were felt to include:

- Increased food security;
- More land under cultivation;
- Reduction of poverty;
- Increases in the numbers of native trees and other less invasive tree species;
- Increased biodiversity; and
- Rural livelihoods maintained.

Conclusions

The communities in which the project has worked have been shown to hold a range of perceptions surrounding the role of exotic invasive tree species in farming situations. The communities have recognised both positive and negative effects of these tree species, and the need for control measures to prevent their further spread.

Research Outputs:

Reports from GOAN and Suntaa-Nuntaa
TAA paper
Workshop paper by Jonas Kpierekoh (Suntaa-Nuntaa)
Research paper in draft

4.1.2 Summary of research carried out by FORIG

The general objective of FORIG's work was to *investigate the natural regeneration of invasive tree species and the biotic factors contributing to invasiveness*. The research described below is focusing on the invasive tree species, neem (*Azadirachta indica*). The specific objectives were to:

- Determine the competitive ability of invasive plants in different habitats.
- Investigate the natural regeneration of neem from seeds, roots and stumps
- Determine invasive plant species recovery after fire
- Analyse the effect of invasive tree species on biodiversity
- Determine the effect of different light intensities on the germination of neem.
- Assess the seed predation rates of neem in grass and understorey of neem pure stands.

Study site

The research was conducted by Bright Kankam (BK) in Shai Hills Game Reserve situated on the Accra Plains approximately 50 km from the capital city of Accra (6°54'N 0°4'E). The reserve is a small-protected area (54 km²) of savanna plains surrounding a range of southern outlier inselbergs that reach to an elevation of 290 m. The hills of the reserve are covered by undisturbed low stature, dry evergreen forest of the south-east outlier type. The plains surrounding the hills consist of short grass savanna with shrubs and evergreen trees. The reserve harbours typical savanna species of animals. The dominant faunal species are kob, bushbuck and savanna duikers. Three species of primate - green monkey, lesser spot-nosed monkey and olive baboon occur in the reserve. Several genet cats and a colony of tomb bats are present. There is a wide array of resident and migratory birds species in the reserve together with a strong population of monitor lizards, turtles, and a wide variety of snakes.

Methods*The competitive ability of neem*

The competitive ability of ground cover vegetation on neem seedling emergence was determined using a randomised complete block experiment with three treatments:

1. Grass vegetation
2. *Chromolaena odorata* vegetation
3. Grass-*Chromolaena* vegetation

Neem seedlings, raised in a nursery at FORIG, were used for the experiment. Seed was collected from the Shai Hills Game Reserve and sown in polythene bags. When the seedlings were six weeks old they were transported to Shai for transplanting. Each experimental plot of size 4m x 6m had 12 seedlings at a spacing of 2 m x 2 m. The plots were replicated three times in the different vegetation types (grass, *Chromolaena odorata* and grass-*Chromolaena* vegetation). Seedling height and diameter was recorded at eight-week intervals.

Regeneration from stump re-sprouts

Two sample plots of size 10 m x 10 were established to simulate the conditions in most farming community plots. One plot was a pure stand of neem, and the other was a mixed stand of neem and other plant species. Initial enumeration of all trees on selected plots was done and plots clear-cut at different height (<0.5m, 1.0m and 1.5m). The fourth plot was left intact. Trees were marked with oil paints so that regeneration could later be distinguished from new neem seedlings. Stem count was categorised into three DBH classes: 0-20mm, 20-40mm and >40mm. Number of coppice shoots arising/tree, the height and diameter of the tallest shoot and stump survival were measured.

Lateral roots coppicing ability

Mature neem trees (>4cm dbh) were selected at the Shai Hills Game Reserve. The lateral roots of the trees were exposed and cut into three parts without altering their original root position. One part was partly 'buried' in the soil after cutting; another was still 'attached' to the parent tree, whereas the last part was 'detached' from the main root. These roots were assessed after eight weeks for re-sprouting ability. Data on stem DBH, root diameter, and numbers of seedlings were recorded.

Species recovery after fire

Regeneration and re-sprouting of tree species following fire was assessed to gain an understanding of how this may facilitate the spread of invasive trees due to the disturbance of natural vegetation. Two plots (20 m x 10 m) were established. An initial enumeration of all trees present was done. Each plot was further divided into two parts (10 m x 10 m): trees on one half were cut while the others were left intact (to simulate the different methods used by farmers and range managers). All trees were tagged with metal plates before burning. Early burning was carried out in October 2001, and late burning in the dry season, i.e. April 2002 and results compared.

Invasive tree species and biodiversity

PRA tools, i.e. time lines, trend diagrams and the problem tree, were used to assess changes in biodiversity in the Shai Hills Game Reserve in participation with staff of the Wildlife Division.

Seedling growth response to light

Neem seeds were germinated and 200 seedlings transferred into polythene bags at the two-leaf developmental stage. Fifty seedlings per treatment will be placed in shade houses with the following light intensities: 10%, 25% and 100% ambient full sun. Seedling growth measurements were carried out at four-week intervals after the commencement of the light trial. Height, stem diameter, and oven dry weight of leaves, stem and roots were measured.

