

Darwin Initiative Main Project Annual Report

Important note: To be completed with reference to the Reporting Guidance Notes for Project Leaders:

it is expected that this report will be no more than 10 pages in length, excluding annexes

Submission Deadline: 30 April

Darwin Project Information

Project Reference	21-002
Project Title	Building mycological capacity for sustainable resource management in Lao PDR
Host Country/ies	Lao PDR
Contract Holder Institution	The James Hutton Institute
Partner institutions	Royal Botanic Garden Edinburgh; Biotechnology and Ecology Institute, Ministry of Science and Technology, Laos
Darwin Grant Value	£243619
Funder (DFID/Defra)	Defra
Start/end dates of project	April 2014 – March 2017
Reporting period (e.g., Apr 2015 – Mar 2016) and number (e.g., Annual Report 1, 2, 3)	April 2015 _ March 2016. Annual report year 2
Project Leader name	Andrew Taylor
Project website/blog/Twitter	<p>Main project page: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr</p> <p>Workshop: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/workshop-may2015</p> <p>Fieldwork 2015: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/field-work-may2015</p> <p>Fungarium: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/fungarium</p> <p>Laboratory: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/laboratory</p>
Report author(s) and date	Andrew Taylor, Mark Newman, Kongchay Phimmakong, April 2016

1. Project Rationale

Lao PDR (Fig. 1) is one of Asia's most forested countries and supports some of the richest biodiversity within the region. However, Lao is also one of the poorest countries within the region with ca. 75% of the population still relying upon non-timber forest products for food and income generation. Fungi have long been utilised in this context being consumed by locals but also sold at markets and, increasingly, exported to neighbouring countries – often in large quantities. Fungi are pivotal organisms in forest ecosystems but in Lao their functions and diversity are virtually unknown: they are absent from the Laotian National Biodiversity Strategy to 2020. This is despite the fact that fungi constitute a major income source in some regions. This project originated from an expression of need raised by the Lao biological community for training and capacity building to enable Lao to realise its commitments to the CBD and manage the mycological resources sustainably.

The project addresses the lack of formal mycological expertise *via* a number of avenues. These include training workshops, both theoretical and practical, and the establishment of a National reference collection of mycological materials, including dried fungal collections. A basic molecular laboratory is being established to allow the extraction and amplification of DNA from fungal materials. This laboratory will also act as a focal point to encourage foreign interest and visits. There is anecdotal evidence that between 15-20 people succumb to often fatal fungal poisoning each year. The project will establish if there is evidence that this is correct and, if so, how measures can be taken to reduce this number. In collaboration with local aid agencies, field studies will be carried out to assess the ecological and economic importance of wild fungi harvesting. In particular, a special study will be made of the highly-prized Matsutake mushroom as recent international interest may be encouraging unsustainable harvesting techniques in Xieng Khouang province (Fig.1), where it is collected for export to China and Japan.



Figure 1. Political map of Lao PDR. The capital Vientiane and Xieng Khouang province, where training courses are given and field studies are carried out.

2. Project Partnerships

There are a number of partners within the project and they can be grouped based on their roles within the project.

Partners within Laos:

The main partner in Laos is the Biotechnology and Ecology Institute (BEI), with the main contact person being Ms Kongchay Phimmakong, Director, Technical Service Division. Dr Souriodong, who was the named partner in the application has been promoted within the ministry and is no longer directly involved in the project. There is still close contact between Dr Souriodong and Ms Phimmakong and his support for the project still apparent. The partnership with BEI has continued to develop well during the second year of the project, with Ms Phimmakong acting as coordinator for logistics during the four visits and the training course held at BEI made during the reporting period. The involvement of ministerial personnel within Laos is critical in initiating contacts and arranging visits to other ministries and other national institutions. Members of Ms Phimmakong's staff have provided excellent support during visits with transportation, secretarial and translation issues.

Also within BEI, Mrs Somsanit Bouamanivong, Director, Ecology Division, who is also head of the National Herbarium of Lao PDR, has been directly involved in planning and development of the project. The National Herbarium under Mrs Bouamanivong is the recipient of equipment and several of the outputs generated from the project. There has been regular contact between the Pi and Mrs Bouamanivong including four face to face meetings. Two staff members from the herbarium participated in the course in May 2015. Mrs Bouamanivong was involved in the development of Outputs 1 and 2: Establishing a reference database and fungal collection (see section 3 for further details).

National University of Laos: The partnership with the University has strengthened greatly in the reporting period. The Dean of the Science Faculty, Dr Somchanh Bounphanmy, has been very supportive of the project and has allocated the project two laboratories rooms within the department of Biology to house molecular laboratory at the University. A staff member of the Biology Department, Mrs Toulaphone Keokene, has also been given responsibility for overseeing the establishment and running of the laboratory. Mrs Keokene and the PI are in regular email contact and have also had four face to face meetings during the reporting period. Mrs Keokene participated in the training course held 4-8th May 2015 and was also responsible for selecting students for the training course (two MSc students attended the course). Mrs Keokene is also one of the two Laotians doing further training in Aberdeen in March to May 2016. The partnership at the University has established the basis for part of Output 2: a functional molecular laboratory (see section 3 for further details).

IUCN Laos: The named partner Mr Banethom Thepsombath has left IUCN and the main contact person is now Adam T. Starr MSc., Country Manager, Lao PDR Country Program. The PI had one meeting with Adam early in the reporting period to discuss the project.

AgroBiodiversity Project (ABP): Mr Ole Pedersen is chief technical advisor in the ABP and has been proactive from the inception of this project. Ole has been invaluable for the development of the project, with his local knowledge and network of contacts and the partnership has continued to be a major supporter of the project during the reporting period. Ole has been integral in project planning and development and to achieving several of the project outputs (see section 3). We have worked closely with Ole particularly on the planning and logistics for the field work in Xieng Khouang province in May 2015. Ole's team and this Darwin Initiative project have worked together to produce a value chain analysis of Matsutake in Xieng Khouang province (see Annex 4).

The Agrobiodiversity Initiative (TABI): Mr Chris Flint is chief technical advisor at TABI. Initial collaborations planned with TABI did not materialise and joint ventures with TABI have not advanced.

New Contacts in Laos:

Following a meeting with the **Plant Pathology group**, Ministry of Agriculture, in Vientiane during 2014, contact was made with Mrs Viengkham Sengsourivong, who heads the group, and arrangements were made for two of her junior colleagues to take part in the training workshop in May 2015. One of these, Ms Khonesavanh Chitterhat, is a gifted individual and is one of the two Laotians to come to Aberdeen for training in 2016.

Professor Paul Newton heads a Wellcome Trust Oxford based research group embedded within the Microbiology Laboratory of Mahosot Hospital, Vientiane. Prof Newton and his team are interested in the problem of fungal poisonings and the PI has been in regular contact with him via email and face to face meetings (discussed further in section 3). Prof Newton is involved in developing Output 2: a functional molecular laboratory and Output 3: Report on poisonous fungi and poisonings in Laos (see section 3 for further details).

UK Partners:

Mark Newman, based at the **Royal Botanic Garden Edinburgh**, is the sole UK partner. Mark's experience in working in Laos and his linguistic skills have been invaluable during the reporting period. The PI and Mark are in regular contact *via* email and face to face meetings, as well as two project visits to Laos to develop the infrastructure of the project and running the training workshops.

European partners:

Unfortunately, due to changes in his personal circumstances, Dr Manfred Binder, Munich, who was a named partner on the project could no longer able to take part in the project. We have been very fortunate to gain the aid of Dr Ursula Eberhardt, Stuttgart, who has many years' experience in molecular approaches to mycology. Dr Eberhardt will teach during the 2016 workshops. The project has also gained the experience of Mr Neville Kilkenny, a Scottish based, freelance mycologist who has considerable experience in teaching mycology to beginners and in collecting and the identification of fungi. The PI has been in regular contact with the three academic partners (Prof. Urmis Kõljalg, Estonia; Prof Mieke Verbeken, Ghent) to

develop strategies and ideas for knowledge transfer and for achieving the outputs for the project, especially Outputs 1, 2 and 3. Although not listed as a partner, a special mention must be made here of the contribution made by Dr Thomas Laessoe, who is working as a consultant on the project. His vast experience and knowledge of working with fungi from around the world is extraordinary and a truly invaluable asset to the project.

Achievements, lessons, strengths or challenges with partnership

As in the 1st reporting period, most of the partnerships have functioned well during the reporting period with progress made towards several outputs (detailed in section 3). The main lesson has been that face to face meetings are an essential pathway to facilitate and foster understanding among and between partners. The greatest strength has been the partnership with BEI, facilitated by Ms Kongchay Phimmakong, Director, Technical Service Division. The work which Ms Kongchay and her team contribute to the project has been crucial to the project. The Dean of the Biology faculty at NUoL has also been extremely supportive with respect to developing the molecular laboratory facilities. In addition, Ole Pederson, in both a professional and a personal capacity, has been very supportive and critical to the success of the project so far (see below). The only really major challenge faced over the reporting period was in finding a suitable candidate to take the Masters course in Edinburgh. This proved impossible and an alternative strategy had to be prepared and organised – this involved training two Laotians in Aberdeen for a shorter period of time (details below in Annex 1).

3. Project Progress

3.1 Progress in carrying out project activities

Training workshops: The project partners (Andy Taylor, Mark Newman, Urmas Kõljalg, Thomas Laessoe, Mieke Verbeken) ran a workshop in Vientiane from Monday to Friday, the 4-8th of May 2015. The course was held at The Biotechnology and Ecology Institute (BEI) in collaboration with Kongchay Phimmakong and her team. The workshop covered many basic concepts and areas within Mycology, including taxonomy, classification, and fungal ecology. There were 8 attendees with representatives from the National University of Laos (NUoL), BEI, and The Ministry of Agriculture and Forestry (MAF). The course participants included MSc students and a lecturer from NUoL, professional plant pathologists (MAF), herbarium staff from BEI. The course was originally designed to have interactive seminars in the morning and a field excursion to collect material for a lab session in the afternoon. This format worked reasonably well but it quickly became clear that two of the participants struggled to comprehend the more formal seminar sessions due to a lack of English. Having reviewed the first day with the partners on the Monday evening, we tried to make the seminars as interactive as possible to enhance the learning of participants with limited English. For the lab and field sessions, participants were divided into small groups (2-3 per group) with at least one of each group having either some prior knowledge of fungi or a good grasp of English – preferably both. Each group was then assigned to one of the teachers and the groups were rotated around the teachers on successive days in order for each group to gain expertise from each teacher. Unfortunately, part of the local electricity transformer was stolen on the Tuesday night and BEI was without electricity from then onwards. Due to the high temperatures (ca. 38 degrees), this made it uncomfortable to have the mornings indoors without air conditioning. Also without electricity for the projector we couldn't have the seminars. However, we came up with some excellent improvised teaching approaches. One example of these was when Mieke Verbeken, who is an excellent technical drawer, drew features of the structures of fungal fruit bodies used in identification on the large blackboard in one of the meeting rooms at BEI and the participants named them. Once we had named them in English, Mark Newman then asked the participants what they would be called in Lao and, as he has reasonable Lao, Mark wrote the names on the board – aided by the much impressed participants. In this way the participants learned to associate the English and the Lao names for the features. In addition, since there are few recognized mycological terms in Lao, this exercise gave us the start of glossary for mycologists. On the final day we all transferred to the University to use one of their teaching rooms. In the afternoon we gave the participants a small exam by showing them photos of fungi and asking them to answer a set of questions relating to which taxonomic group they were in

and why. The participants were very excited by this exercise as competition seemed to be something of a novel concept for them.

