

THE NORWEGIAN MISSION SOCIETY

In partnership with

**The Amity Foundation, People's Republic of China &
The Malagasy Lutheran Church (MLC), Madagascar**

**FINAL EVALUATION OF THE INTERNATIONAL NMS BIOGAS PARTNERSHIP
PROGRAMME**

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Final Report, 24 March 2015

Acknowledgments

The production of this report has been made possible with contributions of various persons, to whom the review team wishes to express their thankfulness.

Particularly, the review would like to present their gratitude to Mr. Samoela George, the General Secretary of MLC, Mr. Arild Bakke, Head Representative of the Norwegian Missionary Society (NMS) in Madagascar, with whom we have shared fruitful discussions around our preliminary findings.

We are also grateful for Gloria / ZhongFei, Project Advisor of the Amity Foundation in China, Félicité Ramiharimanana, Coordinator of Biogas project of the Malagasy Lutheran Church (MLC), Tom Kamau Rode-Christoffersen, Development Advisor of NMS in China, and Stine Pedersen, Development Advisor for NMS Madagascar, for organizing the field trips for the evaluation.

Furthermore, we would like to thank Mr. Lu Erya and all the representatives from the Overseas Friendship Association for guiding us through beautiful Yongshun County. In Madagascar we thank Ranaivomanantsoa William Joseph, Director of FAFAFI in Antsirabe and Alfred Rasamimanana, Director of FAFAFI in Fianarantsoa, and all the FAFAFI staff who took us around in the lush countryside of Antsirabe and Fianarantsoa. Many thanks also to all the friendly people in Bagu, Sicheng, Shuangfeng, Alakamisy, Maroharona and Talatan'Ampano for their kind hospitality and for sharing their stories, opinions and food with us.

We also thank Prof. Jens Bernt Aune for contributing to this report.

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The views expressed in this report are exclusively those of the review team and do not necessarily represent the partner organizations in the International NMS Biogas Partnership Programme, or the positions of individuals that were expressed during the evaluation

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List of abbreviations

FAFITO	Department of Agriculture, Animal husbandry and Environment, MLC
ER	Expected result
FAFAFI	Agricultural extension organization, MLC
IBP	The International NMS Biogas Partnership Programme
MGA	Malagasy Ariary (0.00035 USD, 14 February 2015)
MLC	Malagasy Lutheran Church
NMS	Norwegian Mission Society
OFA	Overseas Friendship Association
PD	Project Document (2012)
RMB	Renminbi / Chinese Yuan (0.16 USD, 14 February 2015)
SO	Specific objective
ToR	Terms of Reference
VMC	Village maintenance centre
WDA	Women's development association

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Figure 1: Some households were not recipients of a biogas digester, but participated in trainings.

Table 1: Women that attended training in Tujia brocade weaving, and number of women that actively weave.

Table 2: Impact on women's lives from Tujia weaving training.

Executive Summary

The International NMS Biogas Partnership Programme (IBP) has transferred skills and technology from China to Madagascar for constructing a standardized 10 m³ fixed-dome biogas digester. The Chinese design has been used to build 212 digesters in three of MLC's synods by Malagasy technicians. In China the programme built 510 digesters in Yongshun County, Hunan Province. Ten of these digesters were constructed with financial support from Central Studio, a private Chinese company. The IBP has also supported construction of one 30 m³ digester at a school in China, and three 30 m³ digesters at schools in Madagascar. Women from the households that have received biogas digesters through the IBP have also received training in environmental awareness, household economy and potential income generating activities.

Through the programme, five Malagasy technicians have received training in China, and a Chinese technician has come on short visits in Madagascar to monitor the construction of digesters. Learning visits between the countries and organisations involved in the IBP have taken place. From China, Amity, NMS China, XinDe Foundation of the Hunan Three Self Church and OFA have visited Madagascar to see MLC's activities. From Madagascar, five technicians, 13 MLC project leaders and the NMS advisor to the IBP in Madagascar have travelled to China to learn about the biogas technology.

Outcomes of the IBP include:

- Technological skills have been transferred from Chinese to MLC's technicians, as observed in the high quality of digesters in Madagascar.
- In China, the appropriateness of the biogas technology in rural livelihoods is evident from 95% of the digesters built by the IBP being in use.
- Biogas has freed time in the household, particularly noticeable in Madagascar. Training in household economy has enabled people to valorize the time saved.
- Biogas and trainings appears to have had impact on perception of gender roles within the household, particularly in Madagascar. In China improved sanitary conditions, training in health, establishment of women's development associations, and income generating activities have improved women's daily lives.
- From the trainings, women have gained ideas on how to improve household income. Some have initiated small entrepreneurial projects following trainings through the IBP in both China and Madagascar.
- Biogas has had an important impact on hygiene in China with improved toilet facilities. Cleanliness and indoor air quality in the kitchen has improved in both countries.
- Biogas has a positive impact on the local environment in both countries. Over time this will be evident in Madagascar where firewood is very scarce and few alternative energy sources are available.

Recommendations from the evaluation are summarized below, arranged as recommendations to IBP's 1) exchange component, 2) activities in China, and 3) activities in Madagascar:

Recommendations from the exchange

- Transfer of skills in biogas has been accomplished according to goals in IBP. Further collaboration and exchange could still be relevant between Amity and MLC, but for institutional capacity building and sharing ideas in diaconal work.
- Future exchange programs would benefit from having more inclusion of organizations responsible for "activities on the ground" in the project development process, and clarify responsibilities and project organization in the PD.
- Transfer of skills in biogas technology from China to other countries than Madagascar where NMS operates can have positive impact on rural livelihoods in these countries. Implementation could be simplified and costs reduced by limiting such a project to transfer of skills between technicians.
- For long-term functionality of biogas, the Chinese design and mode of dissemination with strong post-construction support, is a promising way forward.

Recommendations from activities in China

- For future projects, enhance the project planning at the beginning of project, especially the connection between activities and output and objective. Let the local partner participate in the whole procedure of planning to improve the common understanding on project goals between Norwegian donor organization, Amity and local partners.
- Future donor-funded, biogas-based projects in China would benefit from continued close collaboration and involvement of OFA and local government. Involvement of government bodies ensures long-term support after the project has ended; the NGO provides access to funding which enables an otherwise costly construction of digesters.
- To ensure that the WDAs established through IBP go on to contribute positively in women's lives, the organizations would benefit from more training in management, including financial management, marketing, and leadership.

Recommendations from activities in Madagascar

For the short term:

- Supply of accessories for biogas digesters already constructed.
- Continue to provide technical support, even without continued project funding.
- Training of 'village technicians' by FAFAFI that could provide local support for biogas users.
- Construct digesters for those willing to pay the full cost of the digester.
- Support establishment of biogas user associations.

For the longer term:

- Look for partners or funding agencies willing to build on the capacity that has already been established in MLC on biogas.

1 The International NMS Biogas Partnership Programme

The International NMS Biogas Partnership Programme (IBP) started in 2011 with the aim to transfer biogas technology from China to Madagascar. The responsible partner in China has been Amity Foundation (Amity). The Malagasy Lutheran Church (MLC) has been the responsible partner in Madagascar. The Norwegian Mission Society (NMS) has had coordination- and advisory roles in the programme.

Before the IBP, MLC already had experience with biogas through a project running from 2005 to 2007. The previous project used inexpensive plastic, tubular design digesters. These were fragile and did not last more than three years, but the users had by then experienced the benefits of cooking with gas. In China, Amity has been working with biogas among small-holder farmers for many years. Their projects have been successful on many levels. Unlike traditional fixed-dome digesters which are made from clay bricks, the new design promoted by the Chinese government is based on solid concrete constructed around a mould. It may last as long as 20 to 50 years, depending on how good the maintenance of the digester is.

The exchange program was initiated by NMS in China and Madagascar. An objective with the programme has been to empower women through biogas and income generation. Beneficiaries that have received biogas digesters have received training in how to use the technology, its environmental benefits, and capacity-building on how saved time and money can be translated into income generation for women.

In the IBP's project document (PD), the programme has been termed a "pilot" due to the novelty of having exchange for learning between countries in the global South. IBP has included training of Malagasy technicians in China, monitoring of activities in Madagascar by a Chinese technician, and learning visits by the partner organisations to the two countries.

IBP ran for four years, from 2011 to 2014. This report is the final evaluation of the programme. Fieldwork for the evaluation was conducted in China in December 2014 and Madagascar in February 2015. The report is structured as follows: IBP's objectives (section 2), terms of reference for the evaluation (section 3), findings in China (section 4), the exchange component of IBP (section 5), and findings in Madagascar (section 6). Conclusions and recommendations are summarized in sections 7 and 8.

2 Objectives of the IBP

The general development goal of IBP has been to reduce carbon emissions, to improve women's status in society and to alleviate poverty in China and Madagascar. Programme goals summarized below have been adapted from section 7 of the PD.

Programme goals

The IBP would transfer biogas technology from China to Madagascar. Technicians were to be trained as biogas technicians, and women benefiting from the biogas technology would also be trained in income-generating activities. Biogas digesters were to be constructed both in China and Madagascar.

Specific programme goals were to:

- a. Provide clean, renewable energy for rural residents in project areas.
- b. Save labor and time to promote development opportunities in rural areas.
- c. Promote women rights in the terms of health, leisure time and physical ease.
- d. Improve the living environment and promote the awareness of hygiene and health.
- e. Reduce firewood consumption and deforestation.
- f. Improve the maintenance system of the household digester biogas systems.

The international exchange component of the IBP would result in:

- A transfer of knowledge between the countries and organizations/churches involved, in particular with respect to biogas technology and management, but also on other aspects.
- An increased understanding for cultural differences and the potentials for south-south interactions.
- Good ideas for how the involved organizations could run better and how they could live better lives inspired by the organizations and people involved.

For the biogas programme expected outputs were:

- Effective methods of energy use: The IBP would promote effective methods of energy use among rural residents.
- Forest protection: Reduced rate of deforestation as an effect of reduced consumption of woodfuels.
- Improved health: Public health would be improved through provision of smokeless kitchens and good hygiene.
- Decreased workload for women: Women from targeted villages would benefit in terms of health, time leisure and physical ease.
- Technical and agricultural development: Farmers from targeted villages were to be trained in animal raising skills and maintenance of biogas systems.
 - Human feces and animal manure would be turned into hygienic resources as organic fertilizer.
 - The quality of life would be improved with more pigs/cows for money or meat.
 - More time to explore opportunities of development for the female villagers.
 - Improved maintenance service for biogas system ensuring better and more extensive use of biogas installations.