Seed predation experiment

Seed predation trials were set up comparing (a) neem fruits with pulp, and (b) neem fruits with pulp removed. Experiments were set in two different habitats: in open grass vegetation and under pure neem stands. Four seeds per treatment were randomly placed on the ground along a 100m transect in each site. Seed stations were established at 4 x 4m intervals (i.e. there were 25 stations per treatment). In all, 104 seeds per treatment were exposed. Seed disappearance was assessed daily for 28 days (when most seeds are expected to germinate if they are not predated on).

Results

The competitive ability of neem

Neem was strongly outcompeted by *C. odorata* (neem mortality = 86.1%), but survival was moderate in the grass plots (neem mortality = 61.1%). *C. odorata* is itself an invasive exotic plant, hence the results suggest that under the natural grassland conditions of the Shai Hills, neem can establish itself with moderate ease.

Regeneration from stump re-sprouts

An analysis of the regeneration data reveals that coppicing ability varies with different diameter size trees. It has been observed that medium (diameter 20-40mm) and large (diameter >40mm) trees produce the highest number of coppice shoots per stump, with small diameter trees producing the smallest number of shoots. Cutting height appears to be positively correlated with the number of coppice shoots (i.e. coppicing ability).

Lateral roots coppicing ability

Initial observations suggest that roots of varying size (diameter 4-50 mm) cut from the plant but left in the soil, produce shoots and can regenerate vegetatively. The effect of cutting lateral roots was investigated based on farmer's observations that neem roots re-sprout after stump clearance from agricultural land.

Species recovery after fire

The late burnt plots showed the lowest survival rates for all tree species (63.3%). Neem was found to have high survival rates when compared to native tree species, especially in the control plots. However, tree size (stem diameter) was also a contributing factor with larger sized trees having greater survival rates than smaller sized trees in all plots.

Invasive tree species and biodiversity

Participatory M&E with staff of the Wildlife Division and Shai Hills Game Reserve led to observations surrounding the changes in biodiversity observed in the reserve (using a timeline and trend diagram). Problems and advantages associated with these changes were recognised and discussed. It was felt that before the Reserve was gazetted in 1971, there were few game animals due to excessive hunting. Neem was present in the Reserve, but was not considered invasive. By the 1980's, neem was found mainly at the base of the hills in the Reserve. The baboon population had also increased because the Wildlife Division protected the reserve. During the early 1990's, a dramatic increase in the neem population was experienced, and as a management strategy, some of the neem trees were cut. By 2001, the Wildlife Division staff felt that there was more neem as compared to native trees in the reserve, and the spread of neem is contributing to a reduction in the native plant population. Control measures were felt to be vital to prevent the further colonisation of the Reserve by neem.

Seedling growth response to light

As light intensity increased, stem length and basal diameter of neem seedlings increased accordingly. Dry matter (root and shoot dry weight) production showed that seedlings grown in 100% ambient full sun have significantly higher dry matter (3.6g) as compared to those under 55% (1.3g), 15% (1.2g) and 10% (0.63g) ambient full sun.

Seed predation experiment

Seed predation rate was higher in neem stands (mean 65.4%) than in open grassland (mean 22.1%) during the period of study. Few seeds germinated (mean 6.3%) during the period of the experiment was conducted: 6.3% in neem stands, and 3.35% in open grass vegetation. Most seeds found at seed stations in open grass vegetation had the kernel eaten leaving the coat, whereas, those in pure neem stands were more often removed from seed stations.

Conclusions

The competitive ability and biological characteristics of neem suggest that it is an invasive tree species in undisturbed exotic environments. As the level of neem invasion become severe, habitat change can be observed, i.e. the numbers and range of native trees and grasses becomes reduced. Neem shows a vigorous ability to regenerate from seed and vegetative material (both roots and coppice shoots). Its prodigious seed production, ability to withstand fire, and regenerating ability suggests that the species can outcompete native species in open, undisturbed habitats. Cultural control measures are often rendered ineffective, and are time-consuming and/or labour-intensive. This can threaten food security for farmers and has a negative impact biodiversity in general. Management practices tailored to individual situations (e.g. on the farmer's field, or on protected land) need to be adopted that can benefit farmer's needs and biodiversity (see Box 1).

Box 1: Indicators of invasiveness and possible control measures for invasive neem

Indicators of invasiveness include:

- Trees that are under-utilised or not utilised;
- Heavy seed production;
- Seed not collected or utilised;
- Presence of an effective long-range seed dispersal agent (i.e. birds and baboons);
- Ability to re-sprout after pruning; and
- Regeneration from cut roots of various sizes.

Management and control measures include:

- Pruning to below 0.5 m prior to or during seed production¹;
- Monitor vulnerable areas in the Reserve;
- Develop a market for seed products;
- Cultivate fields for as long as possible using organic manures to maintain soil fertility;
- Plant native trees in vulnerable areas; and
- Remove all the roots as well as stems when clearing land of invasive trees.

Research Outputs

Final Report from FORIG
Workshop paper by Bright Kankam (FORIG)
Draft journal paper

4.2 Training and capacity building

4.2.1 Sensitisation workshops

Felicity Harris (FH) implemented sensitisation workshops in Kumasi and Wa during July 2001. The aim of the workshops was to provide an opportunity for staff from CNRD, GOAN, Suntaa-Nuntaa and FORIG to consider some of the key issues that the project was addressing. In addition there was opportunity for feedback from the baseline surveys conducted in the Accra Plains by GOAN, and in the Upper West Region by Suntaa-Nuntaa.