Field work and training: During the 2nd week (10-16th) of the May trip to Lao, the project partners flew to the town of Phonsavan, north of Vientiane in Xieng Khouang province. The project also paid for two of the course participants from BEI to accompany us during this week to gain field experience in collecting fungi in the field. We were also joined by Neville Kilkenny, a freelance Mycological consultant from Edinburgh, Scotland. The plan for the week had been developed in collaboration with Ole Pedersen from the Agro-Biodiversity Project (ABP), Vientiane. ABP has local contacts in the province and they had arranged for visits to villages where a local would act as a guide to show us the forests where they collect fungi, in particular Matsutake. The latter is of particular interest because it is highly prized on the international market and there was concern that harvesting of this fungus may be threatening its survival. The field work also provided good opportunities to collect material for the proposed National collection of fungi from Lao that was started in the previous November visit. The group split into three with each sub-group going to a separate village each day. Each day consisted of travelling to the village, an excursion into the forest for a number of hours and then returning to the village where we were often fed by the family of the local guide. The late afternoon and evening were then spent working on preparing descriptions, identifying, recording and drying the material. A total of 15 villages were visited and 449 collections were made and identified as far as possible, with most accompanied with photographs.

The two staff from BEI worked closely with the project partners both in the field and in the evenings learning how to prepare short concise descriptions of field collected fungi, how to prepare different parts of the fungi for microscopical examination, how to take photographs, and how to dry and store the material.

Study on Matsutake: In five of the villages information was obtained about Matsutake. It became clear early on that the name is used in a broad sense as the species collected and sold in Xieng Khouang province is not *Tricholoma matsutake*, but a related species, possibly *T. bakumatsutake*. The exact identity of the fungus awaits confirmation from molecular data. No evidence was found that the villagers were harvesting the fungi in an unsustainable manner. Quite the opposite in fact, with the villagers usually having a good awareness that the fungi, and many others they collect, were intimately associated with, and dependent on, particular tree species. The information gathered fed into a report on the value chain of Matsutake with Ole Pedersen which is in the final stages of production in association (see Annex 4).

Additional training: **2nd visit to Laos, 22nd August – 5th September 2015**

A second visit of two weeks was made to Laos in August by Andy Taylor and Mark Newman. A number of small training workshops were also held at BEI for six members of staff at the herbarium. These included training with the project camera, training on using the microscopes donated as part of the project and on handling and curating the fungal collections in the herbarium.

Poisonings: Due to the lack of integration within the Laotian medical system, it is virtually impossible to gain an overview of the extent of the problem across the country. However, one of the participants on the course, Ms Khonesavane Chitterhat from MAF, seem to have become the contact point for poisoning cases where material needs identified. On our return to Vientiane on the 16th of May 2015, we were contacted by Ms Chitterhat, to say that she had been contacted by two hospitals for assistance with identifying fungi involved in two separate incidences of fungal poisoning. We arranged to meet up with Ms Chitterhat before we went to the airport for our return flights to examine the fungal material that had been saved by the hospitals and to discuss the cases. One case resulted in 3 deaths, while fortunately the other did not involve any fatalities. The material from the latter case was in bad condition having been cooked and kept moist for a number of days. The material from the former was in slightly better condition. We were unable to identify with any certainty the fungi involved but the material has been preserved for future molecular analysis. This is the first material that has been successfully linked to any poisoning cases in Laos. Both these cases will be investigated later with Prof Paul Newton at Mahosot Hospital, Vientiane, who is collaborating with the project on fungal poisonings in Laos.

Molecular lab: A meeting was held with the Dean of Science, Head of Biology and two lecturers at the NUoL to finalise plans for the laboratory. The Dean in particular has been extremely supportive in developing the lab. The Dean has proposed that there will be a new department of biotechnology set up around the laboratory as its main facility. This is an excellent outcome as it should ensure the long term survival of the lab. One of the lecturers was Mrs Toulaphone Keokene, who took part in the course in May and who has been given responsibility for overseeing the lab. A small, two room laboratory space has been given over for the lab and our first priority was to clean this space very thoroughly and to increase the security of the entrance to the lab. Most of the equipment for the lab has been purchased from Europe Continent, which has a local office in Vientiane. Using local sources for equipment expedited the logistical issues associated with getting goods into the country. Although using companies based in Europe may have been faster, it in fact proved very difficult to get guarantees of cost and delivery from European countries.

The main purpose of trip in August 2015 was to secure and receive the equipment for the molecular laboratory at NUoL that had been on order. During the second week of the trip, the equipment was delivered to the lab by Europe Continent and each item was carefully marked off against the order invoice. In the following two days, MN and AT, checked each item for any damage and proper electrical contact. The equipment is now stored safely in the lab. A training workshop on basic molecular techniques is planned in the lab for the latter part of 2016.

Fungal collections: The collections made in May 2015 are now at the National herbarium and form the basis of the National Fungarium of Laos. Their condition was checked in August 2015. Some are soft suggesting moisture absorption but none were mouldy. It would appear the moisture is being absorbed through the plastic of the storage bags. Plastic boxes were bought at the local market and the collections distributed among them. Silica gel has been purchased and placed in the boxes in order to keep the moisture content low. All metadata associated with the collections have been entered into the Excel spreadsheet already containing the data from Ole Pedersen's Lao collections from previous years. This spreadsheet forms the basis of the National Lao Fungal collection and is with the BEI staff. The information relating to the collections have also been made available internationally on the PlutoF database (<https://plutof.ut.ee/>) supported by Prof Kõljalg in Estonia.

Market visits: It was originally planned that a local would make regular visit to markets in order to gather information about the fungi on sale at the markets. Until late 2015, no suitable persons have been found to carry out this task. However, quite unexpectedly Kongchay Phimmakong at BEI came into contact with a Laotian, Phongeun Sysouphanthong, who has recently completed an MSc in Mycology in Thailand. We met up with Phongeun at BEI during the August visit and were very impressed with him. He is clearly the most accomplished mycologist in Laos at the present time and is very capable of contributed on a number of fronts to the project. On our recommendation, Kongchay is now trying to get Phongeun employed at BEI from April 2016 as part of the annual uptake of personnel. Until this is established we have employed him in a capacity as a consultant mycologist. Phongeun would be a huge asset for BEI, the Fungi Project and Mycology in Lao as a whole. Ole Pedersen and our project are therefore employing Phongeun to carry out specific tasks as required. For the project these include making the market visits and working on identifying the fungi already in the collections.

3.2 Progress towards project outputs

Output 1:	<i>Mycological training workshops involving international experts training national participants. Establishment of databases.</i>			Comments (if necessary)
	Baseline	Change recorded by 2016	Source of evidence	
Indicator 1.1	No training courses available	One major week-long course and smaller one-day workshops held	See link to workshop webpage in Annex 4	
Indicator 1.2	No national database of Lao	A database of 854 collections	See link to Fungarium	

	fungi	now available, a checklist is under preparation	webpage in Annex 4	
Output 2:	<i>A functional molecular laboratory</i>			
	Baseline	Change recorded by 2016	Source of evidence	
Indicator 2.1	No lab	All the molecular hardware is now in place at NUoL	See link to lab webpage in Annex 4	
Output 3:	<i>Report on poisonous fungi and poisonings collected from markets and medical establishment.</i>			
	Baseline	Change recorded by 2016	Source of evidence	
Indicator 3.1	Anecdotal evidence	Data from two authenticated cases have been compiled. The fungi involved have been secured for identification	Hospital records and case files	
Output 4:	Report on fungi sold at markets.			
	Baseline	Change recorded by 2016	Source of evidence	
	No data	A small amount of data acquired during the workshop in May	See link to workshop webpage in Annex 4	The appointment of Phongoun Sysouphanthong at the herbarium will enable this to proceed as intended in 2016
Output 5:	Impact of logging			
	Baseline	Change recorded by 2016	Source of evidence	
	No evidence	Study underway		Due to issues discussed under Assumption 5 in section, 3.4 there is no change in this indicator
Output 6:	Report on harvesting of Matsutake			
	Baseline	Change recorded by 2016	Source of evidence	
	No data available	Initial report nearly completed with ABP	Report included in Annex 4	

3.3 Progress towards the project Outcome

Outcome:	<i>There will be an increased academic and technical capacity in Laos PDR to carry out fundamental mycological research thereby contributing to safeguarding harvesters, consumers and the National fungal capital.</i>			Comments (if necessary)
	Baseline	Change by 2016	Source of evidence	
Indicator 1	Very limited academic knowledge of fungi	8 participants given intensive training on fungal taxonomy and ecology, 6 more trained on basic principles of curation of fungal material	Section 3.1 of report, link to workshop webpage in Annex 4.	
Indicator 2	No fungal reference material, little available literature	There are now 854 collections deposited in the newly created National Fungarium of Laos.	Section 3.1 of report, link to Fungarium webpage in Annex 4.	
Indicator 3	Only anecdotal evidence of fungal poisoning cases in Laos	Case notes and fungal material acquired from one fatal and one non-fatal poisoning cases		
Indicator 4	Little knowledge of the impact of logging on edible fungi harvesting	Due to issues discussed under Assumption 5 in the next section, there is no change in this indicator		

3.4 Monitoring of assumptions

Assumption 1: Finding possible participants in workshops was relatively easy but finding participants who will benefit and value participation in workshops was more difficult. A set of 8 participants were identified from a range of organisations. This spread the knowledge transfer across organisations and reduced the possibility that knowledge would be lost through changes in circumstances of individuals within a single organisation. Language did prove to be a bit of an issue but by organising course participants into small groups with English and limited English speakers mixed, this issue was to a large extent resolved. The assumption that materials and equipment could be transported to Laos for both the laboratory and the workshops has so far been justified. Unfortunately, due to changes in his personal circumstances, Dr Manfred Binder, Munich, who was a named partner on the project could no longer able to take part in the project. We have been very fortunate to gain the aid of Dr Ursula Eberhardt, Stuttgart, who has many years' experience in molecular approaches to mycology. Dr Eberhardt will teach during the 2016 workshops.

Assumption 2: The assumption is unjustified. No student was found who has sufficient English to pass the required standard. The alternative plan, which was approved by Darwin, was that two Laotians would come to Aberdeen for a period of intense training.

Assumption 3: The rainy season in Laos was rather more variable than we assumed but there was sufficient material both for the course at BEI and more than enough material was found during the field survey. Currently conditions in the National Herbarium are not conducive to keeping collections free from insect attack. It is planned that the collections will be split between the National Herbarium and a herbarium in Europe. The necessary paper work is being produced by BEI.

Assumption 4: This assumption was partly invalid. There is no integration across the medical system in Laos, so it is difficult to obtain information at a national level. Without specific visits to individual provincial hospitals and doctors it will be very difficult to assemble past data on fungal poisoning. However, the involvement of Prof Paul Newton in the project at the hospital in Vientiane means that we have access to any cases within the capital. In addition, Ms Chittarhat is receiving case notes and any fungal material that is available for identification.