The number of technicians trained and biogas digesters that were to be installed:

In China:

- 200 technicians trained (these would assist and repair biogas installations from the programme and ones that were built privately or by other organizations / the local government)
- 500 biogas installations.
- 1 large model school biogas digester.

In Madagascar:

- 60 technicians trained.
- 492 biogas digesters built in households.
- 8 institutional digesters (~35 m³) constructed.

3 The evaluation

3.1 Terms of Reference

This report is an evaluation of impacts and effectiveness of the biogas technology and trainings implemented through the IBP in China and Madagascar. It also discusses impacts from the exchange in the involved institutions. In being a pilot project, the evaluation process is in itself viewed as a learning tool for the programme partners (NMS, Amity and MLC), the project staff and the stakeholders.

According to the Terms of Reference the evaluation report should:

- Identify the results of the programme and compare them to the indicators set out in the PD.
- Evaluate the impacts of training programs for the beneficiaries undertaken by the project.
- Assess the impacts of the biogas digesters on the environment, the household economy and the health of the target group.
- Draw lessons from all and make recommendations for future use.
- Identify Amity, MLC, and NMS's impact on the result, successes and limitations of the project.

The team should focus on the three projects in the program:

1. Identify the results of the biogas project in Hunan province, China.
2. The cooperation China Madagascar: What are the impacts in China and in Madagascar?
3. Madagascar: Is the technique used in this project appropriate for Madagascar?

Amity project in Hunan province, China

- Identify the results of the programme, and compare them to the indicators set out in the PD.
- Evaluate the impacts of training programs for the beneficiaries undertaken by the programme.

- Evaluate the impacts of the biogas digesters and the training:
 - On the environment
 - On the household economy
 - On women's economic situation
- In what way has the programme had an influence on gender/women's rights and livelihoods?
- Scale: What is the scale of this programme?
- Get an overview of the stakeholders:
 - In what way is the government involved? In what way are the Amity projects part of the governmental strategy?
 - Is the Three-self-church involved? In what way?
- Why should the government/villagers cooperate with Amity?

Cooperation Amity/China with MLC/Madagascar

- Lesson learnt from the exchange in China: What have the Chinese participants learnt from the Malagasy?
- Lesson learnt from the exchange in Madagascar: What have the Malagasy learnt from the Chinese?
- Assess the role of NMS. Have NMS had an added value on the programme?
- Conclusion: Was this a smart idea?

MLC project in Madagascar

- Implementation: What are the benefits and limitations of the implementation of biogas digesters? What are the benefits of a digester, according to beneficiaries and non-beneficiaries? Which lessons can be drawn from this for a future biogas project?
- Women business training (how is extra free time used?): What are the benefits and limitations of the women business training carried out in connection with the building of biogas digesters?
- Change in attitudes: Have there been a change in attitudes towards biogas and the environment (1) of the owners and (2) of the surrounding/neighbors?
- Sustainability: what may be done in order to establish sustainable and affordable access to renewable energy in the villages in Madagascar?

3.2 Methodology

The evaluation team has applied a learning, participative and gender-sensitive approach as per the ToR. The evaluation has included document studies of applications and reports, program policies and relevant document from NMS, MLC and Amity. The evaluation also has included interviews with beneficiaries, villagers who are not beneficiaries, project staff in MLC, government officials in Yongshun County, Amity, MLC administration, and NMS project staff in China and Madagascar. Schedules for the evaluation in China and in Madagascar are attached as appendices.

In China, farmers with biogas digesters were visited and interviewed in Yongshun County, in the villages Bagu, Sicheng, Shuangfeng and Hongxing. Women who had received training and had received support for establishing Women's Development Associations (WDA) were interviewed in the same villages, and in Yongshun town.

In Madagascar focus group interviews were held with mixed-gender groups of biogas users, women who received training, and a mixed-gender group of non-beneficiaries. Focus group interviews were held in Alakamisy village in Antsirabe, and in Maroharona and Talatan'Ampano villages in Fianarantsoa. Observations of activities, assets and through unstructured interviews were recorded while visiting beneficiaries' homes.

A formal meeting was held with government officials of Yongshun County, China. Representatives from the Forestry Bureau, Energy Bureau, Health Bureau, Animal husbandry Bureau, Statistics Bureau and the Overseas Friendship Association (OFA) presented their activities in relation to the IBP. In Madagascar a formal meeting was held with a representative of the Chef de Region of Haute Matsiatra in Fianarantsoa.

4 Amity's project in China

The IBP was implemented in rural villages in Yongshun County, Hunan Province. The responsible partner was the Amity Foundation. NMS China has had a coordinating role, and was responsible for communicating project developments and instructions between Amity, and NMS in Madagascar and Norway.

In Hunan Province, the coordinating organ for all Amity projects is the XinDe Foundation, a foundation run and organized by the Three Self Church. In Yongshun County, OFA has coordinated IBP on behalf of Amity and XinDe. OFA's activities have included overseeing construction of biogas digesters, accommodating Malagasy technicians trained in China, and organizing trainings of biogas beneficiaries.

Transfer of project funds for IBP's activities in China can be summarized as follows: NMS to Amity in Nanjing; Amity to XinDe Foundation in Changsha, Hunan; XinDe to the OFA IBP project office in Yongshun. Yongshun County government has co-funded IBP's activities in China.

Outcomes of the project in China:

510 household biogas digesters of 10 m³ were constructed, with attachment to toilets. Toilet facilities were improved. 10 of these digesters were constructed with support from Central Studio, a private Chinese company. Women that participated in health and hygiene-training totalled 1 000. Women that received training in how to weave Tujia brocade were 190. A total of 956 women participated in trainings on a variety of crops, including camellia, kiwi, as well as animal husbandry. Two village technicians were trained and working in Bagu village, and 200 local biogas technicians received training.

4.1 Results: Indicators in PD

4.1.1 SO 1: To improve the protection of the environment

Number of biogas digesters financed through the IBP was calculated to be 500 by the time of the evaluation. Villages visited in the evaluation were Bagu village with 250 digesters built and Hongxing with 100 biogas digesters. Households in Bagu had also received new toilet facilities as part of the installation of the biogas digester.



The scenic Bagu village.

According to village technicians in Bagu and Hongxing villages, and a technician from Yongshun County government's Energy Bureau, only about 5% of the digesters were not in use. This was not due to malfunctioning technology but because beneficiaries had migrated to urban areas permanently or temporarily for work. In Hongxing there are a total of 270 digesters and according to the village technician all were functioning.

From each household that had received a biogas digester, one or two members had received training in maintenance of the digester. To sensitize beneficiaries about the protection of the environment, trainings of biogas users had included awareness-raising about protection of the environment. Respondents that had received the training were aware of the importance of forest conservation, its benefits, and various measures to achieve it.

The government of China trains biogas technicians in technical colleges. Trained technicians receive a certificate which is required for overseeing the construction of biogas digesters. Certified technicians played a pivotal role in the IBP. Many villages have local technicians, 'village technicians', who are permitted to do maintenance on digesters despite not having the official certification. Village technicians trained through the IBP include 2 technicians in Bagu Village.

In Bagu village, the Energy Bureau's technician and one of the village technicians reported that they had tended to malfunctioning digesters 7 or 8 times last year. The village technician in Hongxing village reported that they had followed up 20-30 malfunctioning biogas digesters respectively the last year. Problems included cut gas pipes by pigs, assistance with drainage/emptying of the digester, and drying of water in gas-seal with resulting loss of pressure in the digesters' head space.

Follow-up of digesters has been made easier by the establishment of village maintenance centres (VMC) supplied with enough spare parts to mend several dozens of digesters. Spare parts are provided to users at a fee, but service from the village technician is given for free to households in the village.



ER 1: Reduced need for use of polluting sources of energy (mainly charcoal and firewood)

Renovated kitchen with biogas stove and improved firewood stove.

It was difficult to establish how many kg of charcoal and other polluting energy sources of energy (e.g. litres of paraffin) was reduced per year as a result of biogas technology provided through the IBP. It appeared that there had been some reduction in firewood used for cooking, but firewood was still the preferred source of energy for heating in rural areas. In semi-urban areas charcoal was used for heating, but not much for cooking. Substituting some of the firewood with biogas when cooking *must* have an impact on energy consumption, but it appeared that access to firewood was not a problem to most people. Firewood was mostly collected, and not bought. Several of the individuals the evaluators spoke to did collect firewood once or twice per season, rather than on a daily basis, and firewood collection was therefore not a daily chore for everyone.

An objective with the project was that 80% of biogas digesters would still be functioning at the end of the project. In China all the constructed biogas digesters were in a usable state according to village technicians and the Energy Bureau technician. In Bagu village about 5% were not in operation since people were not living in the house at the time.

There was also seasonal variation in gas generation in the digesters. Cold weather during winter made the gas production drop. Gas production would also vary with number of pigs kept. Some of the pig stys seen during the field visits were temporarily not in use, since the pigs had been slaughtered. The evaluation field trip was done in winter time, when farm activities and function of the digesters would be different than during the warmer seasons.

ER 2: Reduced deforestation

It was difficult to establish the quantity of firewood consumption (m^3) that had been reduced as an outcome of the IBP, and similarly how many m^2 of forest that had been protected compared to the rate of deforestation prior to the project. This is because no records were kept by the households on the amount of firewood that was substituted by biogas. Such recording would have been time consuming to the users, but a valid way of measuring mitigation of deforestation

by biogas technology. Detailed monitoring and record-keeping might be necessary if carbon credits were to be sold from the IBP.

However, regrowth of forest in the areas of the project intervention appears to be happening. This is likely to be because of a massive government policy to prevent deforestation. Biogas is one part this strategy, and the IBP has contributed to reforestation in Yongshun County.

ER 3: Reduced carbon emission

An objective with the IBP was to reduce carbon emissions. Although it appears that some firewood and charcoal was substituted by biogas, and that some bioslurry was used as a substitute for synthetic fertilizers, it is difficult to establish amounts of reduced carbon emissions. This can only be established with rigorous registry of substitution, and a baseline study which has recorded stocks and consumption at the time before programme implementation.

4.1.2 SO II: To reduce poverty

Households constructing a biogas digester received training on the use of bioslurry. Number of participants/users trained on using the compost from the biogas digesters was 1-2 members per household. An assumption with the IBP was that substitution of chemical fertilizer with bioslurry would reduce farm expenditures.