Key points arising from the workshop were as follows:

- Tree species may be determined as invasive as a result of both natural factors e.g. ability to regenerate, and human perception factors e.g. when a community regards control as a problem, where trees occur in areas that have been determined environmentally sensitive.
- There are a number of invasive tree and plant species in Ghana. For all tree species identified the origin was thought to be exotic. *Broussonetia papyrifera*² and *Cassia siamea* were thought to be a problem in the humid transitional zone. *Azadirachta indica* and *Leucaena leucocephala* were identified as problems in semi-arid areas e.g. Upper West Region and Accra Plains.
- A consensus was reached on a definition of biodiversity in which it was thought components and interactions between those components were indicators of healthy biodiversity.
- A number of ways in which communities may become aware of changes in biodiversity were identified. These were categorised under the following headings: climate, soil status, crops, husbandry, species composition, use of natural resource base, water and hazards.

¹ This could potentially be carried out by local communities to assist meet their fuelwood/charcoal needs and reduce or control the incidence of neem in vulnerable areas of the Shai Hills. A suitable agreement between the Wildlife Division and the local communities would have to be made concerning access and mutual benefits.

² Dr Victor Agyeman, of FORIG, is studying the effects of this species.

- Members of the community who would be affected by changes in biodiversity were considered and included: herbalists, traditionalists, landless people, farmers, chiefs, hunters, families, consumers, wildlife departments and those involved in tourism.
- Richard Ninnoni from the Forestry Department commented that the project and its outputs would be extremely useful to the Forestry Department and that members of his department would be extremely interested in the dissemination workshop and uptake of results.

Training & Capacity Building Outputs:

Travel report -Visit to Ghana July 2001
Workshop reports – Wa and Kumasi, July 2001

4.2.2 Capacity building with GOAN, Suntaa-Nuntaa and FORIG

Anna Lawrence (AL) and FH gave training on participatory methods to GOAN and Suntaa-Nuntaa staff in July 2001 (see Box 2), and worked with both organisations to:

- Gain a greater understanding of the issues faced by communities dealing with invasive tree species;
- Sensitise communities to the project and;
- Gain an idea of how various communities wished to be involved in the project.

Communities in the Upper West and Accra Plain were visited and it was possible to set up some meetings for subsequent visits in July when PLA methodologies could be tested. The Shai Hills Reserve has been selected to carry out research on the natural regeneration of neem. The Reserve was also visited at this time, and informal discussions about invasive trees and the effects on biodiversity (both flora and fauna) took place with Wildlife Division and Reserve staff.

Joanne Chamberlain (JC) gave training and reviewed research on the natural regeneration of neem during February 2002 (see Box 2) with BK (FORIG). The Shai Hills Game Reserve was visited, observations were made, the research on natural regeneration was reviewed and discussions took place with regard to new research, indicators of invasiveness and potential control measures.

Box 2. Capacity building and research method development

Participatory research: A basic participatory approach is being used by the project. The methods have been selected from the PRA repertoire, but used specifically to focus on the research topics relevant to the project, i.e. change (especially environmental change) and impact. The basic list of tools was expanded through a participatory testing process, to include those known to project collaborators, and tools which help to familiarise the community with the research theme (i.e. mapping and timelines). The final range of tools selected and appropriate ways of using them, are summarised in Annex 1. This is a 'living' document and will develop during the project, through the experience of all collaborators.

Natural regeneration research: A range of experiments were designed to elicit in a relatively short time frame information on how neem naturally regenerates, and what the impacts on regeneration farm management practices are. The latter was felt to be important in understanding how communities might modify their existing practice to reduce the incidence of invasiveness, but still gain products and environmental services from trees.

Training & Capacity Building Outputs:

Travel report -Visit to Ghana, July 2001
Travel report – Visit to Ghana, February 2002
Workshop reports – Wa and Kumasi, July 2001

4.2.3 Joint planning workshops

Joint planning workshops were held in July 2001, February and July 2002 that involved all project partners, served to review and agree on project activities and methods and covered the following points:

- general objective of the project
- purpose of the meeting
- project outputs
- summary of activities completed to date
- review of activities needed to achieve the outputs
- timetable for activities
- reporting procedures
- communication pathways
- tools to be used
- workshop planning
- manual planning and design

Training & Capacity Building Outputs:

Travel report -Visit to Ghana, July 2001
Travel report – Visit to Ghana, February 2002
Travel report – Visit to Ghana, July 2002

4.2.4 Training workshops**Background**

Two training workshops were implemented in January 2003. The first was organised by BK of FORIG, and was held at FORIG and within communities on the Accra plains between the 14th and 16th January 2003. The second was organised by Jonas Kpierekoh of Suntaa Nuntaa Agroforestry and the Environmental Protection Agency, Ghana, and was held in Wa and Busa between the 21st and 23rd January 2003. The workshop resource persons and facilitators were Paul Maiteny (PM) (in place of Joanne Chamberlain who was on maternity leave) and AL.