Assumption 5: The combination of lack of unlogged accessible areas – there are areas within protected areas but we cannot get access to these due to local unrest – and the huge UXO issues means that taking samples below ground is difficult. However, in the field survey planned for 2016, we will work with the mines advisory group (MAG) in Phonsavan to locate clean areas where we can collect samples directly from single host species to show the impact of the removal of individual host species. The value chain study carried out in association with Ole Pederson demonstrated that it is possible to survey local approaches and value of harvesting the highly prized Matsutake.

3.5 Impact: achievement of positive impact on biodiversity and poverty alleviation

The majority (75%) of the Laotian population still rely on sustainable use of biodiversity, particularly forest non-timber forest products, with fungi being a major source of income in many areas. However, despite their importance as a source of food and in revenue generation, there is surprisingly little awareness of the importance of fungi in the provision of ecosystem services and their vulnerability to over- or incorrect harvesting. The project is focussed on building up the infrastructure whereby assessments can be made of the potentially huge mycological diversity in Laos. The established database and the reference collections coupled with literature and improved skills sets (ecological and identification knowledge) through the training workshops will enable surveys of both markets and field situations to be carried out. These will in turn feed into the national knowledge of fungi and promote foreign interest particularly in neighbouring countries where mycology is much more developed (e.g. Thailand). The project has a number of identifiable impacts on the livelihoods of local peoples. Both harvesters and consumers of wild collected fungi will benefit from the identification of the causal agents of fungal poisoning by a reduction in the hardship and social disruption brought about by this issue. The highly prized Matsutake is the major source of income during the short, two month fruiting season in Xieng Khouang province. Increased foreign interest in the fungus may be leading to non-sustainable harvesting of this fungus. The long-term utilisation of this resource by locals will benefit from increased awareness amongst harvesters of the susceptibility of Matsutake to improper harvesting approaches, thereby safeguarding their livelihoods. The value chain report produced in association with ABP demonstrates the considerable value that the collection of a single species Matsutake has for the villagers.

4. Contribution to SDGs

The project is relevant to following SDGs

1. Food – Most Laotians still rely on NTF products for food and income generation of which fungi are a major component. The project aims at the sustainable utilisation of this valuable natural resource.
2. Health – by investigating the annual poisonings that occur, we are address the wellbeing of the people. We have obtained the fungal material involved in the incidents which we will identify, allowing us to raise awareness about the risks of these species.
3. Education – We are educating a cohort of individuals who will be able to continue and expand the field after the cessation of the project. Eight people took part in the course in 2015.

4. Infrastructure – we have been building the intellectual capacity, personnel and laboratory facilities for the Nation to carry out assessments of its natural capital.
5. Ecosystems – the fungal group the project has focussed on are not only the major edible fungi collected but they are also essential to the health of the forests: they are symbiotic the trees, which rely upon for nutrient uptake.
6. Sustainability - The project aims at the sustainable utilise of fungi as a valuable natural resource. The value chain assessment of Matsutake demonstrates the importance of this fungus for income generation and indicates the need for sustainable harvesting approaches.

5. Project support to the Conventions, Treaties or Agreements)

An almost total lack of mycological knowledge and expertise in Laos means that the outputs from the project (reference collections, trained personnel, laboratory facilities, field evaluations, development of a checklist) directly address the CBD convention objectives of -

1. The conservation of biological diversity
2. The sustainable use of the components of biological diversity
3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

and supports Lao PDR to meet its obligations under the convention. Specifically the project addresses the following CBD articles: 6 (Conservation & sustainable use); 7 (Identification and Monitoring, 12 (Training); 14 (Impact Assessment and Minimizing Adverse Impacts, and 16 (Access and transfer of technology). Similarly, the project contributes to several cross-cutting themes including Public Awareness and Education; Global Taxonomy Initiative; Identification, Monitoring and Indicators; Sustainable use of Biodiversity.

6. Project support to poverty alleviation

Is there evidence that the project is working to poverty alleviation? - Quantitative evidence would be difficult to obtain but the aspect of this project which deals with poisonings will clearly alleviate poverty by reducing the amount that poor people have to spend on treating illness owing to misidentification of fungi. Fatalities resulting from poisonings can have considerable collateral impacts if the victims are the primary income generators within households. Reducing such occurrences will diminish such associated hardships. In addition, teaching people to harvest Matsutake sustainably will enable them to have a continuous income over many years. If they overharvest Matsutake in the short term, then their income source will vanish.

Who are the expected beneficiaries of this work? - The general population in the case of poisonings. Local gatherers of fungi in the case of Matsutake. The country as a whole will benefit from improved adherence to the conditions of the CBD which will result from a deeper understanding of the diversity of fungi in Laos.

Are there expected to be any direct impacts from this project? - The most direct impacts relate to poisonings and sustainable harvesting of Matsutake.

If indirect only, what evidence is there that the project will contribute to poverty alleviation in the long-term? - Contrary to what we reported as anecdotal evidence in the first annual report, we found little evidence in the field for unsustainable harvesting of Matsutake.

Are there any noticeable achievements this year? - Doubling in the size of the National Fungarium. A draft report on the value chain of Matsutake collecting in Xieng Kouang province, in conjunction with Ole Pedersen.

7. Project support to Gender equity issues

There was no gender equity objective explicitly stated within the original project programme. Women are well represented within the participants of the project, as partners and as collaborators within the country. The majority of the personnel which are involved in the project at the technical services at BEI are women. If there is a gender issue then it is with a bias towards women. Of the participants at the workshop in May 2015, eight of the 9 participants were women. The proportion of women to men within the National herbarium staff is more

balanced with a 50:50 split between genders. Most of the top positions within BEI with the notable exception of the overall Director are held by women. As part of the project, we have encouraged the appointment of Mr Phongeun Sysouphanthong at the herbarium. Mr Sysouphanthong is Laotian with a Masters degree in mycology from Thailand. He is an ideal person to take on the responsibility of developing the mycology section of the herbarium. We selected two personnel to travel to Aberdeen for an intensive training in molecular techniques. The two best candidates were women. The training provided will help them progress in their careers as well as support the development of mycology within Laos.

8. Monitoring and evaluation

The complement of the partners within the project steering group (PSG) has remained fluid with some members taking very little interest in the functioning of the project. However, other partners have become more important during this period and this project has benefitted because it has become more focused. In particular, the Dean of the Science Faculty at the National University of Laos, Dr Somchanth Bounphanmy, has become an important influence in the success of output 2: The molecular laboratory. However, BEI remains our central contact point for the project for any Ministry associated issues. Kongchay Phimmakong and her team coordinate contacts and logistics for meetings other members of the PSG. The PI is in very regular contact with Ms Phimmakong and Mrs Bouamanivong at BEI to assess progress towards outputs associated with the National Fungal collection. The PI and Mark Newman have had regular contact with individual members of the PSG to maintain project activities. In total, there were 4 visits to Laos during the reporting period, 4 by the PI, during two of these he was accompanied by Mark Newman. It has become very clear that face to face meetings are the most efficient way to communicate and exchange progress reports.

Measuring the progress of achievements is straightforward and inexpensive for a number of project outputs. The physical existence of the National reference collection, literature, and lab and field equipment allow these achievements to be readily assessed. Similarly the hardware in the laboratory shows that the establishment of the lab is progressing as planned. Improved skills sets and knowledge are more difficult to assess but increases in the numbers of high standard submissions in the National reference collections and accumulating ecological data will be quantifiable measures of success. During the final day of the course we gave the participants a small exam by showing them photos of fungi and asking them to answer a set of questions relating to which taxonomic group they were in and why. The participants were very excited by this exercise as competition seemed to be something of a novel concept for them. They did this as a small group exercise and then we discussed the questions and the reasoning behind their answers. A similar approach will be used during the course in 2016.

9. Lessons learnt

There have been some important lessons learned since the inception of the project but particularly this past year, which if we had known them at the beginning of the project they would have helped at all levels.

- a) On the scoping trip and at the start of your project, contact as many local aid and conservation agencies as you can – from different nationalities – they can often provide you with much better knowledge and experience of local issues than official organisations.
- b) Contact the local British Embassy as they often have a good contact network and knowledge of other groups/projects working in the country.
- c) Some of the best contacts made are often via chance encounters and word of mouth. Talk to as many people in the country as you can to publicise the project. A small leaflet or flyer that you can hand out would be a good idea. Talk to local aid
- d) Ask how much it will cost for people (local and official) to participate in workshops, training course, field trips etc. They may require a 'per diem' payment to take part.

- e) Work out the logistic train for participation of locals – this may involve several levels of administration from central to local government. The initial sorting out of permissions on the ground may take several days – something to bear in mind when you have a weeks field work planned.
- f) Give priority to getting letters of agreement established – these may take much longer than you anticipate. AND without them in place it will be much harder to get support from within the organisation or to arrange things between organisations.
- g) Expect the unexpected – for training courses have alternative methods of teaching prepared in case ‘someone steals the local electricity transformer’.
- h) In south East Asia – check local area for war history – use of antipersonnel mines and current state of Unexploded Ordnance (UXO) clearance. You may need metal detectors if you want to take soil samples.
- i) Although you are likely to have a number of partners within the country, there may be one contact who can act as a focal point, who will disseminate information for you and who can arrange meetings between all host country partners much more easily than you can when you are out of the country. It may help if the contact person/group is part of a government organisation.
- j) Arranging repeated face to face meetings within the host country with partners is very important. People are much more likely to respond to emails if they know you. Hosting meals after project meetings may be part of the accepted culture and important in establishing good relations with partners. Find out on your scoping trip how the system works and budget accordingly.

10. Actions taken in response to previous reviews (if applicable)

There was only one comment from the previous annual report to address: ‘For monitoring changes in knowledge and skill set over the course of the project, a baseline should be set and a standard may for monitoring change used.’

In this case the baseline was simple - there was no knowledge and no skills sets. We encountered two masters students who were meant to be working on fungal ID projects and they were using a picture book from China! These two have now attended the course held in May 2015 and are also attending the 2nd course in 2016. They will have the basic skills they need to carry out a scientific assessment of their finds.

11. Other comments on progress not covered elsewhere

Laos is the most heavily bombed country on earth. The field team were totally unprepared for the extent and intensity of the problems related to field work in the Xieng Khoang province. It is estimated that there is 600K tons of unexploded ordnance in the country. Although the locals were sure it was safe to move on the well used paths within the forests, movements were restricted which has an impact on both the intensity with which we could survey areas and make collecting any samples below ground very unwise. Discussions will be held with the Mines Advisory Group in Phonsavan, Xieng Khoang province before any field work is carried out in 2016.

12. Sustainability and legacy

The involvement of BEI as the main contact point has the benefit that other ministerial agencies are informed of ongoing projects. So the existence of the project has been disseminated within the government. Through Ole Pedersen we now have good contact with the main FAO representative in Laos and the whole project team met up with him in 2016 for discussions about the project and possible assistance from FAO. Ole is now working with the FAO on small production systems for edible fungi. The PI was also contacted by ‘Serving SE Asia’, a foundation which is also supporting small scale production systems. The PI has been assisting with the design of production systems. It is possible that a further Darwin project could be established around these production systems using local fungi.