ER 1: The cost of energy and chemical fertilizers per family is reduced

A woman interviewed in Hongxing village reported that she used the slurry as fertilizer in the vegetable garden near her house, and spread small amounts quite often. This has resulted in reduced need for chemical fertilizer, and she reports to save 100-200 RMB per year. There was general awareness of the benefit of using slurry as fertilizer, but it was difficult to calculate the exact economic benefits. She reported that in her household they had not increased the number of livestock after obtaining the biogas digester. Households interviewed in Bagu village said the same. Households generally kept 1 or 2 pigs, mostly for their own consumption, and some kept a cow for ploughing. On being asked if she felt that she reduced expenditures for charcoal and firewood with biogas she reported that the main benefit was that cooking was faster, cleaner and more convenient. Economic and time-savings from substituting firewood with biogas were not evident to her, but other households reported savings from 0 to 3 000 RMB per year.

ER 2: The organic manure is available for agricultural production

Some villagers visited mentioned that they used the sludge for base fertilizer before they ploughed the paddy field, some use the slurry and sludge for fruit trees and vegetable in garden nearby the house. Amount of compost from biogas digesters used in agriculture and m² of farm land using compost from the biogas digesters was difficult to establish since this was done sporadically, and combined with chemical fertilizers. Based on limited data, it was difficult to determine exactly to what degree the application of bioslurry increased crop yields.

A positive contribution of the digester is that it acts as storage and maturing of manure. By collecting human faecal matter it also functions as a septic, thereby keeping the compound clean.



Vegetable garden in Sicheng village.

ER 3: The family income is increased

Households could not verify if an increase of family income after receiving the biogas technology was due to biogas. Use of biogas for cooking generally substituted only a portion of the firewood previously used, and this firewood had been collected free of monetary cost. All forests are public/government owned in the People's Republic of China. Use of forest resources is strictly regulated to counter deforestation.

The money saved by substituting some of the synthetic fertilizer with bioslurry did not appear significant in Yongshun, based on the few individuals asked about this. The evaluation took place during off-season for crop farming. This may have influenced findings, since fertilizers are not used.

Although it was difficult to point to investments made through monetary savings from transition of biogas, the technology had improved standard of living. Households in Bagu village had received new toilet facilities with the digester, and hygiene had improved. In fact, the biogas digester was in itself an investment in people's homes, since part of the cost had to be covered by the beneficiaries themselves. The subsidy of biogas digester and toilet facilities from the IBP has increased households' physical assets.

4.1.3 SO III: Promote women rights in the terms of health, leisure time and physical ease

An important part of the IBP was to empower women socially and economically. The biogas technology was expected to free time and energy for other activities. Training for women included the art of weaving traditional Tujia brocade. Establishment of WDAs that would

generate income for members from kiwi-fruit trees was another activity that was expected to generate income for women.

The number of women trained in Tujia brocade weaving were 190 (Table 1). These were from Bagu, Shuangfeng, Sicheng, and Yongshun city. More than 50% passed the exam. Income from brocade varied from 800 to 2 000 RMB per month.

Table 1: Women that attended training in Tujia brocade weaving, and number of women that actively weave.

Village	Attended the course	Actively weaving
Bagu	40	15
Sicheng	30	21
Yongshun city (2 sessions)	80	53
Shuangfeng	40	30
Total	190	119

In Bagu and Shuangfeng, WDAs had been established with support from the IBP. From each village 2 women had been sent on a learning visit to an already established women’s association in another Amity project area in Cangyuan County, Yunnan Province. From Shuangfeng two leaders of the women’s association went for training in Management and Organizational skills. These women later initiated the women’s development associations with support from the IBP.

ER 1: The collection time of firewood and cooking time are reduced

An important assumption in the IBP was that the biogas technology would reduce number of hours per week spent on firewood collection and cooking. It was difficult to establish how much time was freed by not having to collect as much firewood, but biogas did save time while preparing food. People reported that as much as 2 hours per day can be saved by cooking with biogas rather than firewood and charcoal.

All the households that had received biogas digesters had also continued to use firewood, but in combination with biogas. Firewood was important for indoor heating and curing meat in winter, since biogas could not be used for these purposes. Firewood therefore still had to be collected. It appeared that firewood commonly was collected while pruning fruit trees. Firewood could be collected in communal forests by manual labour, but some households also used tractors to collect larger quantities of firewood twice a year.

It was hard to establish exactly how much firewood was saved when cooking, although it appears to be quite significant. In Hongxing village a woman interviewed reported that 500 kg of firewood could be saved each year by switching to biogas for cooking.

ER 2: The smoke in the kitchen is reduced; hygiene and the health of women are improved

It was difficult to establish if there had been a reduction in the frequency of the diseases such as respiratory ailments in the target area before and after the project. Local health officials did not

have this information. Pulmonary disease is a consequence of long-term exposure air pollutants, and its remedy may require similarly long time before having an effect. Thus, in order to assess this in a meaningful way, one would need to evaluate this at a much later stage.

Firewood observed in the visited households had been stored for a long time and was therefore dry and burned with less smoke compared to using fresh branches. When burned for heating, it was kept in a tray located in the centre of the room without chimney, but with openings under the roof. The little smoke generated escaped easily. Smoke was used for curing pork meat; pigs that had previously provided feedstock for the biogas digesters.

All the households visited had electricity installed, and water- and rice boilers were common. Multiple fuel use was common. In combination, different fuels contribute to reduce indoor air pollution. Biogas contributes positively although it is difficult to establish exactly to what extent.

ER 3: The time available for women for other/new activities has increased



Women weaving Tujia brocade in Sicheng village.

The number of women engaged in and gaining some income from Tujia brocade weaving were 119 by December 2014. These were women in Sicheng, Yongshun city and Shuangfeng, where biogas digesters had not been installed through the IBP. The brocade weaving in Bagu village seems not to have been so effective due to the location far from Yongshun town and poor infrastructure.

In Bagu 80 women had been clearing bush in camellia plantations to generate some income for the WDA, and villagers commented that ‘the upgrading of camellia may improve the yield’. In addition, the WDA had been allotted a plot that had been planted with kiwi. It would still take 3 years for earnings could be made from kiwi sales.

In Shuangfeng 60 women were engaged in tourism enterprises organised through the WDA. The ethnic culture performance can create about 100 RMB for each participant per month (in Shuangfeng village only).

In Bagu village, the WDA had tended plantations of 800 mu camellia trees by clearing undergrowth and pruning of the trees. There were claims that this had increased income by 60-100 RMB per mu, but full impact of maintenance of the camellia plantations is expected in 2016/2017. Assessment of economic returns from this initiative was therefore too early at the time of the evaluation.

4.1.4 SO IV: Enhance the knowledge and the ability of technicians and farmers in the field of biogas

A part of the programme was to educate technicians on the installation and maintenance of the biogas digesters. The Chinese design involves making a mould around which the digester is built with concrete. In China technicians are required to hold a license from a technical college which certifies them to design and oversee construction of biogas digesters. Such training was not part of the IBP. The technician's role in the Energy Bureau in Yongshun is to oversee construction of biogas digesters for the government. The same technician has been responsible for construction and trainings in the IBP.

Households that acquired biogas digesters with support from the IBP received training in how to manage their digesters. A few of the farmers became village technicians with responsibility for supporting the local community of biogas users with technical assistance. The village technicians are responsible for VMCs with equipment for making basic repairs on the digesters, the VMCs are supplied by the Energy Bureau, which ensures the long-term viability of biogas digesters.

ER 1: The farmers are trained and motivated to use and maintain biogas digesters

From each household that had acquired biogas digesters one or two members had received training in management of the digester, use of the slurry, hygiene, and protection of the local environment. Households visited during the evaluation seemed satisfied with the ease of cooking with gas, and the cleanliness of their stables and toilet facilities.

ER 2: The technicians have received techniques for additional knowledge

An objective with the programme was to provide technicians with income from their service to biogas users. Village technicians interviewed in Bagu and Hongxing villages said that they provided their service free of charge, and that people would aid each other in the small and transparent communities in these villages. Village technicians have received the same training as users of biogas. The number of village technicians that had received training funded through the IBP numbered 2 in Bagu and 1 in Hongxing. In 2013, 200 technicians were also trained in practical maintenance of biogas digester.

ER 3: The leaders and managers of the two organizations have learned new strategies, idea or techniques from the other organization

An expected outcome of the IBP was that it would lead to a) new projects, or b) change to operations in each organisation (Amity & MLC). According to the project partners, one new project is in the pipeline. More information can be found in the section in this report which discusses the exchange component of IBP.

ER 5: A relationship is established and blooming between the organisations to continue the training

The IBP has involved several exchanges between the partner organizations in China and Madagascar; at least one per year between 2012 and 2014. Representatives from NMS China,

Amity, XinDe/Hunan Three Self Church and OFA in Yongshun have been to Madagascar. Representatives from NMS Madagascar and MLC have been to China. Yongshun County Energy Bureau's technician has travelled from China to Madagascar to train Malagasy technicians and to monitor project activities. Five Malagasy technicians stayed seven weeks in Yongshun and constructed and learned how to build biogas digesters.

4.2 Impacts of training programs

Training has played an important role in the IBP from the very beginning of development of the project, as can be seen in the PD. The emphasis on exchange across cultures and countries in a natural manner made way for learning and sharing.

Visits to people's homes during fieldwork in China showed that training on management of biogas digesters had been rewarding. Most of the digesters were in use (~95%) and few users had experienced technical problems. Village technicians had received sufficient training to assist farmers if they had problems, without having to call advanced technicians from the Energy Bureau in Yongshun County. These findings exemplify why a partnership between a dedicated NGO and local authorities can be beneficial. Involvement of government bodies ensures long-term support after the project has ended, and the NGO provides access to funding which enables an otherwise costly construction of digesters.

Awareness-raising on environmental protection had been included in the biogas training; a training that fit well with the strong current government policy in China that addresses deforestation. People that were interviewed in Bagu and Hongxing villages during the evaluation were aware of the relevance of biogas to forest protection.

The added value of agricultural training and training on animal husbandry supported by IBP was harder to elucidate. Households in the areas visited were already adept at maximizing and balancing food security and diverse income generating activities within the given context. However, biogas technology touches on a multitude of aspects in rural livelihoods, and introduction of the technology should be accompanied by training on how it can fit in existing integrated farming systems, as it has been done in the IBP.