The purpose of the workshops was to train participants in the participatory assessment of the impact of invasive tree species. This would be done through training in the use of the methodology developed through the project. Early in the workshop process, a decision was taken to expand this purpose to share project findings, explore their relevance to key Ghanaian stakeholders and clarify stakeholder-relevant action for managing invasive species. The workshop participants were representatives of governmental and non-governmental organisations, and of local communities, as well as the workshop organisers and facilitators.

Methods

Participatory systems methods were both the focus of the training and formed the basis of design for the workshop. Hence, by experiencing the workshop methods themselves, participants were expected to simultaneously learn about the methods they themselves could use in their own work.

By drawing on participants' first-hand experience, the methods used allowed for a more collaborative approach to inquiry, learning, awareness-raising and capacity building, e.g. in-depth dialogue, focus groups, semi-structured interviewing, and enhanced facilitation skills. These methods can elicit meanings and purposes underlying the situations revealed by the more descriptive tools used in PRA, e.g. diagramming, mapping, etc. As such, the methods can reveal the values, interests and priorities underlying stakeholder criteria for monitoring and evaluation. Presentations and field visits were also utilised in the workshops.

In keeping with the methodologies employed, flexibility and adaptability to participant input was retained throughout. Ongoing learning informed modifications to the workshop programme as appropriate, within the remit of the project and workshop purposes.

Results

The participants were introduced to the context of the project and the research findings. Planning and preparatory work then took place in advance of field work with communities which centred on training in participatory methods and stakeholder inquiry. The final part of the workshop reviewed the field work, completed a planning and role play exercise, and assessed the structure and content of the draft training manual. Overall 22 participants were trained in the project findings and methods. A full account of the training workshops and the materials used is documented in the following reports and papers.

Training & Capacity Building Outputs:

Training and dissemination workshops report
Workshop papers (Suntaa Nuntaa and FORIG)
Draft training manual

4.2.5 Dissemination workshop

A dissemination workshop was held on the 27 January 2003 in Accra. The aim of the workshop was to sensitise policy makers and decision makers in government and non-government institutions to the main findings of the project and the role PM&E can have in helping to control invasive tree species, or to address other natural resource management issues.

Sixteen participants attended the workshop, which was opened by Prof A. A. Oteng-Yeboah, Director-General, Centre for Scientific and Industrial Research, and Dr. J.R. Cobbinah, Director of the Forest Research Institute of Ghana. Presentations were made by AL, BK, JK and PM. A discussion on the management and control of invasive species followed the presentations.

Themes, issues and priorities arising in the Kumasi and Wa workshops were repeated here with an emphasis on the need to stem the tide of invasive species whilst reconciling various stakeholder interests, some of which view fast-growing, vigorous species as providing benefits. A summary of the main findings of the project was presented by AL.

Training & Capacity Building Outputs:

Training and dissemination workshops report
Workshop papers (Suntaa Nuntaa and FORIG)

5. Project Impacts**5.1 Project purpose**

The purpose of the project was to develop a framework for monitoring the impacts of invasive tree species on biodiversity in rural communities of Ghana. Participatory research led to an understanding of the perceptions surrounding invasive tree species in rural communities, and community-driven means of building on the benefits of alien species and ways of controlling the problems they may have caused. The process of this research led to the testing and selection of participatory tools that form the basis for a framework for monitoring the impacts of invasive tree species. The draft framework was tested and refined during the training workshops, and a final version, to be published as a field manual, is currently in press.

5.2 The project and the CBD

The project has assisted in meeting Ghana's obligations under Articles 7, 10, 12, 13, 14 and 17 of the Biodiversity Convention (see Appendix I for the contribution made by different components of the project to the measures for biodiversity conservation defined in the CBD Articles). The project aimed to focus on developing a framework for monitoring the impacts of invasive tree species, and in this respect, Article 7 was seen as a focus for the project. As the project progressed, it was clear that research and training activities also had a high profile, in terms of both the research and training outcomes. A number of outcomes from the project have resulted in:

- revised plans for extension work carried out by NGOs;
- the development of possible control measures that could be implemented by rural communities;
- the Wildlife Division has revised plans for the control of neem in the Shai Hills Reserve that could include the community harvesting of the species for fuelwood and charcoal making; and
- the Environmental Protection Agency (EPA) have asked FORIG to advise them on control and utilisation measures for invasive species, so to include them in their Tree Monitoring Database Scheme.

5.3 Training & capacity building

Capacity building was undertaken during visits by the UK staff to Ghana. The local partners felt that the project has directly benefited their ability to carry out other environmental or biodiversity conservation work. Key benefits were:

- Participatory training skills developed (the partners are now more likely to use participatory methods for project design, research and monitoring)
- Planning capacity improved
- Recognition that without community involvement, the problem of tree invasiveness can not be addressed

Formal training was given to 22 workshop participants on participatory monitoring and evaluation, and more general training on alien species and their capacity for invasiveness. A selection of comments from the workshop participants is given in Box 3.