Part of the legacy of the project was to have a mycologist employed at the University. Mrs Toulaphone Keokene, who has participated in the course and the intensive training in Aberdeen, is already employed at the University and she has been given the responsibility of maintaining the molecular lab. The Dean of Science is also considering establishing a department around the laboratory which would further support its survival. The appointment of Mr Phongseun Sysouphanthong at BEI, with our assistance, also ensures that there will be a mycological legacy at the herbarium.

13. Darwin Identity

2015 was the International Year of Soils, and the PI was involved in a number of events in relation to this and the project and the Darwin initiative were included in presentations, including 5th December World Soils Day a public event at RBGE.

The Darwin Initiative has been publicised during presentations within the UK at national events including the annual Kew meeting of the British Mycological Society, and at local KE events (Café Scientifique Aberdeen early 2015, Science show on local Aberdeen radio). The logo was used in presentations. The PI has given presentations at the James Hutton institute on the project.

The project has been covered in a number of online media coverage outlets which mention both Defra and the Darwin initiative:

Another article appeared in the Botanics magazine of RBGE in spring 2015 (<http://www.rbge.org.uk/assets/files/Publications/botanics60spring15lores.pdf>), mentioning the Darwin Initiative in the title and the text.

The Darwin Initiative was also publicised during presentations by the PI at Universities in Sweden, Finland and Norway during the reporting period. The project was recognised as a distinct entity with Darwin Initiative support.

The Darwin initiative logo and the project are included in the email signature of the PI.

The success of a previous Darwin Initiative project that was carried out in Laos by the UK partner Mark Newman has left a lasting legacy of familiarity with the Initiative. Personnel within the BEI and the National University of Laos are familiar with the Darwin Initiative. The support from Darwin Initiative for the present project has been emphasised during face to face meetings with local members of international organisations in Laos, including IUCN and FAO.

14. Project Expenditure

Table 1 Project expenditure during the reporting period (1 April 2015 – 31 March 2016)

Project spend (indicative) since last annual report	2015/16 Grant (£)	2015/16 Total Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)			0	
Consultancy costs			0	
Overhead Costs			-6	
Travel and subsistence			-10	
Operating Costs			3	
Capital items (see below)	0	0	0	
Others (see below)			0	
TOTAL				

Due to not being able to find a suitable candidate for taking the MSc course in Edinburgh and the alternative plan to have two trainees for an intensive period in Aberdeen, the allocations of finances has been altered. This has been discussed and approved by Darwin. Most of the changes are not visible in the table below as they mainly applied to the operating costs, but the slightly higher international costs are due to the additional airfares of the two trainees to Aberdeen.

Annex 1: Report of progress and achievements against Logical Framework for Financial Year 2015-2016

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016	Actions required/planned for next period
<p>Impact</p> <p>To enable Laos PDR to manage its mycological resources and fulfil CBD commitments through increasing awareness of fungi, their conservation, economic sustainability, and ecological importance.</p>		<p>The existence of the project and the numerous meetings at which the importance of fungi has been highlighted have raised the awareness of fungi as an important component of biodiversity in Lao PDR. A number of discussion with FAO representative Mr. Stephen Rudgard have raised the awareness of fungi as a valuable natural resources.</p>	<p>Contact has been initiated with Serving SE Asia, a charity involved in supporting the development of small businesses in Laos. The project PI has been contributing to the design of approaches for growing cultivated fungi. The potential for this will be explored further for developing the potential to cultivate other native fungi. The data from the fungarium has been uploaded onto the International database PlutoF, making it available to the international community and raising awareness of the collections available in Lao PDR. The addition of creating a checklist for Lao PDR will also give international exposure to the project and support the intellectual legacy of the set by the project.</p>
<p>Outcome There will be an increased academic and technical capacity in Laos PDR to carry out fundamental mycological research thereby contributing to safeguarding harvesters, consumers and the National fungal capital.</p>	<p>Indicator 1: Knowledge assessments will be made as part of the workshops. Present baseline = no knowledge of fungi. Post workshops the participants should have a good basic theoretical and practical knowledge of traditional and molecular fungal taxonomy, conservation, and ecology. One graduate trained to masters level.</p> <p>Indicator 2: Present baseline = no fungal reference material, little literature or knowledge of ethnomycology - vernacular names and uses. Post project: Representative reference collections made of fungi for sale in markets and of fungi collected during workshops. Each collection associated with a fact sheet and photos in web-</p>	<p>Progress has been achieved in achieving the project outcome with increased technical capacity to support mycological research in Lao PDR with database establishment and the ongoing development of laboratory facilities. A total of 10 persons received training either as part of the intensive week long workshop in May 2015 or in the field during the following week. An additional 4 people received training in September at the national herbarium.</p> <p>No suitable candidate could be found for the MSc course. An alternative plan was developed and approved by Darwin, where two persons came to Aberdeen for a period of 10 weeks for intensive training on molecular</p>	<p>A workshop and a field study will take place in the last two weeks of May. Eight participants from different Institutions will attend and be tutored by all the project International partners.</p> <p>The field study will gather data on both the ecology and harvesting of Matsutake and on fungi collected for income generation at local markets. Further collections will be made for the National Fungarium.</p> <p>Collaboration with Prof Newton at Mahosot hospital, Vientiane will continue the issue of fungal poisonings in Laos.</p> <p>A study will be made into the fungi associated with specific species of tree</p>

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016	Actions required/planned for next period
	<p>accessible database.</p> <p>Indicator 3: Currently only word of mouth reports exist of poisonings due to fungi. Documented cases will be compiled. Increased awareness of potential toxicity being the desired end state.</p> <p>Indicator 4: Currently there is no knowledge of the impact of logging or of harvesting techniques on sustainable utilisation of edible fungi associated with forest trees in Laos. Case studies will provide this data.</p>	<p>techniques and sequence processing. The two women chosen have worked very hard over the study period and have generated sequence data from a number of their own Laotian collections, which they have then created phylogenetic trees from.</p>	<p>to show the impact of tree removal – this is an adaptation of the logging case study.</p>
<p>Output 1. Mycological training workshops involving international experts training national participants. Establishment of databases.</p>	<p>1a. Measure = Workshops taking place and attract the required participants</p> <p>1b. Expected change: 10-15 participants trained (previously 0)</p>	<p>Two workshops took place during the reporting period. The first one in May which involved all of the European experts as tutors was attended by 8 participants from a number of organisations. The 2nd workshop took place in September and was primarily for the herbarium staff at BEI. They were shown how to curate the collections, take photographs and prepare microscope slides to examine the microscopic characters of the collections. Overall 12 people received training during the period.</p>	
<p>Activity 1.1 Setting up the logistics for the workshops. Recruiting participants for the workshops from BEI and NUoL and other interested parties.</p>		<p>The planning of future workshops will take place throughout this reporting period.</p>	
<p>Activity 1.2, Run three workshops, including field excursions and lab practical sessions.</p>		<p>See box above</p>	
<p>Activity 1.3. Finding suitable servers, hardware and software for initiating and developing of databases</p>		<p>No suitable hardware exists at present either at BEI or the National University. A top of the range Laptop was purchased to store the data and literature accumulated during the project. External backups safeguard the data.</p>	
<p>Output 2. A functional molecular laboratory supported by training manuals and SOPs for processing and establishing mycological collections from material collected locally and nationally.</p>	<p>2a. Measure = development of a dedicated facility for preparation of fungal DNA.</p> <p>2b. Training manuals and SOPs - project leader and tutors will correspond monthly to ensure progress on track</p> <p>2c. Local collections will be checked by project leader (and tutors) 3x per year to ensure satisfactory progress.</p>	<p>The establishment of the laboratory is an ongoing process. The location at the National University of Laos and dedicated personnel assistance greatly facilitated the delivery of this output. All of the hardware for the Lab is now in place. A total of 854 collections are now in the fungarium, generated during the field surveys of Matsutake. Any additions made by BEI personnel are routinely checked during each visit.</p>	

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016	Actions required/planned for next period
	Expected change: existence of manuals and collections not previously available.		
Activity 2.1. Identifying a secure, suitable location within BEI or NUoL to house the fungal laboratory. Acquiring the suitable consumables and equipment for the lab.		A suitable location for the laboratory was found at the National University of Laos. Installation of equipment has been completed	
Activity 2.2. Liaising with other tutors for the development of the necessary manuals for the workshops		Each tutor has developed suitable manuals based on their own areas of expertise. All presentations have been given to the course participants on a memory stick.	
Activity 2.3. Preparing manuals for each workshop		Handouts of seminars and protocol manuals have been prepared and are given to course participants.	
Output 3. Report on poisonous fungi and poisonings collected from markets and medical establishment.	Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: empirical data on quantification of severity and frequency of this issue, not previously available and critical for addressing this in the future	This output was scheduled for the first reporting period but the lack of central information sources means that data will be collected over the course of the whole project and a report will be produced in the final period. No additional expenditure is required. We have acquired the hospital case notes from two poisoning incidents along with the fungi involved. We are trying to identify them.	
Activity 3.1. Contacting medical establishments for cases of confirmed or suspected fungal poisonings. Checking newspapers for poisoning articles. Interviewing traders.		Collaboration has been established with Prof Paul Newton at Mahosot hospital, who has an interest in poisoning cases. The main aim is to identify the causal fungal agent, which is currently unknown. Once this is known it will be possible to raise awareness highlighting the danger.	
Activity 3.2. Checking and collating the data		Ongoing.	
Activity 3.3. Preparing the final report in conjunction with TABI and ABP		After failed attempts to engage with TABI, contact has been dropped. However, collaboration with ABP and Ole Pedersen is very good. And a general report on potentially toxic species is in preparation.	
Output 4. Report on the fungi sold at markets, including ecological data.	Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: There is currently little empirical data on the diversity of fungi sold at markets and no information on their ecology. The report will provide this, enabling future comparative assessments.	Local markets have been identified near the capital Vientiane, which are easily accessible and which have several traders who supply fungi. These markets will be targeted for data collection during the next reporting period. There has been no available or suitable personnel to carry out the necessary visits to the markets. The appointment of Mr Phongeun Sysouphanthong t BEI will now allow this output to proceed as planned.	

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016	Actions required/planned for next period
Activity 4.1. Working with TABI and ABP on gathering data from different markets to establish the diversity and identity of fungi sold. Local Laotian project assistant to participate in this.		See above comment	
Activity 4.2. This will be done during the May-August season each year with yearly reports prepared		Ongoing data collection	
Activity 4.3. The final report will be compiled with TABI and ABP		Planned for final period but only with ABP	
Output 5. Data generated from molecular study of fungal communities in logged and unlogged areas, analysed and written up	5a. Report will be compiled by project leader to ensure quality control and timeliness. Progress will be reported regularly to project steering committee. Expected change: There is no data or awareness within Laos on how logging impacts on edible fungi, the report will redress this deficit.	Samples will be taken and analysed in 2016, see explanation for delay under section 3.4, Assumption 5.	
Output 6. Data collected from interviews with local villagers involved in harvesting Matsutake, processed and written up.	6a. Report will be compiled by project leader, TABI and ABP progress will be checked once a year at the end of the fruiting season of Matsutake. Expected change: currently little information available on scale of harvesting, none of harvesting approaches or local knowledge. The study will provide this information to assess if harvesting approaches appear sustainable.	This is ongoing. A report on the value chain of Matsutake has been compiled in association with Ole Pedersen at ABP. See Annex 4.	