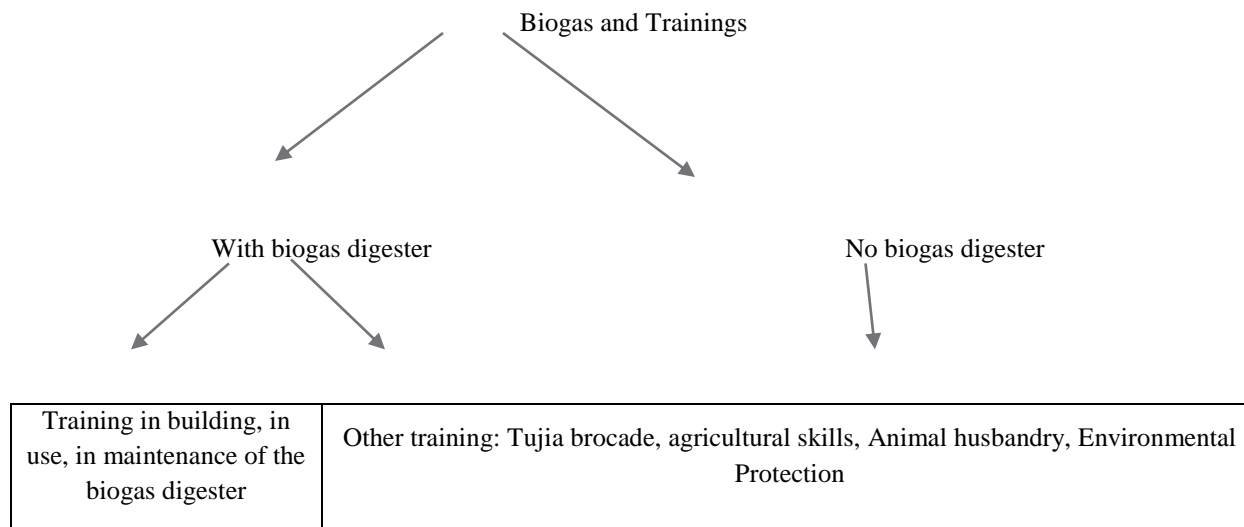


Figure 1: Some households were not recipients of a biogas digester, but participated in trainings.

Women who had received trainings in the potential income-generating activity of weaving Tujia brocade in Yongshun town and Sicheng and Shuangfeng villages were not biogas users (Figure 1). This does not coincide with objectives as specified in the PD.

A woman interviewed in Yongshun could make 800-2 000 RMB per month, depending on her capacity, by taking contracts from a commercial enterprise. Tujia brocade sells only in the tourist market, and therefore has a value chain which is contingent on market trends and seasons. Those who had Tujia weaving as a source of income combined it with other income sources, such as remittances from spouses in migrant work.

119 out of 200 women that received trainings on weaving Tujia brocade were generating some income from it. Table 2 below shows how the IBP impacts on women who have received the Tujia training.

Table 2: Impact on women’s lives from Tujia weaving training (+/- indicate pros and cons).

With impact on women’s economic situation	Without impact on women’s economic situation
+ trained	+ trained but didn’t succeed to the examination
+ good quality of work requested by the market	- quality of individual work of the trainee is not at the level required for selling
+ continuous work with a company	- women’s involvement in field work and familial duties
- risk for the trainees of suspension of the work due to the dependency to one main client with one “specific product”	- low expectation to succeed at the next examination of the company despite a continuation of the training by the women themselves: because of the light follow up of the trainer (no real expectation of short term impact)
+ contract with company is not exclusive (women could work their individual way)	- no other training apart from brocade that could constitute a possible reconversion
- but the lack of insertion of the trainees to a larger economic network remains a limitation for their use of their knowledge and their capacity to react	- an evaluation of the women’s assets should be more appropriate
+ each one is a sure labor force requested for the brocade company = assurance to have continual work and added income	
- limitation of the economic potential of each one: due to the narrowness of the market of brocade products	
+ added income up to 1 000 RMB to 2 000 RMB per month	

All the visited villages had beautiful scenery. Sicheng and Shuangfeng villages were aiming at generating income from tourism. As such, Tujia brocade could be an investment in future income generation also after the IBP has ended. The training in Tujia embroidery also could have an effect as a cultural heritage project, since Tujia is a minority group in China.

4.3 Impacts of the biogas digesters and the training

4.3.1 On the environment

Assessment of impact from the biogas technology on the local environment has not been possible in this evaluation. Relevant information has not been collected and reported in IBP’s baseline and during the project’s duration.

It is clear that transition to biogas will have some impact on firewood and charcoal consumption. However, effect of biogas on the environment may have been less than anticipated in the PD since people visited during the evaluation relied on multiple fuels rather than only biogas. Firewood and charcoal was used for heating and cooking; biogas and even electricity for preparing food, but not heating.

In China governmental support for biogas is part of a set of policies to reduce deforestation, and has had a visible impact on the environment. According to an officer of Yongshun County’s Forestry Bureau the forest cover had increased by 1.9% over the last 10 years. Availability of

firewood was not a challenge for rural households in the locations visited. If access to firewood was a challenge, this would most likely be due to the situation of the household (e.g. elderly, single mothers).

4.3.2 On the household economy

The households interviewed expressed different economic savings from substitution of other fuels with biogas: From no obvious saving to 3 000 RMB per year, depending on the economic situation of the family. Families having better economic situation showed more savings since the biogas could reduce their purchase of firewood and charcoal. In poor families, the biggest benefit of the biogas is time saved while cooking. There was little evidence to show that the biogas had improved the family economy by increasing income. Firewood was collected free of cost on own property or in communal forests. Since only a small part of the total heat energy use in each household is substitutable with biogas, little time is saved for collecting fuelwood.

Savings from substituting part of the chemical fertilizers with bioslurry amounts to a small part of the household budget.

A few of the women who had received training in weaving Tujia brocade generated income from it. The teaching was given over a period of 30 to 40 days and the loom was provided to them through the project for their practice. If they did not succeed at the examination by the company, the loom remains with them for their personal practice.

The biogas technology also had a positive impact on household economy since it was an investment subsidized by the IBP and the Chinese government. The household would only pay about 1/3 of the cost for having a digester installed, but would contribute with labour. In Bagu village the IBP had sponsored the beneficiaries with a new toilet “free of charge”. Physical assets including biogas digester and gas stove increases value of the household’s property.

4.3.3 On women’s economic situation

Gender did not seem to matter in management of the biogas digester, and possible savings thereof. The biogas digester was an integral part of the household economy, and not an item more beneficial to either gender in the household. Both women and men are involved in farming activities. Increased earnings through improved yields, as a result of agricultural trainings that were part of IBP, would most likely benefit both husband and wife in a family.

4.4 Influence on gender/women’s rights and livelihoods

The general objective of the IBP includes contributing positively to global climate, local environment, poverty, and empowerment of women. The solution – biogas – is technical. The IBP has emphasized women’s rights in the trainings, although this is a politically sensitive topic in China and thus cannot be addressed in the same direct way as it is in e.g. Madagascar.

Support in establishing WDAs in two villages appears to have given a platform from which women can share their concerns and work together for a common cause. In Shuangfeng the women through their WDA claimed that they have a stronger say in community matters than

before. The WDA has served to organize women in activities such as clearing land for camellia and kiwi, and in tourism-based income generating activity. Impacts on gender-related matters may require longer time to mature and become visible.

Gender-roles seemed to be of less concern to respondents than for example migrant work which separates family members. Although biogas technology makes life easier for a single parent, it is not likely to make a radical difference compared to having a spouse working far away 10 months of the year. Biogas implies having an integrated farming system that includes animal husbandry and farming. This is a full time occupation for one person, particularly for a single parent. Saving some time every day through more efficient cooking and ease of management of the pig sty will make a positive contribution in women's lives.

4.5 Scale

The project intends to span a scale from global to local. It is global in the sense that it uses biogas technology to create a connection between Madagascar and China; local because each biogas digester or brocade-trained woman can be to the benefit of a handful people in a family.

The biogas-component of IBP can be regarded as an extension of the Chinese government's strategy to provide biogas to the millions. Biogas digesters similar to those constructed in Bagu and Hongxing villages are being built all over the country. As such the project is already scaled up, and IBP has contributed in the process. People are willing to pay their share of the cost of a digester. The integrated farming system in this part of China fits very well with the biogas technology and many more farmers can be reached. The strong involvement of the government of China ensures long-term support for having village maintenance centres, village technicians and engineers from the Energy Bureau that can support villagers when they need help with their digesters. This aspect is vital for transfer of technology to other countries.

Focus on hygiene in the project led to inclusion of upgraded toilets as part of the biogas construction. It is not likely that the government of China will subsidize renovation of toilets in the same way the IBP has due to the high cost it incurs.

Establishment of WDAs through the IBP demanded substantial funding. However, locally initiated groups could also be started at zero cost. If the WDAs are successful in their commercial enterprises they could inspire others to follow their model and establish their own civil society organisations.

The knowledge in China about biogas does merit more transfer of their technology.

4.6 Stakeholders

4.6.1 Government involvement

The government of China coordinates its engagement with international development organisations through the OFA. In Yongshun, OFA communicates with and instructs the relevant bureaus (e.g. the Energy Bureau and the Animal Husbandry Bureau).

The government has co-funded IBP. Government staff from different bureaus ran the trainings in animal husbandry, biogas management and environmental protection for hundreds of beneficiaries of the IBP. OFA were responsible for finding beneficiaries and constructing biogas digesters. In sum, most of the on-the-ground activities in China were implemented by bureaus coordinated by OFA.

Objectives in the IBP fit well with government policy to introduce biogas *en masse* in China. The scenic villages of Sicheng and Shuangfeng are focal points for tourism development in Yongshun County. Choosing these villages for trainings in the art of Tujia brocade weaving was strategic.

OFA has not had easy access to the PD, since the PD was not translated to Chinese. This meant OFA had limited overview of the project which in turn may have had consequences for implementation of the IBP.

4.6.2 Involvement of the Three-self-church

The official Church of China, the Three-Self Church and the Hunan Christian Council are the official “owners” of this project in Hunan through the XinDe Foundation, and have been following up the IBP on a provincial level. The local Church in Yongshun is relatively small and marginalised and has not been able to contribute to the project as much as planned. No interview had been arranged with the local church, or the leader of the Three Self Church in Hunan as part of the evaluation.

4.6.3 Government/villagers’ cooperation with Amity

The impacts from the IBP in Yongshun County exemplify why a partnership between an NGO like Amity and local authorities can be beneficial in China. By combining government structures with training in biogas management, the IBP is showing that high user rates can be accomplished relatively inexpensively. Involvement of government bodies ensures long-term support after the project has ended, and the NGO provides access to funding which enables an otherwise costly construction of digesters. This model of collaboration could be copied by local authorities elsewhere in China.