**Box 3: Workshop participants' answers in response to the question
'What have I learnt through this training course?'**

- *The participatory approach at looking at the problem and arriving at a workable solution.*
- *Invasiveness is a problem that needs to be solved by stakeholder communities and all others.*
- *Interesting divergent views on neem as an invasive plant species and the opportunity to practice PRA in the field with knowledgeable colleagues with diverse backgrounds.*
- *Different peoples of communities have different opinions as far as socio-economics are concerned and may not take the future into consideration when making decisions.*
- *I know other species are invasive in other areas but now I know neem is also invasive in the Accra Plains. Also, Chromolaena odorata is in the Shai Hills.*
- *I have learnt that there are invasive trees. They have to be control.*
- *I have learnt about the different ways of solving a community problem.*
- *I have learnt a lot about invasiveness of trees. Also I have learnt a lot from the various participants and resource persons who guided us through the workshop.*
- *More about leucaena, participatory learning cycle, interpersonal relationships, more on PRA*
- *Problems that some stakeholders perceive as problems might not be problems in another community*
- *For the first time my attention was drawn to the potential of some flora species to invade the environment.*
- *People perceptions over problems and issues are different.*
- *Participatory approach involving stake holders in analyzing issues.*

Some of the workshop participants made a comment on how the training has affected how they intend to proceed with their own work. A selection of these comments is shown in Box 4.

**Box 4: Workshop participants' answers in response to the question
'What I intend to do next in my own context'.**

- *This is an eye-opener for me on this problem and I am going to interact with the park staff and the Wildlife Division as whole with the view to educating them and perhaps arriving at a common solution. I will also interact with the Oyibi community to learn what progress they are making on their common problem.*
- *I am going to assist to solve the problem of invasiveness.*
- *Keep in touch to see what conclusions FORIG and the community would arrive at as the best possible control method so as to help in whichever means possible in its implementation.*
- *As researcher, would like to know the degree of invasiveness of Leucaena and how farmers are coping with the problem of Leucaena as a weed and their perceptions about that multipurpose tree.*
- *I shall write project proposals on other invasive species in Ghana.*
- *When the final results had been produced then we should go back to the community so that we are able to convince them on the best result findings and how to be able to go about the implementation of methods, tools used, etc.*
- *They have to be controlled or eliminated for nature to be interested for all.*
- *A way of carrying out my duties as a conservationist in a much easier way.*

5.4 Project collaboration

The project has had a positive impact overall on the collaboration between the various project partners. Collaboration with FORIG has been very productive and excellent working relationships were established between FORIG and all the project partners, but in particular with GOAN and Sunntaa-Nunntaa. Sunntaa-Nunntaa Agroforestry proved to be very valuable partners with a heavy responsibility for the implementation of project work in the Upper West Region of Ghana. Despite staff changes, a commitment to the project was maintained by Jonas Kpierekoh, and it was felt that the PRA training was a valuable means of building capacity within the organisation. Collaboration with GOAN was not maintained during the lifetime of the project due to staff changes and a lack of commitment to the project activities. Their involvement in the project ended in October 2002, and the activities earmarked for GOAN were carried out by Sunntaa-Nunntaa and/or FORIG.

5.5 Social impact

The social impact of the project was not specifically assessed, but feedback from the communities who collaborated with the research and training tended to have a very positive response to their own involvement, and the increased awareness of invasive species that the project created. Other beneficiaries were Wildlife Division staff at the Shai Hills Reserve, and the raised profile of invasive trees and their impacts amongst decision-makers in the Wildlife Division and Forestry Commission. Positive benefits in terms of controlled access by local communities to neem in the Shai Hills Reserve may be granted as a direct result of this project.

6. Project Outputs

The project outputs are described in Appendix II according to the coding and format of the Darwin Initiative Standard Output Measures.

6.1 Differences between actual outputs and those agreed in the 'Project Outputs Schedule'

An additional person was trained on PRA methods due to the involvement of Suntaa-Nuntaa Agroforestry in the project. Fewer weeks than expected were spent in Ghana by UK staff on training on natural regeneration due to the excellent capacity of FORIG staff to implement the natural regeneration research. A broadcast on national radio was made after the dissemination workshop held in January 2003, but a local radio broadcast has yet to be made. This is still being planned by Mr Bob Loggah of Suntaa-Nuntaa. An invitation to make a presentation on the Darwin research was received in February 2002 by the Tropical Agriculture Association (TAA). A short article was prepared to accompany the presentation, which has been published in the TAA Newsletter.

6.2. Project publications

The majority of project publications are yet to be publicly available. However, details of those publications expected either this year, or in early 2004, are detailed in Appendix III. The project leader has the responsibility of finalising the publication of the manual, and for co-ordinating with the publisher for the submission of journal papers and their potential revision. Dissemination of project activities has largely been through the training workshop and dissemination workshop plus one national radio broadcast and a further local radio broadcast planned for later this year. The publication of journal papers will result in the dissemination of project results to an academic audience, with the manual reaching further government and civil society extension workers in Ghana.