Annex 2 Project's full current logframe as presented in the application form (unless changes have been agreed)

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Goal: Effective contribution in support of the implementation of the objectives of the Convention on Biological Diversity (CBD), the Convention on Trade in Endangered Species (CITES), and the Convention on the Conservation of Migratory Species (CMS), as well as related targets set by countries rich in biodiversity but constrained in resources.</p>			
<p>Outcome: To enable Laos PDR to manage its mycological resources and fulfil CBD commitments through increasing awareness of fungi, their conservation, economic sustainability, and ecological importance.</p>	<p>Knowledge assessments will be made as part of the workshops. Present baseline = no knowledge of fungi. Post workshops the participants should have a good basic theoretical and practical knowledge of traditional and molecular fungal taxonomy, conservation, and ecology. One graduate trained to masters level.</p> <p>Present baseline = no fungal reference material, little literature or knowledge of ethnomycology - vernacular names and uses. Post project: Representative reference collections made of fungi for sale in markets and of fungi collected during workshops. Each collection associated with a fact sheet and photos in web-accessible database.</p> <p>Currently only word of mouth reports exist of poisonings due to fungi. Documented cases will be compiled. Increased awareness of potential toxicity being the desired end state.</p> <p>Currently there is no knowledge of the impact of logging or of harvesting techniques on sustainable utilisation of edible fungi associated with forest trees in Laos. Case studies will provide this data.</p>	<p>Assessments will take the form of short practical and written exams. Workshop satisfaction surveys will be given out to all participants and analysed. One student with a MSc degree in Biodiversity and Conservation.</p> <p>The project leader and tutors will inspect all reference collections to ensure agreed quality standards, including fact sheets and photos. Project leader and local Project Steering Committee will be responsible for ensuring online access is created and fully functional.</p> <p>Project leader, the local assistant and aid agencies will ensure proper use of standard reporting forms in data acquisition from medical establishments and will also make sure the storage/filing of these records takes place in these establishments. Verification of awareness of both buyers and sellers will be established using market surveys carried out by project leader, local assistant and aid agencies. Project leader will ensure consistency of approach and analysis of findings.</p>	<p>There is an assumption that there will be 10-15 participants who will benefit and value participation in the workshops. The level of spoken English may be an issue and a translator may have to be employed. That the international experts who have already agreed to participate will actually be available or will find alternatives.</p> <p>One student must have sufficient English and skills in order to qualify for inclusion on the MSc programme in Edinburgh.</p> <p>That there will be fungal fruit body material to gather and process for inclusion within the National Mycological collection. That conditions can be maintained where dried fungal collections can be kept free from insect attack.</p> <p>That it is possible to obtain information regarding fungal poisoning cases from hospitals and doctors.</p> <p>There is an assumption that accessible suitable logged and unlogged areas can be found in which to do the analyses</p>

Project summary	Measurable Indicators	Means of verification	Important Assumptions
		Quality of survey data on logging impacts will be ensured as project leader is directly involved in collecting it. The quality and consistency of household and field surveys of fungi harvesters will be ensured by the project leader overseeing all the work.	
Outputs: 1. Mycological training workshops involving international experts training national participants. Establishment of databases.	1a. Measure = Workshops taking place and attract the required participants 1b. Expected change: 10-15 participants trained (previously 0)	1a. Trained personnel 1b. Usable database 1c. National reference collection	There is a risk that insufficient suitable participants may be found for the workshops and that they can be taught over the three consecutive years. This may be countered by having a number of BEI and NUoL employees as participants.
2. A functional molecular laboratory supported by training manuals and SOPs for processing and establishing mycological collections from material collected locally and nationally.	2a. Measure = development of a dedicated facility for preparation of fungal DNA. 2b. Training manuals and SOPs - project leader and tutors will correspond monthly to ensure progress on track 2c. Local collections will be checked by project leader (and tutors) 3x per year to ensure satisfactory progress. Expected change: existence of manuals and collections not previously available.	2a. Training manuals and protocols for processing fungal material 2b. DNA prepared in the laboratory	That it will be possible to transport and maintain <i>in situ</i> the equipment required for the workshops and new lab. That suitable personnel can be found to maintain the facility
3. Report on poisonous fungi and poisonings collected from markets and medical establishment.	3a. Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: empirical data on quantification of severity and frequency of this issue, not previously available and critical for	3a. Report on fungal poisoning in Laos	That it is possible to obtain information regarding fungal poisoning cases from hospitals and doctors

Project summary	Measurable Indicators	Means of verification	Important Assumptions
	addressing this in the future		
4. Report on the fungi sold at markets, including ecological data.	4a. Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: There is currently little empirical data on the diversity of fungi sold at markets and no information on their ecology. The report will provide this, enabling future comparative assessments.	4a. Report on the diversity of marketed fungi in Laos	There is a risk that there may be poor fruiting years during the period covered by the project, which could significantly impact on the number of collections and observations that can be made. However, the seasonality experienced in Laos is much more dependable than the vagaries of the temperate zones.
5. Data generated from molecular study of fungal communities in logged and unlogged areas, analysed and written up.	5a. Report will be compiled by project leader to ensure quality control and timeliness. Progress will be reported regularly to project steering committee. Expected change: There is no data or awareness within Laos on how logging impacts on edible fungi, the report will redress this deficit.	5a. Publication on logging impacts.	There is an assumption that suitable study areas can be found.
6. Data collected from interviews with local villagers involved in harvesting Matsutake, processed and written up.	6a. Report will be compiled by project leader, TABI and ABP progress will be checked once a year at the end of the fruiting season of Matsutake. Expected change: currently little information available on scale of harvesting, none of harvesting approaches or local knowledge. The study will provide this information to assess if harvesting approaches appear sustainable.	6a. Publication on Matsutake harvesting	The participation of the villagers in surveying local knowledge and harvesting techniques for Matsutake is critical for the case study.
<p>Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)</p> <p>Output 1</p> <p>Activity 1.1: Setting up the logistics for the workshops. Recruiting participants for the workshops from BEI and NUoL and other interested parties.</p> <p>Activity 1.2: Run three workshops, including field excursions and lab practical sessions.</p>			

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Activity 1.3: Finding suitable servers, hardware and software for initiating and developing of databases</p> <p>Output 2</p> <p>Activity 2.1: Identifying a secure, suitable location within BEI or NUoL to house the fungal laboratory. Acquiring the suitable consumables and equipment for the lab.</p> <p>Activity 2.2: Liaising with other tutors for the development of the necessary manuals for the workshops</p> <p>Activity 2.3: Preparing manuals for each workshop</p> <p>Output 3</p> <p>Activity 3.1: Contacting medical establishments for cases of confirmed or suspected fungal poisonings. Checking newspapers for poisoning articles. Interviewing traders.</p> <p>Activity 3.2: Checking and collating the data</p> <p>Activity 3.3: Preparing the final report in conjunction with TABI and ABP</p> <p>Output 4</p> <p>Activity 4.1: Working with TABI and ABP on gathering data from different markets to establish the diversity and identity of fungi sold. Local Laotian project assistant to participate in this.</p> <p>Activity 4.2: This will be done during the May-August season each year with yearly reports prepared</p> <p>Activity 4.3: The final report will be compiled with TABI and ABP</p> <p>Output 5</p> <p>Activity 5.1: Suitable logged and unlogged sites will be identified in collaboration with TABI and ABP. The impact on the above ground tree vegetation will be assessed. Root samples will be taken and dried for shipping to JHI.</p> <p>Activity 5.2: Samples will be extracted and processed for high throughput sequencing. Data will be analysis and community analyses carried out.</p> <p>Activity 5.3: A report will be prepared and a scientific paper produced for publication.</p> <p>Output 6</p> <p>Activity 6.1: Suitable areas producing Matsutake will be identified in collaboration with TABI and ABP. Observations will be made of harvesting techniques and interviews will be carried out with the harvesters.</p> <p>Activity 6.2: Data will be collated from different areas to identify potential differences in knowledge and harvesting approaches</p> <p>Activity 6.3: A final report will be prepared in conjunction with TABI and ABP</p>			

Annex 3 Standard Measures

Table 1 Project Standard Output Measures

Code No.	Description	Gender of people	Nationality of people (if relevant)	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
Established codes								
2	No. of people to attain Masters qualification		Laotian	0	0	0	0	1, no suitable candidate was found
4C	No. of postgraduate students to receive training		Laotian	0	2	2	2	2
4D	Number of training weeks provided		Laotian	0	2	2	2	4
6A	No. of people to receive training		Laotian	1	14	8	15	17,
6B	No of training week provided		Laotian	1	3	3	4	5
7	Number of training materials to be produced for use by host country			0	3		3	5, includes molecular technique protocols, Translations of Mycological terms.
12A	Number of computer based databases to be established and handed over to the host country			1		1	1	2
13A	Number of species reference collections to be established			300	554		854	600
14B	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.			1	1		1	3
20	Estimated value of assets to be handed over to host country			Ca. 57K			Ca. 57K	60K In addition 10 teaching microscopes have been donated – value undetermined

								d
21	No. of permanent Facilities			2	0		2	2, A molecular laboratory (in progress) and a National Mycological collection
23	Value of resources raised from other sources for project work			3660 0	3660 0	3660 0		Ca. 110000 This includes overhead shortfall from James Hutton Institute, In-kind time from tutors, and Aid money allocation from ABP.

Table 2 Publications

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)

Annex 4 Onwards – supplementary material (optional but encouraged as evidence of project achievement)

Workshop: <http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/workshop-may2015>

The Fungarium: <http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/fungarium>

The Laboratory: <http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/laboratory>

Report on value chain for Matsutake

MATSUTAKE - HET WAI/PEAK

Value Chain Analysis

Xieng Khouang Province, Lao PDR



TABLE OF CONTENT

Agro-biodiversity Project

Ole S. Pedersen and Viravanh Phannorath
Vientiane, January 2016

Index

1. BACKGROUND	3
2. METHODOLOGY	4
3. GROWING AREAS AND HARVEST OF MATSUTAKE	4
3.1 Growing area and forest type	4
3.2 Production and harvest trend	29
4. HET WAI VALUE CHAIN	29
4.1 Village level sales	30
4.2 District level sales	30
4.3 Provincial level sales	30
4.4 Export to other provinces and abroad	30
4.6 Quality, grading and handling	31
4.6 Non fresh sales	31
5. FOREST MANAGEMENT AND LEGISLATION	32
5.1 Forests management & sustainable harvest	32
6. DISCUSSION	32
7. RECOMMENDATIONS	33

Annexes

Annex 1. Income from sale of Matsutake by villages in five districts of Xieng Khouang Province

Annex 2. References

Annex 3. Map of Het Wai collecting villages

1. BACKGROUND

The Matsutake mushroom carries the local name Het Wai and sometimes Het Phaek. A few decades ago the “Xieng Khouang Matsutake” was unknown in Lao PDR as an edible mushroom, but after a sudden foreign demand, it has emerged in local markets and today the Het Wai mushroom is famous for Xieng Khouang Province.