A note on the OFA is that it aims to promote friendship and mutual understanding between the Chinese people and foreign nations. The organisation was created in 1954. OFA is an organisation that is part of the party, but has their offices in the government building. It was established with the awareness that state to state relations must be based on friendship and on cultural, sporting and economic exchanges. The close collaboration in IBP between OFA, Amity and NMS exemplifies how the Chinese people can build relations with other countries.

The biogas digester at Ximi school

The digester at Ximi school was finished in 2012 with 30m³ tank. It is connected to the school's toilets, and is fed with pig manure from less than 5 pigs. At the time of the evaluation there were no pigs in the sty. The digester functions as a septic tank and contributes positively to the school's environment. The biogas is used by 20 teachers for cooking light meals during lunch. 3 months of the year it is out of gas because of temperature under 10°C and pigs sold or slaughtered. Biogas is used in combination with electric cookers and natural gas stoves. Knowledge of construction and management of the digester was lost with the departure of the previous headmaster, leading to technical problems. The IBP did not fund new kitchen for the school. The initiative of biogas was to be used in new kitchen for children, which was not constructed due to lack of funds and support from the government. To use biogas to cook for the children, an additional digester, more pigs and more technical capacity is needed.

The biogas digester has a model value, and could be used in teaching and as an example for the local community. Biogas can exemplify alternative energy, and recycling of human and animal waste. But the choice of biogas seems to be an investment not well handled by the school's management. There was no report of costs and benefits of the biogas digester. The users' capability to run digester seemed to be low, and they depend on technicians from the Energy Bureau.

5 Exchange between China and Madagascar

An important objective with the IBP was to see how technology, skills and institutional learning could be transferred between countries where NMS are working with local partners.

Outcomes of the exchange component of IBP:

The IBP has had several exchange visits between Madagascar and China. Technical skills and technology has been transferred from Chinese biogas technicians to Malagasy technicians in MLC's extension service FAFAFI. A Chinese biogas technician in Yongshun County and staff from Amity (one volunteer in 2013) have visited Madagascar to monitor construction of biogas digesters. Activities have included a learning visit from MLC in 2011 and NMS Madagascar to China in 2011 and 2012, and one learning visit with a Chinese delegation coming to see some of MLC's activities in Madagascar in 2014.

Representatives from NMS' administration in Norway, and Amity's and MLC's administrations have visited the projects in Madagascar. The institutional learning outcomes from these exchanges was not intended to be a central goal with the original program documents, but is an added effect of the project.

Coordination of the programme's activities in the two countries has been facilitated by NMS' representatives in China and Madagascar. Nearly all communication between the two countries' programme-components has gone through the NMS advisors.

5.1 Partner organisations

The two implementing partners, Amity and MLC, are large organisations with numerous on-going projects and sources of economic support. NMS in China and Madagascar have

communicated to coordinate the project activities in the two countries. The two organisations have different arrangements for implementation of projects.

Amity was created in 1985 on the initiative of Chinese Christians to promote education, social service, health, community development and strengthening civil society from China's coastal provinces in the east to the minority areas of the west. MLC has approximately 3 million members in 22 synods. MLC became autonomous in 1950 after having been under Norwegian and American mission since the 1850s. It works in a variety of development projects, including agricultural development. Both MLC and Amity has a long history of collaboration with NMS in development projects since the very beginning of establishment of the organisations.

Amity is partnering with the Hunan Christian Council and OFA in Yongshun County. The local OFA office has implemented trainings, constructed digesters, and is responsible for coordinating activities of the local Energy Bureau. The Energy Bureau employs biogas technicians and has organised a system of village technicians, as was an objective with the project. In Madagascar, MLC's extension service, FAFAFI, has worked in rural communities since 1985. The local FAFAFI offices in Antsirabe, Fianarantsoa and Fort Dauphin have been contracted to construct biogas digesters and train beneficiaries.

5.2 Learning outcomes for China

5.2.1 Biogas

The local project leader in Yongshun County OFA and the Energy Bureau's technician, travelled to Madagascar together with representatives of Amity and the Three Self Church. They both spoke warmly of the meeting with the people there, and the programme activities coordinated by MLC. Chinese participants felt they were recognized for their positive contribution of biogas technology and training of technicians in Madagascar.

5.2.2 MLC's other activities

The Chinese delegation that visited Madagascar identified 5 project ideas/components that they observed in Madagascar and would be interested in implementing in China as well as some ideas of projects where Amity could support work in Madagascar. Most of the ideas are most relevant for Amity whilst some are already implemented by the Three Self Church.

According to NMS, although formal agreements are not made, fruits of the cooperation are in the pipeline.

- The idea of systematically training small holder farmers in new farming technology through schools such as Tombontsoa is new to Amity.
- The "Tobies" represent very interesting way social work and faith is integrated. The teaching of diaconal and agricultural techniques in the Theological Seminary was something they all found very relevant and interesting.
- Popular participation in MLC's project, such as what was seen in "Use your talents", has inspired Amity to have new project to be more asset-oriented. Amity's projects have

previously been more needs-oriented.

- To promote a more positive relationship between the two countries/peoples Amity with the help of its Fundraising department, is interested in working with Chinese business people and agricultural academics to do projects to help the poor in Madagascar.

5.3 Learning outcomes for Madagascar

The IBP has resulted in successful transfer of technology and skills from China to Madagascar. The Malagasy technicians have learned theory of anaerobic digestion, and about the importance of exact measurements in constructing biogas digesters. Interviews with technicians from FAFAFI who had gone to China for training, revealed that more than technical skills had resulted from the exchange.

- The Malagasy technicians had seen that the landscape and forest cover had improved with biogas in China.
- When working in Madagascar and meeting an obstacle, they would just envisage how they did it during the training in China. This would guide them in their work.
- The Malagasy technicians were proud that the Chinese appreciated how hard they worked.
- Malagasy technicians also learned the Chinese government involvement ensured stable supply of spare parts and technical assistance from certified biogas technicians employed in public sector.
- One Malagasy technician's recommendation for scaling up access to biogas in Madagascar was to supply biogas kits and cement, to have government subsidy as in China, and technical support by FAFAFI.

5.4 Role of NMS

NMS has acted as coordinator in the programme. NMS has also been responsible for reporting from the programme. In their respective countries, the NMS advisors have acted as advisors to Amity and MLC. Good communication between NMS China and NMS Madagascar has been crucial for implementation of the exchange-component of the IBP, since communication between Amity and MLC met language barriers. In conclusion, NMS has been vital to the implementation of the exchange-component of IBP. The trust built up between NMS and the two partner organisations over the decades they have worked together has been very significant in making such an exchange possible.

5.5 Conclusions

The quality of construction of the biogas digesters in Madagascar bear witness to the successful transfer of technical skills from Chinese to Malagasy technicians. It also shows that it was a smart idea to delegate responsibility for selection of beneficiaries, construction and trainings to the local implementing partners OFA and FAFAFI.

Through the IBP people have met, but organisations have not met to the same extent. Technology has been transferred, but capacity building of partner organisations through international learning has perhaps not happened to the extent which was envisaged in the PD.

- IBP has been a pilot project, and has played its part in transferring knowledge from China to Madagascar. Amity has also received some inspiration for their environmental and diaconal work. In terms of scaling up access to biogas for rural people in China and Madagascar there appears to be little to gain from continuing the exchange-component of the project.

6 MLC's project in Madagascar

In Madagascar the IBP was implemented in the three MLC synods Antsirabe, Fianarantsoa and Fort Dauphin. The responsible partner was MLC through FAFITO. Instructions from FAFITO and the project Coordination Committee were handed down to the local FAFAFI extension offices. FAFAFI is a permanent structure (established 1985) within the church working in agricultural and animal husbandry areas and who has got the responsibility of building the biogas digesters. The FAFAFI offices in each synod were responsible for: 1) identifying beneficiaries, 2) supervising construction of biogas digesters, and 3) giving trainings.

NMS Madagascar has been advisor to the project, and has worked closely with the project coordinator in FAFITO. The NMS advisor to the IBP in Madagascar has communicated project developments and instructions between MLC, and NMS in China and Norway.

Outcomes of the project in Madagascar:

In Antsirabe, Fianarantsoa and Fort Dauphin a total of 212 biogas digesters of 10 m³ have been constructed. An impressive number of digesters – around 90% – were built only within the last 6 months of the project. Importantly, efficiency of construction has not compromised quality of the digesters. FAFAFI technicians have clearly been able to apply what they were taught from the Chinese technicians.

Three 30 m³ were constructed at Tombontsoa agricultural school in Antsirabe, at a vocational training school for women in Fianarantsoa, and at the Fihaonana agricultural school in Vohipeno at the east coast. The digester at Tombontsoa can generate electricity through a gas generator for use at the agricultural schools' farm.

The trainings were given by FAFAFI and were held with women from all the households benefiting from the biogas. The business trainings given were held in December 2012 and for the last beneficiaries in December 2014, after completion of the digesters. Women that were interviewed through the evaluation in Antsirabe and Fianarantsoa had received a two-day training. This included: 1) management of the biogas digester, 2) household economy, and 3) choice between various vocational skills including intensified chicken and pig rearing, baking and embroidery.

6.1 Context

Livelihoods of the farm households visited as part of the evaluation, in Antsirabe and Fianarantsoa, are highly suited for the type and scale of biogas technology introduced from China in this project. The integrated farming system which includes stall-fed milking cows and year-round, area-intensive cultivation of rice and vegetables provides both feedstock and is a continuous recipient of bioslurry. Farms



Intercropping in the fertile soils of Antsirabe.

commonly combine livestock with farming of cash and subsistence crops. Livestock include cows, pigs and chicken. Crops include rice, maize and vegetables. Ox carts are common, and used for transport of compost, harvest, water, etc. This makes it easy to transport compost and bioslurry to the fields for use as fertilizer.

Deforestation causes firewood to be scarce and its quality low. Firewood is scarce to the extent that people in one focus group interview said they even use maize cobs, bean pods and other farm yard residue as fuel together with firewood. People did not use kerosene for cooking, but relied on a mix of charcoal and firewood. For lighting some used kerosene lamps, but most seemed to rely on candles.

Farmers visited in Fianarantsoa and Antsirabe so not have access to natural forest, but cultivate pine (*Pinus patula*) and eucalyptus (*Eucalyptus spp.*) for firewood and timber. Forest cover is very low, and households relying on collection of firewood typically spend a couple of hours twice/thrice a week to provide the fuel necessary for own consumption. Alternative forms of energy to reduce burden of firewood collection or reduce costs of acquiring firewood or charcoal, are welcome. In the households visited, no improved firewood-stoves were observed.