7. Project Expenditure

Table 1: Project expenditure

Item	Budget	Expenditure
Total	93793	93793

8. Project Operation and Partnerships

8.1 Project partners

In the UK, the project partners were;

- The Centre for Natural Resources and Development (CNRD), Nature Bureau International
- Environmental Change Institute (ECI), University of Oxford

In Ghana, the project partners were:

- The Forestry Research Institute of Ghana (FORIG)
- Ghana Organic Agriculture Network(GOAN)
- Suntaa-Nuntaa Agroforestry

At the start of the project, the lead organisation was CNRD which was then based at Green College, University of Oxford. In November of 2001, CNRD moved to become institutionally based within Nature Bureau International, a research, consultancy and information organisation working in the UK and overseas on biodiversity conservation. Anna Lawrence left CNRD at this time, and began work at the ECI. The original Ghanaian partners were FORIG and GOAN, but in July 2001, Suntaa-Nuntaa as members of the GOAN network, were brought in to undertake on behalf of GOAN the project activities in the Upper West Region. The most active partners have been FORIG and Suntaa-Nuntaa, and the UK organisations (specifically for training and project management). FORIG has been responsible for research into the natural regeneration of neem and its impact on biodiversity in the Shai Hills Reserve. Suntaa-Nuntaa has been responsible for research into community perceptions of invasive tree species and the development of a framework for participatory monitoring of the impacts of such species. Both organisations have carried out training in their respective areas of expertise. GOAN itself was responsible for the same research as Suntaa-Nuntaa in the Accra Plains. Initially the work proceeded well, but reports were not submitted on time, staff changes meant capacity was lost from the organisation, project activities were not implemented, and overall the project lacked commitment from the remaining staff. As a result, from October 2002, GOAN ceased work with the project and the activities remaining at that time (largely workshop planning and organisation) were shared between FORIG and Suntaa-Nuntaa. Project plans were reviewed in consultation with the project partners on a bi-annual basis during 2001 and 2002 during the UK partners visits to Ghana (see reports on the visits to Ghana).

Local partnerships have been active since the close of the project. The partners have been in contact through the writing of two research papers, and FORIG maintain collaboration with the Shai Hills Reserve. In addition, the Global Environmental Facility (GEF) of the United Nations Environment Programme has provided funds to Ghana's Council for Scientific and Industrial Research (CSIR) and three other African countries through CAB International to enable them carry out a project entitled 'Removing Barriers to Invasive Plant Species in Africa'. In Ghana, FORIG is part of the team identified as stakeholder institutions for the project.

9. Monitoring and Evaluation, Lesson learning

9.1 Monitoring and evaluation

A logical framework for this project was not drawn up, hence a baseline timetable of activities which was revised over the lifetime of the project was drawn up for planning and monitoring purposes. The detailed status of project activities against our agreed baseline timetable is shown in Annex 1. As detailed in sections 3, 4 and 6, research and training has been undertaken and has yielded the planned project outputs. The project partners submitted regular progress reports and final reports, which were used to both monitor progress and report back to the Darwin Initiative.

The value of the project has been demonstrated by the increased awareness communities have with regard to invasive tree species, the development of indicators for change and control/use methods for invasive tree species. The impact of control measures and the further monitoring of invasive species could not be achieved within the lifetime of the project nor was it planned for in the initial project design. Similarly, the impact of control measures in the Shai Hills planned for, or being introduced as a result of the project activities, is a significant achievement but again could not be monitored within the lifetime of the project.

There has not been an external evaluation of the project.

9.2. Lesson-learning

A number of lessons have emerged from the project activities and their outcomes and impacts for projects undertaking a similar remit. One of the major lessons learnt concerned the use and understanding by different stakeholders of terms such as 'biodiversity' and 'invasiveness', and how to then incorporate different stakeholder values into a framework for monitoring the impacts of invasive tree species on biodiversity.

As a project formulated according to Darwin Initiative criteria, it was framed from a perspective that defines the vigorous spreading of trees onto areas of biodiversity as an *a priori* problem. As has become progressively clear through the project, including from workshop participants, the term 'invasive' assumes in advance that stakeholders view it as a problem. It anticipates what the priorities, interests and concerns of stakeholders are: that all stakeholders - farmers, women and youth, landowners, etc - experience vigorous tree growth as a 'problem' in the same ways, and/or to the same extent as conservationists do. Another assumption follows on from this: that all stakeholders are strongly motivated to put time, energy and money into controlling the spread of these trees so as to benefit biodiversity. 'Invasiveness as stakeholder problem' was established as a guiding assumption of the project.

However, the project has shown that 'invasiveness' is, in fact, a values-laden term. Not all stakeholders are equally concerned about the trees, and where they are it is not always for the same reasons. They do not necessarily see them as negatively 'invasive' and some consider them positively beneficial. Given this situation, awareness raising, management proposals, etc that did not take account of the cultural diversity of attitudes towards the trees would most probably not be followed through. It therefore became evident early on the workshop process that drawing out commonalities, divergences and possible synergies of perspective towards the trees would be a pre-requisite to any hope of collaboratively managing them. This was a key challenge for the workshops and the further development of the training manual.

10. Darwin Identity:

10.1 Publicity

All outputs of the project have carried the Darwin logo, i.e., reports, training materials, and manual or have been publicised as a Darwin Initiative funded event, i.e., the training workshops.