Directly translated from Lao, Het Wai means rattan mushroom and Het Phaek means pine mushroom and similarly the English adapted name “Matsutake” is a Japanese word meaning the pine mushroom.

Matsutake comprises several closely related species belonging to the *Tricholoma* genus growing under various conifer tree species (*Pinus*, *Abies*, *Picea*, *Larix*, *Cedrus*, etc.) and trees of the oak family (e.g. *Castanopsis* and *Quercus*). The Matsutake species are known from Eastern Asia, Himalaya, Northern Africa, some European countries, the Northwestern part of United States, and Canada. The true Matsutake (*Tricholoma matsutake*) grows in few Asian countries including Japan, China, Tibet, Nepal, and Bhutan. The Matsutake in Xieng Khouang is likely to be *Tricholoma fulvocastaneum*, also known from Thailand, China and Japan. This mushroom, together with its sister mushroom *Tricholoma bakamatsutake* grows only under trees of the oak family, whereas the true Matsutake grows mainly under pine trees. The three mushrooms are very similar and edible, though the true Matsutake reaches much higher prices, due to its special flavour.

Traditionally, in Laos, mushrooms are divided into mushrooms growing on wood and from soil. The latter group can be divided into mushrooms growing on litter and partly decomposed plant material and those forming a mutual beneficial association (mycorrhiza), essential for uptake and exchange of nutrients of both the mushroom and the living tree. Without mycorrhizal fungi most trees cannot survive and without host trees the mycorrhizal fungi cannot exist. The Xieng Khouang Matsutake is a mycorrhiza fungi growing under trees belonging to the *Fagaceae*¹ family and rarely mixed with pine trees. It typically grows at altitudes above 1,000 m a.s.l.

The occurrence of Matsutake in neighboring provinces with similar ecology is possible, but not well known. Small quantities are sold in Huaphan Province, mainly coming from the border area between Xieng Khouang and Huaphan provinces.

The world’s key consumer of Matsutake is Japan, where the true Matsutake (*Tricholoma matsutake*) is known for its special aroma and the “thousands years symbol of longevity”. Due to high demands, the price of true Matsutake in Japan reaches Yen 20,000-100,000 (USD 85-800) per kg fresh, depending on supply, freshness and shape. Highest prices are offered to young non-opened Matsutake of a size of 10-15 cm. The imported fresh Matsutake at the Japanese wholesale market fetches prices between Yen 3,000 to 35,000 (USD 25-285) per kg, whereas the wholesale market price of fresh Matsutake in Yunnan, China is in the range of USD 25-60 per kg. The price of *T. fulvocastaneum* and *T. bakamatsutake* is less.

Main supplier to Japan is China with some 80-90% of total import. Among the exporting countries only South Korea has a long tradition of eating Matsutake, but in much less quantities, hence nearly all of the harvested Matsutake are exported to Japan.

Japanese annual consumption is in the range of 1,000 - 3,000 ton fresh of the true Matsutake of which only 100-200 ton is collected in Japan, compared to some 1,000 ton 75 years ago. The recent decrease is mainly due to root diseases caused by a nematode in red pine (*Pinus densiflora*), although overharvesting is also reported to be a reason for the decline in Matsutake harvests in Japan.

The Biodiversity Strategy and Action Plan for Xieng Khouang Province (PBSAP) includes a specific action plan for Matsutake (1.5.2.2a): Prepare sustainable harvest plans and market development for Het Wai (*Tricholoma matsutake* s.l.) and other endangered mushrooms including improved packaging and marketing.

¹ Probably species of *Castanopsis*, *Lithocarpus* and *Quercus*

In 2015, the Agro-biodiversity (ABP) and the DARWIN Initiative² projects carried out field studies of the habitats of Matsutake and confirmed the forest type for the “Xieng Khoung Matsutake” is high altitude forests containing oak trees. The more detailed ecological requirements are still to be described.

Due to the increasing popularity of Xieng Khouang Matsutake, the district and provincial authorities requested the ABP project to carry out this value chain study. The field survey was carried out from 25 to 31 October 2015, which marks the end of the wild mushroom season.

2. METHODOLOGY

The gathering of information was done by interviewing the district and provincial government officers, middlemen/traders, shop owners, companies and selected village leaders with the objective to assess the different stages of the value chain, to estimate harvest volumes, grading, prices, and uses. Follow-up data and information from remote villages were done by local staff of the Agro-biodiversity project.

3. GROWING AREAS AND HARVEST OF MATSUTAKE

3.1 Growing area and forest type

Matsutake is grown in nearby forests of at least 49 villages, from Kham (19), Pek (11) Phoukout (7), Nonghet (7), Khoun (7), and Kham districts, see map Annex 2. These villages are located around higher altitude forest areas containing oak trees. Villagers generally return to known spots, indicating that specific soil conditions, hosts and age of the trees are playing an important role of re-emergence of matsutake fruit bodies from the same mycelium.

3.2 Production and harvest trend

The Xieng Khouang Matsutake normally peaks three times a year during the period from end of May to end of August. In between the peaks, the harvest is minimal.

There are no official data on yearly harvest of Matsutake, but from sale information obtained from village leaders and district foresters, the total annual harvest of Matsutake for Xieng Khouang Province can be estimated to be in the range of 20-24 tons. In 2015, the district with the biggest harvest was Pek District with total of 8.0 tons collected by families from 11 villages and the district with the lowest harvest was Nonghet District of a total of 1.1 tons collected by families from 7 villages, see table 1. Compared to five years ago Phoukout District harvested only one third in 2015, whereas families from the 11 villages of Pek District had about 60% harvest increase during the same period. The villages with highest harvests are from Ngodphe in Phoukout District as well as the Khong, Pong Vien and Viengthong villages of Pek District often exceeding one ton per year. Most villages, however, are harvesting a few hundred kg or less, see Annex 1. According to local government officers the yearly fluctuations are due to weather conditions, possibly as a result of climate change.

Table 1: Matsutake harvests, by district

District (Village)	2010	2014	2015
	Ton		
Phoukout (7)	9.6	7.3	3.1
Khoun (19)	2.7	2.0	2.1
Pek (11)	5.0	6.7	8.0
Kham (5)	5.9	6.7	6.6
Nonghet (7)	0.8	1.0	1.1
Total (49)	23.9	23.7	20.7

4. HET WAI VALUE CHAIN

² Building Mycological Capacity for Sustainable Resource Management in Lao PDR
<http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr>

The main actors in the value chain are villagers, middlemen/traders and merchants/traders at the Provincial market. However, some farmers sell directly to local markets, at road side or at the central market in Phonsavan, see overview in below fig. 1 and fig 2.

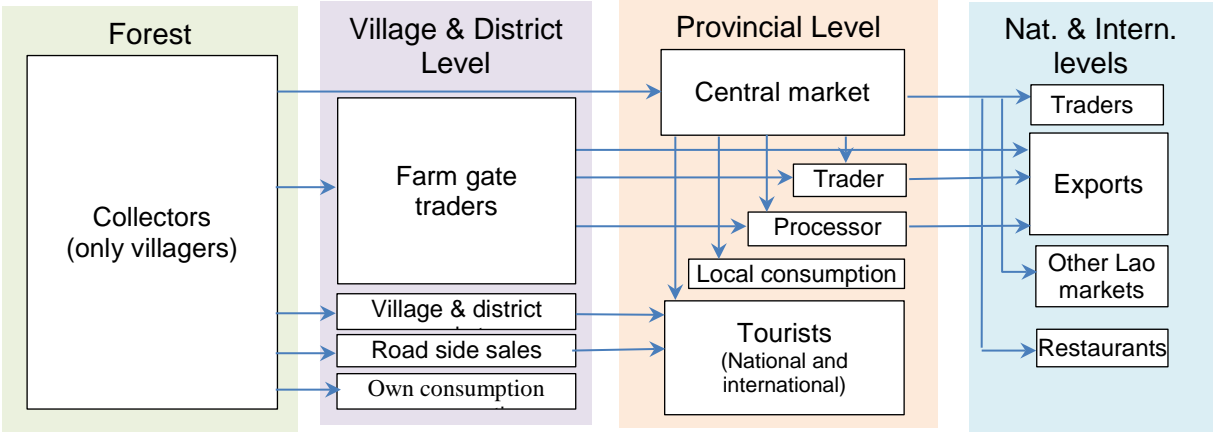


Fig.1: Key actors in the value chain of Matsutake

Information on in-country sales of Matsutake mushrooms to larger markets in other provinces is not easily available, but some trading occurs.

4.1 Village level sales

The mushroom picking in the villages is considered as a family business and sales at this level is normally done by contacting local traders and selling in-bulk without grading, at a price between 50,000-80,000 kip. In few cases and in small quantities together with other wild mushrooms family members sell at road side or at small village markets.

4.2 District level sales

Due to no tradition of eating Matsutake mushrooms, farmers sell a very little amount at local and at district markets and normally as a by-product of other Non Timber Forest Products. Prices at this level range from 60,000-80,000 kip/kg.

4.3 Provincial level sales

To attain higher profits some middlemen will do the grading themselves, but in most cases it will be done at Phonsavan Central Market by the merchants selling to wealthy customers. Most other Lao buyers regard the mushroom as souvenir than a delicious mushroom. A big share of the sales goes to local and some foreign tourists mainly Japanese, Korean and Thai. Yet, there are no restaurants in Phonsavan and in Vientiane which have specialized in preparing Matsutake dishes.

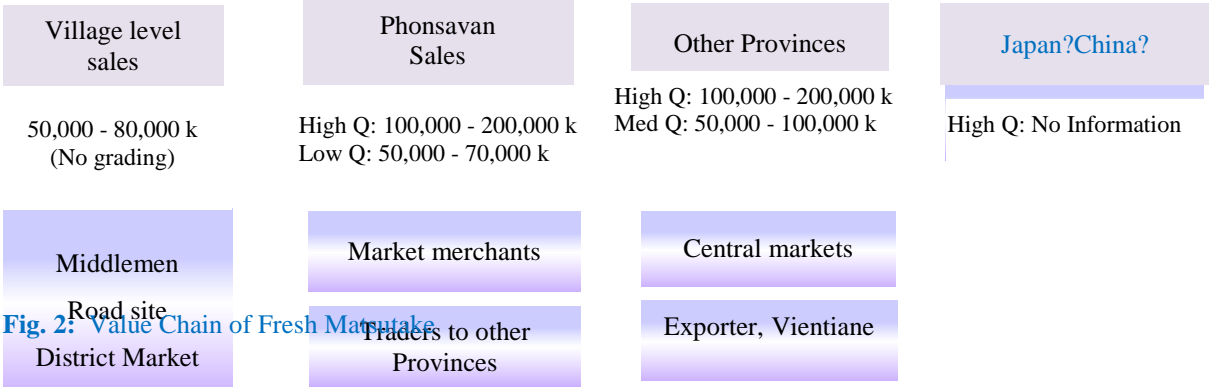


Fig. 2: Value Chain of Fresh Matsutake

4.4 Export to other provinces and abroad

In recent years Matsutake mushrooms from Xieng Khoung Province are increasingly sold at larger markets in other provinces such as in Vientiane and Luang Prabang.