Antsirabe has a long history of agricultural training at the Tombontsoa and FIFAMANOR. People are well educated in agriculture, and even in semi-urban areas people keep livestock. Several of the respondents had worked before or still work through formal employment in agricultural sector. There had been a previous project on biogas at Tombontsoa that respondents knew about, and between 2005 and 2007 a project on biogas had been implemented that several of the interviewed people knew about and had participated in.

There is long tradition for using cow manure in Madagascar. In some areas they have dried it and used it as fuel. In Antsirabe and Fianarantsoa, most farmers use composted manure as fertilizer and for soil improvement. People know the importance of adding organic matter to the extent that they are reluctant of only adding synthetic fertilizer because they know it makes the soil poorer. The volcanic soils of Antsirabe make it a productive area, and people cultivate throughout the year because of the high ground water table. Water is easily accessible to most, and several of the households visited had their own well.

People are connected through FLM. This is an important part of their social network, and is a venue where information is shared. This was where most learned about the IBP for the first time. Many had participated in FAFAFI projects before. Farmers live close together, and often relatives help each other. Access to this kind of labour was vital for being able to receive the biogas digester through the IBP.

6.2 Implementation

Biogas beneficiaries first had to apply to FAFAFI for getting a biogas digester. FAFAFI then selected households based on a set of criteria established by the project Coordination Committee of IBP in Madagascar. The criteria included having stall-fed cows, and being able to provide sand, gravel, bricks, and a hole to install the biogas digester in. Fulfilling these criteria would require much labour, and not all the applicants were able to meet all the criteria. Digging the hole for the biogas digester could take 1 week for 3 people digging every day. One respondent had a position in the local church and got 15 people together from the congregation to dig, which shows the importance of social capital in rural livelihoods. There were many households who could not meet the criteria, and there were those that did meet the criteria, but there was not enough funds and time in the project to construct digesters in their farms.

Many of the interviewed beneficiaries were people who had already previously been involved in FAFAFI's other projects. They had clear opinions of benefits and limitations with the technology. This was also the case for non-beneficiaries interviewed during the evaluation. The following sections discuss benefits and limitations of the biogas technology from the point of view of beneficiaries and non-beneficiaries.

6.2.1 Beneficiaries: Benefits of biogas

Impact on allocation of labour and time

According to the mixed-gender groups interviewed in Antsirabe and Fianarantsoa, biogas has a positive impact on allocation of labour and time in the household. Biogas makes cooking much faster than charcoal and firewood: "Cooking takes shorter time with biogas". Particularly charcoal takes time to ignite, and biogas is much quicker. Boiling rice with the biogas-based rice cooker was praised for its efficiency, but also because it frees time to see to other tasks in the kitchen while boiling rice: "Just leave the pot and see to other activities". Quick boiling on biogas in the morning gives less stress to see to the cows when they are milking: "Before I was always late for milking".

Management of the biogas digester is not labour intensive: “Only one bucket of manure, then you cook”. The farmers had been recommended to add two buckets of manure twice a week to supply enough energy for the family needs, and followed this advice.

Biogas saves time by avoided collection of firewood. Many of the households had woodlots, and would spend several hours every week to prune trees and bring the firewood home before they got biogas. Men, children and women would participate in this activity. With biogas they did not have to go out for firewood as often as before; firewood was still used for some purposes in the household after having received biogas.

Impact on household economy

Biogas light reduces costs otherwise used for candles and kerosene light. Expenditure for kerosene was commonly reported as 200 MGA/evening. The few households that had electricity had halved their electricity bills by using biogas for light. Light increases households’ security in an area with high risk of cattle robbery. One respondent previously used a generator for providing electricity for light during night, now he used biogas light and therefore saved a lot of money.

For households that would buy firewood, biogas reduces expenditures equivalent of 500 MGA/morning and 500 MGA/evening. For a household that need energy for boiling pig feed, they may spend the equivalent of 3000 MGA/day for firewood. With biogas savings could be made, but biogas was not commonly used for preparing animal feed or water for milking.



A biogas digester outside the barn.

Instead it was prioritised for preparing food.

Biogas reduces cost of buying charcoal, particularly for urban and semi-urban households. Some homes reported a reduction in charcoal consumption going from 4 to 1 sack/month. A sack of charcoal costs between 6 000 and 8 000 MGA.

Use of bioslurry can decrease input of chemical fertilizer, but it is difficult to establish since many have only had the digesters for a short time, and they do not keep records. Households interviewed that had used biogas since 2012 reported substantial savings from substituting chemical fertilizer with bioslurry. A farmer in Talatan’Ampano, Fianarantsoa, previously used 2

kg fertilizer at 2 000 MGA/kg on his tomatoes. Now he tries to use 96 l bioslurry from the digester. He is optimistic and intends to use it in the rice paddies as well. A farmer who had previously relied on compost for fertilizing the rice, and now had started using bioslurry, reported a yield increase from 300 kg to 520 kg/da. There is a positive impact from use of bioslurry, but it is difficult to quantify.

Entrepreneurship seems to have increased as a consequence of time freed for other activities because of biogas. Several informants report that they have started new business activities such as raising chicken. Many of the people interviewed during the evaluation were already quite entrepreneurial before participating in the IBP.

A potential future income could be that rather than cutting the trees on the farm for firewood when they were small. One farmer in Fianarantsoa said he «can now wait till they were big logs and thereby make an income from selling timber».

Some respondents had drawn the conclusion that the contribution they had to make to get the digester would be down-paid within a year. Their contribution included bricks, gravel, sand, labour and food for the workers. This roughly translates to about 1 million Ar if opportunity cost of labour is set equal to cost of casual labour (3000 MGA/day), and is about 25% of the total cost of the digester.

Impact on cleanliness and health

Kitchens in households with biogas were very clean, and free of soot on walls and ceiling. With biogas there is no smoke in the kitchen, and the respondents reported that they did not have running noses and sore eyes anymore. Once she got biogas, the situation had also improved for a woman with asthma. She had reduced her expenditures for asthma medicine: “For us it is really a new life with biogas”.

Some respondents complained that while studying with kerosene light in the evening, children would breathe the fumes. Biogas light had made it easier for children to study and play in the evenings not only because of improved lighting.

Human and social capital

Social status may have increased among beneficiaries of biogas that were interviewed in Fianarantsoa and Antsirabe. Visitors would not see the soot on the walls from firewood, and all the kitchens had been painted. In one household a biogas lamp had been installed outside the house to provide security during night. Many people would see the light and come to see how the biogas works; “They see the light and envy that”. “Before, we thought only rich people in cities can use gas”.

Light makes studying at night possible: “Children can do homework”. “Light really opens your eyes”. Also, children would not need to spend time fetching firewood together with their parents, and could play or study instead.

Gender roles may have change a little with the new technology: “Even men can cook now!” Men complained that they did not like to breathe the smoke while making the fire, and that this was the reason why they were not involved in the kitchen before. Conversely, men exclaimed that “Even the wife can feed the digester”.

Biogas gives increased energy security: “We don’t worry about the cyclone”. Price for charcoal and firewood goes up November to March, but this is not a problem for biogas users.

Construction of the digester brings local community of biogas owner closer together. Families are involved, and even within families there may be changes. Jokingly, couples would comment that because there was less smoke in the kitchen “now we see each other”.

Impact on local environment

It was unanimously agreed among the beneficiaries that biogas had reduced use of firewood and charcoal, and that this had an effect on the local environment. Reduced deforestation: “My mind has opened to destruction of the environment. I’m telling the others”. Charcoal consumption has been reduced from 4 bags per month to 1 bag per month.

Biogas users in an association (Voly Avotra) in Talatan’ Ampano, Fianarantsoa, estimated having saved 2.25 Ha of forest per year. In their respective woodlots they just did pruning of branches for firewood for cooking the pigs’ food and/or making food for workers hired for fields’ works in times of harvest.



Kitchen with biogas cook stove, rice cooker and biogas light.

Those interviewed had not reflected around how large these savings were in terms of forest biomass. Below is an example of how saved biomass from the IBP in Madagascar can be estimated:

Example of calculated contribution from IBP in Madagascar to avoided deforestation

Assuming 0.4 t/capita/year firewood consumed per year. Full transition from firewood to biogas among 212 households, each with 5 people, would give avoided deforestation of 424 tons of wood per year.

6.2.2 Beneficiaries: The limitations of biogas

Without exception the primary limitation of biogas technology reported by the beneficiaries was the high cost of inputs that the beneficiaries themselves had to provide as equity to get the rest of the digester financed through the IBP. The beneficiaries argued that this was the biggest constraint to scaling up access to biogas in Madagascar.

A common comment was that the biogas technology cannot provide energy for TV, radio and mobile phone. This suggests an increasingly felt demand for electricity in rural Madagascar.

Another limitation associated with how the IBP was implemented was that access to spareparts was beginning to be a cause for worry. The biogas lamps had brittle parts, and users were not sure if FAFAFI could provide these once the project had ended. «Before I had a motorbike, now I have a car. So I know how important spares are». Some respondents were aware that FAFAFI still were in possession of biogas kits (each containing 4 lamps, a stove, 30 m pipes, valves and filters) after project-end in December 2014. One person was ready to buy an extra kit for spareparts, at its cost of 300000 MGA.

A limitation with the 10 m³ digester was that it was difficult to cook for many, for example if they have casual labour working in the fields, or visitors. Boiling of feed for pigs and heating of water for milking cows was commonly done with firewood because there would not be sufficient biogas to provide light in the evening if they used it for the pigs. A few hard-boiled foods such as dried cassava consumed much biogas, and it was common to use charcoal for this purpose.

Some farmers had asked for advice from FAFAFI because of low gas production. A common reason for low quantity of gas in the digesters' headspace was because the users removed slurry from the pressure chamber too seldom. For optimal gas production the bioslurry should be removed at frequent intervals from the pressure chamber. According to FAFAFI technicians another reason for low gas production could be caused by too much water in the digester. The evaluation took place during rainy season. Most of the household had covered the inlet and pressure-chambers in the digester to avoid dilution of the feedstock.

A respondent with a 15 Ha farm said that the amount of bioslurry would not suffice as fertilizer for his farm. Most farms had smaller cultivated areas. Fertilizer is only added to crops at certain times of the year. Most of the farmers mixed the bioslurry with the waste from the stables, and composted it. This compost was then transported to the fields when needed. Organic fertilizers were commonly combined with chemical fertilizer for positive synergies between the two (biogas and compost will have to be complemented with phosphorus for balanced fertilization).