10.2 Host country perceptions

Within Ghana, it is difficult to know if the public are familiar with the project and the aims of the Darwin Initiative. Researchers and government staff are more likely to have been familiar with the Darwin Initiative, and certainly the aims of the CBD. As a result of this project, however, participating rural communities are now aware of the Darwin Initiative and the concept of biodiversity and its conservation. Awareness will have also increased amongst researchers and government staff. The training and dissemination workshops provided a good vehicle for publicising the Darwin Initiative, especially as there was a radio programme and article in a daily Ghanaian newspaper (Wednesday, January 15 2003 in 'THE EVENING NEWS').

The project was not part of a larger programme, but has been viewed as a distinct project with a clear identity, even amongst some communities who had previously been involved with Suntaa Nuntaa Agroforestry through other environmental work.

11. Leverage

11.1 New funding for biodiversity work

No new funds have been attracted to biodiversity work associated with the project, however, the involvement in the GEF project as outlined in 8.1 will yield funding in the future. The work undertaken by FORIG in this project was a key factor in their selection as a stakeholder institution for the GEF project.

11.2 Capacity building for fund raising

There were no specific plans for capacity building amongst partner staff for fund raising activities from either national or international donors. However, general advice on sources of funding from international donors was given to the partners by UK project staff, as was advice on project proposal preparation and the review thereof.

12. Sustainability and Legacy

The project outputs/activities that are most likely to endure and have an impact on project, or environment sustainability are the following:

- *Increased awareness of invasive tree species amongst environmental field-oriented staff.*
- *Implementation of measures to control neem in the Shai Hills Reserve.*
- *Increased capacity to undertake participatory research and M&E.*

Project staff are all involved in ongoing research, training or project work in the field of biodiversity conservation and/or livelihood development will continue with that work. The Ghanaian partners have permanent posts within their respective organisations, hence continue with a mix of research and training work, or community education and extension work. The project partners have either formally or informally collaborated on other project work during the lifetime of the project (e.g. CNRD and Suntaa-Nuntaa submitted a new proposal for funding to the Darwin Initiative, which was not selected, and CNRD and FORIG have collaborated informally on a project proposal with DFID in Ghana for which the outcome is pending). Hence, it is very likely that the partners will stay in touch and look for further opportunities for collaboration.

The project and its outputs were focused, both in terms of scope and geographical area, i.e., centring on two regional areas of Ghana. As a result, the projects conclusions, outputs and legacy are necessarily limited. However, the dissemination workshop towards the end of the project and the training workshops themselves were an opportunity to expand the impact of the project more widely, i.e., to other organisations working both within and outside of the project's geographical focus. The legacy of the project could have been improved further by extending the training workshops to provide training to a much wider range of organisations and a greater number of individuals. Furthermore, additional training could have been given not only in the project area, i.e., the impacts on invasive trees on biodiversity, but also participatory monitoring methods in other areas of environmental or biodiversity management. The latter could be an area for post-project funding (see below).

13. Post-Project Follow up Activities

The project training workshops reached 22 individuals from 20 organisations, and hence were restricted in terms of maximising the results of the project. The majority of these organisations operated in the same geographical area as the project itself, and yet the impacts of invasive tree species are not restricted to any one area of Ghana.

To further embed the results and outputs of the project and hence strengthen its legacy and impact, a further set of training workshops implemented in other areas of Ghana and developed from the 2003 workshops would be useful. This would have the impact of further increasing the awareness of invasive tree species and/or increasing capacity in terms of participatory approaches to research and M&E. Approaches to participatory M&E have had an increased profile during the life of the project, and are now used within many donor-funded projects. For many practitioners, however, this is a new concept but one that would have applicability both in the context of monitoring the impacts of invasive trees, and wider issues of biodiversity management and conservation.

The training manual accompanying the workshops has been aimed at extension workers. However, participant feedback suggested that a simplified manual would be useful for communities taking part in monitoring work. Neither of the above formed part of the original project plan, nor have resulted from project slippage, but instead are based on the evaluation of the workshops and the draft manual. The project partners show continued commitment to the project through field activities and time given *gratis* for the development of journal papers. The partners are keen to further the impact of the project and interest has also been expressed by other organisations that may be able to assist with new training courses outside the project geographical area, e.g. NCRC and Green Earth.

14. Value for money

Many of the financial benefits of the project are intangible, and hence, trying to place a financial value upon them would be subjective without carrying out a total economic valuation (TEV). However, the cost of the project is known, and the benefits can be listed and some conclusion as to value-for-money drawn in a qualitative and subjectively quantitatively manner.

A summary of the known and perceived costs and benefits of the project are outlined in Table 2. The value of the benefits detailed is very subjective, but on this basis the pay back time would therefore be less than two years after the end of the project. This and a qualitative assessment of the benefits of the project would suggest that the project has been good value-for-money.

Table 2: Costs and benefits of developing a framework for the monitoring of invasive tree species in Ghana.