In early 1990'ties a Japanese expert, Mr. Oide, and a local businessman, Mr. Bounnoy, purchased Matsutake mushrooms in Khoun District, packed with dried ice and transported the Matsutake by air to Vientiane for Japan. The yearly quantity is believed to be around one ton, but after a few years the export stopped probably due to unsteady supply.

4.5 Quality, grading and handling

The villagers seem to pay little attention to quality either due to lack of knowledge of added value from grading or the simple fact that some traders and consumers do not differentiate quality. Compared to the boletus (Het Pheung) family the Matsutake mushrooms can be kept fresh in a relative long time if kept in cool places. However, the common practice of picking and transporting Matsutake mushrooms in plastic bags are harmful as many mushrooms get destroyed by moving against each. Lack of airing and storing under warm conditions also quickly (1-days) reduces quality.

At higher levels in the value chain an informal grading system seems to emerge and divided into grades where young (not opened) and large Matsutake (measured on length of stem) achieves highest prices (up to kip 200,000) and the lowest price are those mushrooms that are fully developed opened mushrooms showing the gills. Some traders divide the dried Matsutake mushrooms in small, medium and large sizes, with the smallest size giving highest price.

Possible introduced system could be:

- 1st grade: Young large mushrooms with stems more than 10 cm long
- 2nd grade: Young medium sized mushrooms with stems 5-10 cm long
- 3rd grade: Young small mushrooms with stems less than 5 cm long
- 4th grade: Full developed mushrooms showing the gills

One trader, Ms. Manivanh, from Khoun District claimed that he could distinguish between sweet and the bitter Matsutake.

4.6 Non fresh sales

Some 60% of Matsutake mushrooms are believed to be sold fresh with the remaining been dried, frozen, added in liquor or as a medicinal tea. None of these products are subject to quality control.

a) Dried Matsutake

The fresh Matsutake mushrooms are mainly sundried and sold in simple and unsealed plastic bags without logos (see fig. 3), mainly for sales during off-season in Phonsavanh. The dried Matsutake reaches price of 140,000-1,200,000 kip/kg (USD 18-150/kg) depending on season and quality.



Fig. 3: Sun-dried mushrooms, Phonsavanh market

b) Frozen Matsutake

At least one shop, Sengsavanh Handicrafts, in central Phonsavanh, is selling frozen Matsutake mushrooms, packed in 2 kg plastic bags (see figure 4). The shop sells 15-200 kg per year at a price of 400,000 kip/kg and the shop owner ensured that the quality is maintained. It is not known how widely this conservation method



Fig. 4: Frozen matsutake

is, but it seems to be a good alternative to drying.

c) Matsutake liquor

One local trader, Ms Sormany, in Phonsavanh is producing Het Wai liquor where sliced and dried and fresh Matsutake mushrooms soaked in locally produced alcohol and mixed before bottled with own stickers. The product is registered with own brand with the approval of the local Foods and Drugs Office. The shop has changed from wishy bottles to new imported 750 ml bottles and larger bottles from



Fig. 5: Matsutake liquor

Thailand, see fig. 5 and among others sold at the International Trade and Exhibition Convention Center in Vientiane. The bottle is sold for some 75,000 kip and in this way the matsutake mushrooms increases its value with 5-10 times.

d) Matsutake medicinal tea and mixed in rice

Ms. Sormany is also making a medicinal drink by adding powder from dried Matsutake into boiled water. The ‘Het Wai Tea’ is believed to be good to reduce blood pressure, detoxification and preventing diabetes. In some cases dried powdered Matsutake is mixed in rice dishes.



4.7 Total value of Matsutake

Based on information provided by the ABP project and district and village heads, the accumulated annual Farm Gate sales of Matsutake mushrooms are estimated in the range of 1.2-1.4 billion Kip equal to USD 155,000-180,000. Adding 25% - 50% profit, the total values for the province is in the range of 1.5-2.0 billion kip equal to USD 200,000 – 250,000. However, it is stressed that the estimate is based on informal sources.

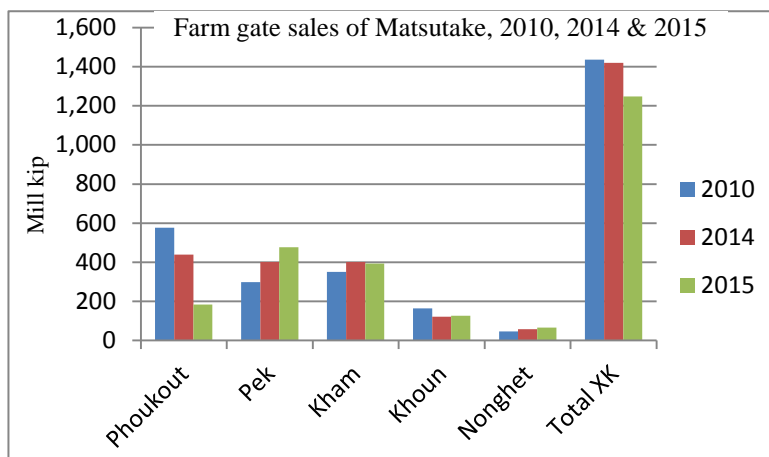


Fig. 7: Income from sales of Matsutake, by District 2013-2015

5. FOREST MANAGEMENT AND LEGISLATION

5.1 Forests management & sustainable harvest

Some 40% of the Province is covered by forests of which most are categorized as District and Provincial Protection and Conservation forests and it is from these un-disturbed and higher altitude forests the Matsutake mushrooms are picked.

Currently, there are no provincial and district development plans that specifically protect forests where Matsutake mushroom are growing. However, villagers have a long tradition and good understanding of protecting the native forests but so far rarely make the connection between the oak and/or chestnut trees and the Matsutake mushrooms.

The provincial trading licenses are provided in bulk to all NTFPs products and no specific trading licenses are given to wild mushrooms including Matsutake. The province has given permission to establish a NTFPs Association in Xieng Khoung with Mrs. Somphone Keomany as the chairman.

6. DISCUSSION

The intensive livestock grassing in the forests was mentioned by one officer in Khoun District to have a negative effect on the growth of Matsutake mushrooms. Similarly, in China, the heavy disturbance in the upper litter layer by the pickers has been mentioned as one cause of reduced harvests of the true Matsutake. In Laos, the litter is based on broad leaves and not litter of conifer needles, but still supports “the disturbance argument” caused by cattle and humans. The full understanding of better management of the Lao forests to maintain or even stimulate the growth of Lao Matsutake is lacking.

The Matsutake mushrooms has the advantage of keeping fresh in relative long time, and due to its current status as being a gift rather than included as delicious dishes in the menu of local restaurants there is very limited pressure on quality control.

Farmers are keeping some 10% of the harvest which is normally consumed fresh in various dishes, Knowledge on how to get the best taste of the dishes and how to preserve the Matsutake mushroom over a longer period seems to be based on trial and error rather than from recipes from China or Japan.

The information on total sale values and volumes of the Matsutake mushrooms is very difficult to obtain as villages and traders are not willing to share such information. Hence the obtained yearly harvest data is likely to be in the lower end. As mentioned earlier, no official trade statistics exist.

Grading at farm level would probably provide villagers with additional income, but would much depend on more knowledge on how to profit from such grading system. Although one trader claimed to know how to distinguish between sweet and bitter Matsutake mushrooms, such variation in taste does not occur within one species or within the matsutake group and in this case probably involves another genus.

Due to the relative new discovery of the Xieng Khouang Matsutake as an edible mushroom there is very little knowledge on alternative use than the fresh mushrooms.

There seems to be very little attention to marketing aspects including improved transport and packaging of Xieng Khouang Matsutake, neither by the sales people at the central market nor shops nor restaurants in Phonesavan nor by private traders.

7. RECOMMENDATIONS

Research and in-depth studies should be carried out to better understand the importance of protecting native forests and particular the host trees and the soil and micro-climatic requirements of Lao Matsutake mushrooms.

Quality issues and grading should have an increased focus at Village level to encourage villagers to transport Matsutake in stiff containers rather than in plastic bags.

The Xieng Khouang Province should exercise more quality control and obtain statistics on trade of Matsutake mushrooms as well as other traded mushrooms such as the red Russula and medicinal species.

Provincial forest management regulations should be issued to ensure sustainable harvest and conservation of the Matsutake mushrooms.

The Province should produce more information and awareness of Xiang Khouang Matsutake products including standard grading system and improved packaging of international standards and thereby promoting Xieng Khouang as the Matsutake Province of Laos. A Geographic Indication of Matsutake Mushrooms should be pursued as a product of Xieng Khouang Province.

Some shops and stands at the markets should specialize in making gift packages of fresh and dried Matsutake mushrooms and local restaurants should expand their menu with Matsutake dishes.

Soft loans to businesses should be made available for improvements of Matsutake trade and quality improvement of Matsutake products.

Annex 2. Matsutake sales by villagers in five districts of Xieng Khoung Province

Phoukout District										
No	Village	2010			2014			2015		
		Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)
1	Bong	80,000,000	1,333	11%	73,500,000	1,225	11%	24,000,000	400	11%
2	Misay	63,000,000	1,050	10%	48,000,000	800	10%	21,000,000	350	10%
3	Yai	48,000,000	800	10%	36,000,000	600	10%	18,000,000	300	10%
5	Lethong	76,000,000	1,267	11%	56,200,000	937	11%	23,000,000	383	11%
6	Ngodphe	284,000,000	4,733	12%	210,000,000	3,500	12%	85,000,000	1,417	12%
7	Say	25,000,000	417	10%	15,000,000	250	10%	12,000,000	200	10%
7	Total	576,000,000	9,600	11%	438,700,000	7,312	11%	183,000,000	3,050	11%
Khoun District										
No	Village	2010			2014			2015		
		Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)
1	Phoumamueng	12,000,000	200	13%	9,000,000	150	13%	12,000,000	200	9%
2	Thoum	15,000,000	250	12%	13,000,000	217	12%	12,000,000	200	8%
3	Sankhing	6,000,000	100	10%	4,000,000	67	10%	4,000,000	67	6%
4	Om	32,000,000	533	10%	16,000,000	267	10%	28,000,000	467	10%
5	Siviengkham	16,000,000	267	10%	9,000,000	150	12%	9,000,000	150	9%
6	Nabong	12,000,000	200	12%	5,000,000	83	12%	5,000,000	83	8%
7	Nalam	9,000,000	150	12%	6,500,000	108	12%	6,500,000	108	6%
8	Na Meuang	10,000,000	167	11%	11,000,000	183	11%	8,000,000	133	10%
9	Na Phakkaad	4,000,000	67	11%	3,000,000	50	11%	4,000,000	67	11%
10	Nongluang	7,000,000	117	13%	6,000,000	100	13%	5,000,000	83	9%
11	San Noi	6,000,000	100	13%	5,000,000	83	13%	6,000,000	100	8%
12	Thaen Phoun	7,000,000	117	14%	8,000,000	133	14%	7,000,000	117	6%
13	Keoleuk	2,000,000	33	16%	2,000,000	33	16%	3,000,000	50	10%
14	Buak Seua	4,000,000	67	14%	4,000,000	67	14%	2,000,000	33	14%
15	Thaen Thong	7,000,000	117	13%	7,000,000	117	13%	4,000,000	67	9%
16	Dokmai	8,000,000	133	12%	6,500,000	108	12%	4,000,000	67	8%
17	Hoi	8,000,000	133	12%	10,000,000	167	11%	15,000,000	250	12%
18	Tham	8,000,000	133	12%	11,000,000	183	12%	18,000,000	300	11%
19	Pieng	2,500,000	42	10%	2,500,000	42	10%	2,500,000	42	6%
20	Tantai	2,500,000	42	11%	1,500,000	25	11%	2,500,000	42	10%
21	Tanneua	2,500,000	42	11%	2,000,000	33	11%	2,500,000	42	11%
21	Total	180,500,000	3,008	12%	142,000,000	2,367	12%	160,000,000	2,667	9%
Pek District										
No	Village	2010			2014			2015		
		Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)	Tot. income (Kip)	Kg	Village Consumption (pct)
1	Khong	78,000,000	1,300	12%	82,000,000	1,367	11%	92,000,000	1,533	11%
2	Poung Vaen	34,000,000	567	10%	58,000,000	967	11%	69,000,000	1,150	10%
3	Viengthong	32,000,000	533	12%	81,000,000	1,350	10%	88,000,000	1,467	11%
4	Viengkham	29,000,000	483	9%	37,000,000	617	11%	51,000,000	850	11%
5	Phonxai	27,000,000	450	12%	37,000,000	617	13%	43,000,000	717	9%
6	Bua	25,000,000	417	10%	25,000,000	417	12%	29,000,000	483	11%
7	Khay	18,000,000	300	12%	17,000,000	283	12%	26,000,000	433	12%
8	Muanhpha	22,000,000	367	11%	21,000,000	350	11%	24,000,000	400	12%
9	Waan	18,000,000	300	12%	22,400,000	373	12%	22,400,000	373	11%
9	Total	283,000,000	4,717	11%	380,400,000	6,340	11%	444,400,000	7,407	11%