Access to technical assistance was reported to be a cause for concern for the biogas users. They were unsure how this would be provided after the project's expiration. In meetings with FAFIFI in Fianarantsoa and Antsirabe the technicians made it clear that they would visit the biogas users and provide assistance if required, when working on other projects in the area.

6.2.3 Non-beneficiaries' perspective

Focus group interviews with representatives from households that had not received the biogas technology showed that the community surrounding biogas-owners were much aware of its benefits. One man suggested that "biogas could green Madagascar". The respondents gave many of the same arguments and benefits of biogas as the beneficiaries had done.

The limitations of biogas were another matter. On this subject non-beneficiaries only reported the high upfront cost as an obstacle: "It is already difficult to find [money for] food". They would have a hard time gathering sand, gravel, bricks and digging the hole for the digester.

6.2.4 Lessons for a future biogas project

Biogas is a positive contribution in households that received it in Antsirabe and Fianarantsoa, and fit well with their livelihood activities. It is clear that biogas has multiple positive impacts in people's lives. The quality of the Chinese technology and the work of FAFIFI technicians suggests that beneficiaries of IBP may have the benefits of biogas for decades to come.

The PD points out that "It is also clear that the target group for this project cannot be the poorest of the poor". In the IBP, a range of criteria had to be fulfilled to gain access to the biogas technology. It is not unlikely that households that have the capacity to benefit from biogas have different social, natural, physical, human and financial assets than many other in their communities. It appears from the interviews with beneficiaries and non-beneficiaries that biogas owners may act as role models in the local community.

Almost nothing was mentioned about the training in environmental awareness that they had received. To a woman interviewed, "environmental protection was already an important thing" before the biogas project. Similarly non-beneficiaries reported to be well aware of the negative impacts human activity had on the environment. This is already taught in schools. Calculating the environmental benefits with the biogas users could have made it clearer what the impact of the technology was.

A limitation which was identified through focus group interviews with biogas users was the uncertainty of where spare parts could be accessed. Technical assistance was available through

the FAFAFI technicians, but such support was done out of good will from FAFAFI, and FAFAFI would not be compensated economically. Therefore technical support in Madagascar in principle is limited to the IBP's duration. An objective with the IBP in China was to establish a system for providing biogas users with technical support. However, this project component has not been part of the exchange in IBP. Technical support through village technicians, FAFAFI technicians and associations of biogas users appear to be vital for continuation of activities related to biogas in Madagascar.

Based on the benefits and limitations of biogas technology that were put forth by beneficiaries and non-beneficiaries, the bullet points below gives some recommendations for ensuring long-term viability of biogas in future projects:

- Continue with selection criteria for biogas users.
- Accept that people combine biogas with other fuels ('multiple fuel use').
- Try to reduce costs of technology and implementation, but without compromising quality.
- Budget for post-project technical support.
- Train village technicians as part of the extension service.
- Support local associations of biogas users.

6.3 Women business training

The IBP has offered business training for women based on the following assumption: Biogas frees women and gives them extra time that the project will use to stimulate their entrepreneurial capacity in order for them to generate activities increasing their incomes. FAFAFI has given most of the trainings by relying on skilled staff already in the organisation. Some training was outsourced to external specialized teachers in areas.

In the context of biogas project, no special lesson in environment was given. Rather, FAFAFI has used environmental awareness-raising as a way of interacting with people to interest people, and introduce farmers to biogas. In Antsirabe, even though trainings had been conducted only two months prior to the evaluation, many women had initiated their business ideas already. It must be noted that for the evaluation the short time between training and evaluation made it difficult to see the long-term viability of the entrepreneurship ideas.

In all the project areas, women beneficiaries were called for the two days' training sessions that were advancements in already familiar areas, such as raising pigs and local chicken, peanut farming, pig rearing, coffee, cooking (yoghurt and baking), fruit conservation and embroidery. Trainees were also given lessons in nutrition, hygiene and health.

6.3.1 Consistency with IBP's objectives

Trainings were consistent with the project objectives in that they focused on women and how they could provide themselves with income-generating activities. An assumption of the IBP was that such activities would lead to women's empowerment. Several of the interviewed women had started active rearing of chicken for sales. One woman said "I can handle the chicken myself and

don't have to rely on my husband". An impact of having biogas technology and receiving training could be empowerment of women. This will be discussed in the following sections.

6.3.2 Benefits of business training

A family asset

Although business training was addressed to women, sometimes both spouses were present at the training. In fact, business training was considered by beneficiaries as investment in starting or extending initiatives generating familial incomes. In cases where the woman could not attend the training, the husband went instead of his wife.

Business training for women can be a valuable family asset, and impacts are not limited to the women. The women said that they shared the knowledge they had gained with their husbands. Some entrepreneurial activities require large investments, such as stalls for modern pig rearing. This would require a family-decision rather than the women being self-reliant. Economic returns would likewise be shared in the family.

Small entrepreneurial initiatives

Small entrepreneurial initiatives such as peanut farming, chicken, pig rearing, and coffee had already at the time of the evaluation been initiated by several women. For example, a widow in Maroharona village, Fianarantsoa, had several small initiatives. She had calculated expected incomes from the lessons she got from the business training: "Selling coffee for 200 000 MGA/year, chili pepper for 5 000 MGA/sack, milk for 60 000 MGA/month".



Women received business training.

In Antsirabe, small initiatives were still not launched by beneficiaries, due to the recent business training held in December 2014. But one woman was working on an embroidery made with a technique taught in the business training. The on-going embroidery was brought to FAFAFI for correction and improvement. She wished to continue with embroidery and sell her works through FAFAFI.

Several women were interested in the prospects of shifting from free range chicken to caged and fed chicken to produce eggs or broilers. This activity has the advantages that the investment is

relatively small and it can be stepped up with one and one chicken as the household saves with biogas.

Advancements in knowledge of familiar practices

The trainings were advancements in knowledge and practices that were already familiar to the women. When asked why they would opt for training in improved piggery practices, they would answer “that’s what we do every day here, pig raising”. In practice the content of the training was on how to shift from having grazed pigs, to rearing stall-fed pigs. Following the training, women realized that they would lose money with the traditional grazing. Training in chicken rearing had the same way of intensifying production from free-grazing to caged and fed chicken.

Positive household economy training and valorisation of freed time from biogas

Trainings on household economy were well received. It taught how time [freed with biogas] can be valorised through opportunity cost of for example casual labour. Most of the households were already familiar with cost of hired labour since they would hire farm hands at time for rice cultivation. Receiving the training made the beneficiaries more aware of the value of biogas, and how the benefits could be turned into income generating activities.

A woman in Talatan’Ampano, Fianarantsoa, now puts her savings from charcoal and kerosene aside as savings (in a “boatin-drakitra”). At the end of the month she will have saved 8 000 MGA that she will use to buy a chicken. She now has 80 local chickens. Another beneficiary in the same village reported to have saved 240 000 MGA in a year that would otherwise have been used to buy firewood. The saving she used to buy a pig for 100 000 MGA, 40 000 MGA for the pigs veterinary services, and 100 000 MGA for feed. From this she will have piglets.

6.3.3 Limitations of the business training

Starting up a microbusiness?

Women business training were given in familiar areas of beneficiaries, and generally it has been set up according their requests. A follow up of the trainees in terms of support to the concrete start of their own microbusiness is one way that could have produce more impact and visibility on the beneficiaries’ lives and their local community.

Some of the skills-trainings were perhaps not that relevant for the prospect of establishing businesses. A microbusiness based on orders from customers could make yoghurt and cake baking an additional source of income. However, yoghurt production would be useful for households with access to cooling facilities, but most biogas beneficiaries did not have such facilities. Cake baking was difficult to make a business out of, but it was argued that it could be nice to do for the family and to bring to church meetings.

Women’s empowerment?

The logic behind the IBP is that biogas frees time otherwise used for firewood collection and for cooking. Biogas therefore not only results in savings, but also enables people to allocate freed

time to income-generating activities. However, free time can also be used for leisure. When confronted with this choice, the focus group respondents said they would rather work more than have more time off. It is likely that biogas can translate into increased savings and income. But does this also mean that women are empowered?

6.3.4 Impact

Improved managerial capacity

The tendency to think of small initiatives generating incomes seems developed by the trainees. Any area of their land is a matter of thinking ways to cultivation in order to increase incomes. Those participating in the trainings have developed a more managerial way of considering their lands. They report a clear view of the use of each portion: for subsistence, for generating incomes in the short term and financing cultivation on other areas for longer duration.

To illustrate, a woman in Fianarantsoa shared her way of starting micro initiatives for increasing her income: She cultivates rice (X243 variety) through Sustainable Rice Intensification (SRI). This produces 2 tons/year for subsistence. She also cultivates coffee, chili pepper for having a current treasury to face the wages of workers in the fields (casual labour: 7 000 MGA from 7:00 to 12:00), and expenses for schooling her children. The income from selling milk of 60 000 MGA/month also adds to the economy.

The business training ultimately seems to have improved people's lives through starting, extending and multiplying activities generating incomes.

Changes in gender equality



Biogas and trainings had opened possibilities.

Women's own initiatives in microbusiness add incomes to the households. Not only was the business training seen as a family investment enhancing the possibility of having more income to the household, but it also positioned the women as a familial source of income. This suggests why it was observed that both husband and wife sometimes decided together the choice of topic for the woman to follow in the business training.

Consequently, the IBP may have contributed in making women partners in providing incomes for the family's needs. In doing so, difference in roles between genders is changing.

6.4 Change in attitudes

An indirect effect of technical development interventions and trainings may be changes in people's attitudes. Although difficult to measure in quantitative terms, such effects may have a wider impact than the technology in itself. Not only are the direct recipients of development assistance affected, but also other people in the communities in which they live. Among respondents interviewed in the evaluation of IBP it was clear that there was a wide awareness of the positive impacts of biogas on local environment, living standards and children's lives.

6.4.1 Focus on children

An effect of gaining access to biogas is that improved light and less labor allocated to firewood collection has made it possible for children to study more: "Children can do homework". Children would not have to spend time fetching firewood and could play or study instead. In terms of changed attitudes it seemed through the interviews that biogas had made parents more *aware of the importance of children being out playing and studying*, rather than contributing to work on the farm.

6.4.2 Gender roles

An impact of the IBP appears to be that there is raised *awareness of gender roles* in the households with biogas. When cooking with firewood, men complain that they don't like the smoke and that they therefore do not do the cooking. But with the easy gas stove, it was commented that "even men can cook now!" Conversely it was exclaimed that "even the wife can feed the digester". New technologies and knowledge can change people's perception of social structures.