Costs	Value (£)	Benefits	Value per year (£)
Darwin grant	93 793	Capacity-building:	
Additional funding	18 496	- <i>Partner staff</i>	7 500
		- <i>Training workshop participants</i>	11 000
		Control of neem in the Shai Hills:	
		- <i>Increased revenue from game viewing</i>	5 000
		- <i>Reduced cost of control measures.</i>	5 000
		- <i>Conservation of biodiversity</i>	TEV required
		- <i>Increased accessibility to wood products by local people</i>	500
		Improved utilisation of trees in communities	500
		Increased awareness of invasive trees and their potential negative and positive impacts	TEV required
Total	112 289		>£59 000 over two years

Author(s) / Date

First Draft Joanne Chamberlain 21 September 2003

Comments from partners received 20 October 2003

Final Draft Joanne Chamberlain 11 November 2003

15. Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	Project %	Article Description
7. Identification and Monitoring	35	Identify and monitor components of biological diversity, particularly those requiring urgent conservation; <i>identify processes and activities which have adverse effects</i> ; maintain and organise relevant data.
10. Sustainable Use of Components of Biological Diversity	10	Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; <i>support local populations to implement remedial actions</i> ; encourage co-operation between governments and the private sector.
12. Research and Training	40	Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; <i>promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations)</i> .
13. Public Education and Awareness	5	<i>Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media</i> ; cooperate with other states and organisations in developing awareness programmes.
14. Impact Assessment and Minimizing Adverse Impacts	5	Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; <i>exchange information on impacts beyond State boundaries and work to reduce hazards</i> ; promote emergency responses to hazards; examine mechanisms for re-dress of international damage.
17. Exchange of Information	5	<i>Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge.</i>
Total %	100%	

The text of the articles highlighted in italics describes the section of the article that this project has been addressing in particular.

16. Appendix II Outputs

Code	Total to date	Detail
Training Outputs		
6a	3 people	Training on PRA methods and natural regeneration.
	22 people	Training on how to monitor and evaluate invasive tree species
6b	9 weeks	Training on PRA methods and natural regeneration.
	2 weeks	Training on how to monitor and evaluate invasive tree species
7	Various	Informal materials
	1	Workshop programme
	3	Workshop papers
	1	Draft training manual
Research Outputs		
8	12 weeks	6 weeks - July 2001 – Sensitisation; Training on PRA methods; Project planning. 1 week - February 2002 - Training on natural regeneration; Project planning. 2 weeks - July 2002 – Additional training; Project output planning. 3 weeks - January 2003 – Training and dissemination workshops.
11a	2	Both in draft for submission to the journal <i>Environmental Conservation</i> .
11b	2	Tropical Agriculture Association Newsletter
		Ghana Organic Agriculture Network Newsletter

Dissemination Outputs		
14a	3	Kumasi and Wa Training workshops January 2003; 11 participants at each workshop; 3 days for each workshop. Dissemination and sensitisation workshop, Accra January 2003; 16 participants; 1 day.
14b	1	Tropical Agriculture Association meeting February 2002
15a	1	The Evening News – feature post the Kumasi training workshop
16a	1	Ghana Organic Agriculture Network Newsletter
16b	500	Members of GOAN
17b	2	Dissemination networks of GOAN and FORIG enhanced
19a	1	GBC Radio – feature post the dissemination workshop
Physical Outputs		
23	Value of additional resources raised for project	

17. Appendix III: Publications

The publications listed below are largely in draft. The expected publishers and their contact details are listed, however.

Type * <i>(e.g. journal paper, book, manual, CD)</i>	Detail <i>(e.g. title, authors, journal, year, pages)</i>	Publishers <i>(name, city)</i>	Available from <i>(e.g. contact address, email address, website)</i>	Cost £
Newsletter	J.R. Chamberlain	TAA	TAA Membership	None
Manual	Framework for the participatory monitoring of invasive tree species	Pisces Publications	NatureBureau International, 36 Kingfisher Court, Hambridge Road, Newbury www.naturebureau.co.uk http://uk.cambridge.org/journals	None
Journal	An invasive tree species and its impact on biodiversity in the Shai Hills Resource Reserve, Ghana. Bright Kankam, Joe Cobbinah, and Joanne Chamberlain.	In draft for Environmental Conservation.		
Journal	Local attitudes towards invasive tree species and their impact on biodiversity in Ghana. Jonas Kpierekoh, Diana Dery, Beatrice Kuusaana, Bob Loggah, Anna Lawrence, Felicity Childs, Paul Maiteny, and Joanne Chamberlain.	In draft for Environmental Conservation	http://uk.cambridge.org/journals	

18. Appendix IV: Darwin Contacts

Project Title	Framework for monitoring invasive tree species in Ghana
Ref. No.	162/0/019
UK Leader Details	
Name	Dr Joanne R. Chamberlain
Role within Darwin Project	Project leader
Address	Centre for Natural Resources and Development Nature Bureau International 30 Kingfisher Court Hambridge Road Newbury RG14 5SJ, UK
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	Dr Anna Lawrence
Role within Darwin Project	Project researcher
Address	Environmental Change Institute University of Oxford 5 South Parks Rd Oxford OX1 3UB, UK
Phone	
Fax	
Email	
Partner 1	
Name	Dr Joe Cobbinah & Mr Bright Kankam
Organisation	Forestry Research Institute of Ghana
Role within Darwin Project	Project researcher & collaborator
Address	PO Box UP 63, U.S.T., Kumasi, Ghana
Fax	
Email	
Partner 2 (if relevant)	
Name	Mr Bob Loggah
Organisation	Suntaa-Nuntaa Agroforestry
Role within Darwin Project	Project researcher & collaborator
Address	Box 207, Wa, UWR, Ghana
Fax	
Email	