Kham District										
No	Village	2010			2014			2015		
		Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)	Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)	Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)
1	Nhodlieng	85,000,000	1,417	12%	100,000,000	1,667	12%	90,000,000	1,500	11%
2	Soummaen	80,000,000	1,333	11%	90,000,000	1,500	11%	78,000,000	1,300	11%
3	Phouhin	55,000,000	917	11%	75,000,000	1,250	12%	80,000,000	1,333	10%
4	Nong On	76,000,000	1,267	12%	76,000,000	1,267	12%	85,000,000	1,417	10%
5	Tha	55,000,000	917	12%	60,000,000	1,000	10%	61,000,000	1,017	13%
5	Total	351,000,000	5,850	12%	401,000,000	6,683	11%	394,000,000	6,567	11%

Nonghet District										
No	Village	2010			2014			2015		
		Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)	Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)	Tot. income (Kip)	Harvest (kg)	Village Consumption (pct)
1	Huaylom	5,000,000	83	10%	15,000,000	250	10%	20,000,000	333	10%
2	Buakser	15,000,000	250	12%	10,000,000	167	12%	12,000,000	200	12%
3	Kodu	8,000,000	133	10%	9,000,000	150	11%	8,000,000	133	10%
4	Thampong	5,000,000	83	11%	8,000,000	133	11%	8,000,000	133	11%
5	Kabo	2,000,000	33	10%	4,000,000	67	10%	5,000,000	83	10%
6	Tham thao	7,000,000	117	13%	7,000,000	117	13%	8,000,000	133	12%
7	Khokmou	4,000,000	67	10%	5,000,000	83	10%	5,000,000	83	10%
7	Total	46,000,000	767	11%	58,000,000	967	11%	66,000,000	1,100	11%

Annex 2. References

Ka K-H, et al, 2015. First Record of *Mattirolomyces terfezioides* and *Tricholoma bakamatsutake* in Korea, *Korean Journal of Medicinal Mycology*, June

MAF, Decree on Forest Management, 2010. No. 33/PM, 29 October

NAFRI, 2007, Non Timber Forest Products in Lao PDR. A Manual for 100 Commercial and Traditional Products, the National Agriculture and Forestry Research Institute, Vientiane, Lao PDR.

Pedersen, O.S., 2014. Wild Mushroom Pilot Survey, ABP Project

Sanmee. R. et al. 2007. First record of *Tricholoma fulvocastaneum* from Thailand, *Mycoscience* 48(2):131-133.

Xuefei Yang, Jun He, Chun Li, Jianzhong Ma, Yongping Yang, Jianchu Xu, 2006 Management of Matsutake in NW-Yunnan and Key Issues for its Sustainable Utilization. Sino-German Symposium.

Wan J. et al., 2012. Species of host trees associated with *Tricholoma matsutake* and close allies in Asia *Japanese Society of Mushroom Science and Biotechnology*, Vol. 19(4) 167-174.

Wan J. et al., 2012. Species of host trees associated with *Tricholoma matsutake* and close allies in Asia *Japanese Society of Mushroom Science and Biotechnology*, Vol. 19(4) 167-174.

Xieng Khouang Province, 2015. Biodiversity Strategy and Action Plan, ABP Project

Yamada A. et al., 2014, *Tricholoma matsutake* Y1 strain associated with *Pinus densiflora* shows a gradient of in vitro ectomycorrhizal specificity with Pinaceae and oak hosts *Mycoscience* 55(1):27-34.

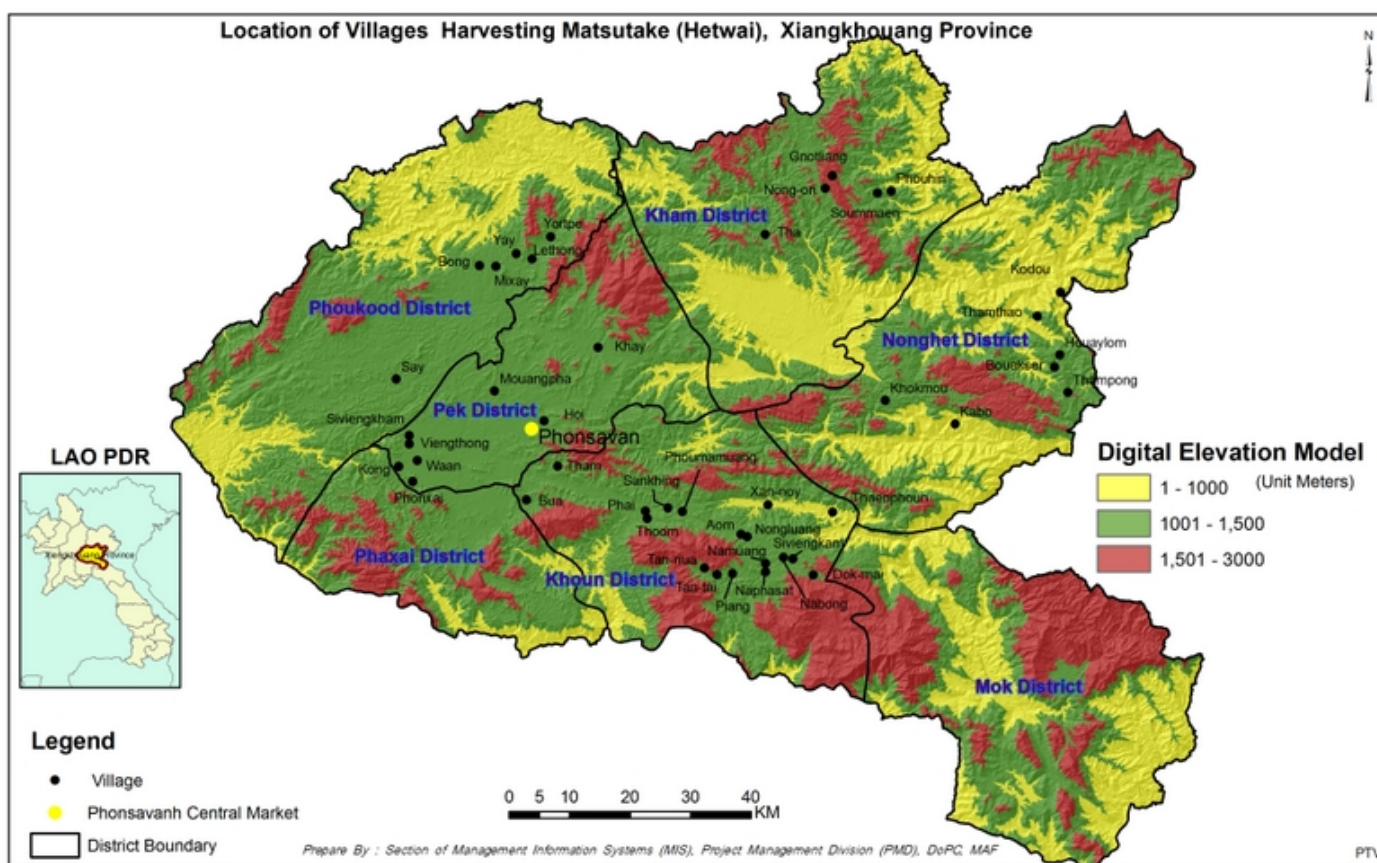
Yamada A. et al, 2010 In vitro ectomycorrhizal specificity between the Asian red pine *Pinus densiflora* and *Tricholoma matsutake* and allied species from worldwide Pinaceae and Fagaceae forests, *Mycorrhiza* 20:333-339

Yamanaka T. et al, 2012. Phylogenetic relationship and species delimitation of matsutake and allied species based on multilocus phylogeny and haplotype analyses. *Mycologia*, 104(6), 2012, pp. 1369–1380.

Annex 3. List of persons consulted

1. Mr. Khamsi Chantavongsy, Director, PAFO, Xieng Khouang Province
2. Mr. Khamsing and Mr. Sengvong. Head of forestry Conservation Section, PAFO
3. Ms. Khanthong Phavilakhamsy, Technical Officer, DAFO, Phoukout District
4. Mr. Phimpha Sinmalavong, Dep. Head of DAFO, Khoun District
5. Mr. Sengkeo Thepphavong, Head of Enterprises Unit, Commercial Section, Department of Industry and Commerce.
6. Mr. Bounnoy, Deputy, Department of Industry and Commerce, Phansavanh
7. Mr. Bounpun Sunlasern head of Bong Village, Phoukhout District
8. Ms. Manivanh Xayyalath, Siphonh Village, Khoun District
9. Mr. Khamsene and Ms Fanta Sengsavanh Gift Shop, Phonsavanh
10. Ms. Sormany S. Phapmixay, Saodoy Restaurant, Sy Village, Phonsavanh

Annex 3. Map of Het Wai collecting villages



Checklist for submission

	Check
Is the report less than 10MB? If so, please email to Darwin-Projects@ltsi.co.uk putting the project number in the Subject line.	yes
Is your report more than 10MB? If so, please discuss with Darwin-Projects@ltsi.co.uk about the best way to deliver the report, putting the project number in the Subject line.	no
Have you included means of verification? You need not submit every project document, but the main outputs and a selection of the others would strengthen the report.	yes
Do you have hard copies of material you want to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number.	no
Have you involved your partners in preparation of the report and named the main contributors	yes
Have you completed the Project Expenditure table fully?	yes
Do not include claim forms or other communications with this report.	