6.4.3 Indoor air quality

Indoor air pollution is often difficult to combat in developing countries since it is not strongly enough perceived as a problem by those affected by it. Respiratory ailments are commonly a consequence of long-term exposure to air with high particulate matter content. For people living with smoke in the kitchen every day, it is easy to forget how hazardous it may be over time.

The improved cleanliness and indoor air quality associated with biogas may contribute to increase the *awareness of connection between smoke and respiratory ailments*. One woman with asthma said she had reduced her expenses for asthma medicine after receiving biogas. Non-beneficiaries also made references to the health benefits associated with transitioning from firewood to biogas.

6.4.4 Environmental awareness

Biogas owners have become active agents to protect the environment. Construction of the digester brings local community of biogas owner closer together because many people are involved, including families and neighbors. Word of the technology spreads quickly. Non-beneficiaries interviewed in the evaluation were very aware of the savings of firewood and charcoal that could be made by switching to biogas. People in the local community would come

to see the biogas digester, and the owner would tell about its efficiency and how it reduced the need for cutting trees for firewood. The trees in their forests are not cut since they use biogas, they are aware of the importance of forests and intent to extend their surface. Moreover, their time is saved for not continuing to take firewood. These visible effects in beneficiaries' households have an attraction power among their neighbors. Biogas technology has *increased awareness of impact of firewood use on the local environment*.

6.4.5 Visibility of beneficiaries

Biogas digesters have brought a significant change in beneficiaries' life: biogas brings easiness and comfort of cities' life in rural villages where usually darkness is reigning and smoke, long cooking and dark walls are common. Added with improved incomes from entrepreneurial initiatives, better domestic tools, children' s education, financial resources to handle various small initiatives, make the beneficiaries "visible" among the local community, apart from the light shining in the night from the biogas lamps and the quickness of preparing tea or coffee while hosting people at home. Biogas has increased the visibility of beneficiaries in the local community, and this may have *raised or reinforced an elevated social status in the local community*: "Before, we thought only rich people in cities can use gas".

6.5 Sustainability

According to the socio-geographical context where the evaluation was made in Madagascar, namely among small-holder farmers in the central plateau, biogas appears to be an accessible renewable energy alternative. The livelihoods of people visited in Antsirabe and Fianarantsoa are dominated by households having rice, maize, legume and vegetable production. Crops can be grown throughout the year in the rice-paddies, and beans are typically grown in the "lean season" to replenish soil nitrogen stocks. Composted manure from one to four heads of stall-fed cattle, and often a few pigs, is applied as fertilizer. Chemical fertilizers are often used to complement the organic manure. Firewood is relatively scarce. Most of the interviewed households had woodlots of pine and eucalyptus. The quality of the firewood is low, since the firewood typically consists of pruned branches cut when needed. High ash and moisture of firewood content makes cooking dirty and cumbersome.

All the biogas beneficiaries reported one limitation of biogas to be that they could not power TVs, radios and mobile phones with it. Solar, wind or micro-hydro could in theory supply the sought-after electricity. However, experience in the evaluation team suggests that wind and micro-hydro are too expensive and too technically complex to be viable without substantial long-term support. Solar home systems on the other hand have in recent years become so inexpensive and accessible in many countries in Africa that market demand and supply are sufficient to spread this technology – at least to the wealthier rural and urban households. It is important to keep in mind that small scale electricity generation cannot compete with biogas in cost-effectiveness for heating purposes.

Reasons why biogas seems to be a suitable energy option for improving rural livelihoods in the central highlands of Madagascar are: 1) feedstock from zero-grazed cows is available, 2) water is available, 3) organic manure is already used as fertilizer in the area, 4) there is a demand for energy which is easier accessible than firewood.

The IBP has contributed to build FAFAFI's reputation, and it is being noticed by officials in public institutions as working in environment protection. This could be relevant for the prospect of MLC's future provision of sustainable and affordable access to renewable energy in villages in Madagascar. An example of FAFAFI's visibility is that they were invited to participate in the regional environment days in 2013 and 2014. Their stand was well visited and shown on national TV: they presented biogas technology from the IBP.

6.5.1 Technical support

A limitation which was identified through focus group interviews with biogas users was the uncertainty of where spare parts could be accessed. Technical assistance was available through the FAFAFI technicians, but such activity would be out of the goodwill of FAFAFI, who would not be compensated economically. Technical support in Madagascar is in principle limited to the IBP's duration.

In contrast, in China the certified technicians are under the Energy Bureau, and the village technicians have been trained by these. China's massive campaign to reduce deforestation, which includes subsidy and dissemination of biogas digesters to the rural population is exemplary. But it is also costly for the Chinese government. In Madagascar the situation is another; the government has limited capacity for implementing relatively costly projects to reduce deforestation. The evaluation included a meeting with a government official in Haute Region, Fianarantsoa. She made it clear that support for government-based dissemination of biogas would be difficult. She argued that biogas was not for everyone but was limited to a specific segment of the rural population.

6.5.2 Cost of construction

A matter relevant to the sustainability of alternative renewable technologies is the cost. The beneficiaries in the project all mentioned that their contribution to receive biogas digesters had been so high that it would be unlikely that everyone in the community could afford it.

Taking into the calculation the opportunity costs of buying all the inputs that the beneficiaries themselves would have to contribute, they provided about ¼ of the total value of the digester. It is worth noting that the beneficiaries also said that the investment was worth it, and that their expenses would be down-paid within a year.

One way of reducing the contribution for each household could be to share the cost of the construction and the running costs of one biogas digester among two or three closely located

households. This solution would require instruments for measuring and sharing biogas management and consumption in an equitable manner, and would not be unproblematic.

6.5.3 Alternative biogas solutions

Several of the households interviewed in Antsirabe already had had experience with a previous biogas project implemented through FAFABI, financed by Danmission and implemented between 2005 and 2007. The technology used was tubular plastic digesters. These digesters cost less than concrete- or brick-built digesters, but also have shorter life-spans. The users in Antsirabe reported that their plastic-digesters had broken down after only one to three years. At the time, FAFABI were not able supply equipment for repairing or replacing the tubular digesters.

Similarly, at Tombontsoa agricultural school in Antsirabe a floating dome digester had been built several years ago but was no longer operational at the time of this evaluation.

The preferred construction material of small-scale, low-tech digesters as those built in the global South, has traditionally been burnt clay bricks. This was also used in China before the contemporary solid-concrete design was developed. Chinese technicians have now gone away from using bricks, as this lasts shorter than solid-concrete digesters.

Recently full-plastic digesters have been developed, both as floating dome and fixed-dome. The former has been criticized for having too many movable parts. The experience of the evaluation team is that the plastic floating dome is impractical to scale up to provide sufficient biogas for a household. The plastic fixed-dome could be worth looking more into. But for long-term functionality, the Chinese design and mode of dissemination with strong post-construction support, is the most promising way forward.

7 Conclusions

The IBP has achieved a number of outcomes:

- Technological skills have been transferred from Chinese to MLC's technicians, as observed in the high quality of digesters in Madagascar.
- In China, the appropriateness of the biogas technology in rural livelihoods is evident from 95% of the digesters built by the IBP being in use.
- Biogas has freed time in the household, particularly noticeable in Madagascar. Training in household economy has enabled people to valorize the time saved.
- Biogas and trainings appears to have had impact on perception of gender roles within the household, particularly in Madagascar. In China improved sanitary conditions, training in health, establishment of women's development associations, and income generating activities have improved women's daily lives.
- From the trainings, women have gained ideas on how to improve household income. Some

have initiated small entrepreneurial projects following trainings through the IBP in both China and Madagascar.

- Biogas has had an important impact on hygiene in China with improved toilet facilities. Cleanliness and indoor air quality in the kitchen has improved in both countries.
- Biogas has a positive impact on the local environment in both countries. Over time this will be evident in Madagascar where firewood is very scarce and few alternative energy sources are available.

8 Recommendations

8.1 The exchange

An important outcome of the IBP is that skills for constructing biogas digesters successfully have been transferred from Chinese to Malagasy technicians. The exchange component of the IBP has enabled capacity building of MLC staff, particularly in FAFITO, and it is unlikely that another, less comprehensive approach to technology transfer would have made possible the incredible effort of constructing biogas digesters in Madagascar in 2014. The learning visits between Amity and MLC have enabled sharing of ideas between countries and cultures. The IBP has also opened new possibilities for diaconal work. In these regards the exchange between the two countries has been a success.

Recommendations:

- Transfer of skills in biogas has been accomplished according to goals in IBP. Further collaboration and exchange could still be relevant between Amity and MLC, but for institutional capacity building and sharing ideas in diaconal work.
- Future exchange programs would benefit from having more inclusion of organizations responsible for “activities on the ground” in the project development process, and clarify responsibilities and project organization in the PD.
- Transfer of skills in biogas technology from China to other countries than Madagascar where NMS operates can have positive impact on rural livelihoods in these countries. Implementation could be simplified and costs reduced by limiting such a project to transfer of skills between technicians.
- For long-term functionality of biogas, the Chinese design and mode of dissemination with strong post-construction support, is a promising way forward.

8.2 Activities in China

The IBP in China has largely met the goals and targets set in the PD, with an impressive number of biogas digesters constructed and number of people trained. Although it was hard to establish to what extent outcomes of the IBP met the verifiable criteria in the PD at the time of the evaluation, the programme will undoubtedly improve the livelihoods of many in rural Yongshun County. The high user rating suggests that the biogas technology is well adapted to livelihoods in

the integrated farming system typical for the area in which IBP was implemented. The IBP has benefited from the partnership between Amity, Three Self Church, and OFA and Yongshun County government. This has made donor funding available, opened for co-funding of project activities, provided skilled technicians and trainers, and made possible long-term sustainability of the project interventions.

China has much experience with biogas through its massive government-led campaign to introduce biogas as part of a strategy to curb deforestation. Implementation for long-term viability of biogas in Madagascar could take learning from this.

Recommendations:

- For future projects, enhance the project planning at the beginning of project, especially the connection between activities and output and objective. Let the local partner participate in the whole procedure of planning to improve the common understanding on project goals between Norwegian donor organization, Amity and local partners.
- Future donor-funded, biogas-based projects in China would benefit from continued close collaboration and involvement of OFA and local government. Involvement of government bodies ensures long-term support after the project has ended; the NGO provides access to funding which enables an otherwise costly construction of digesters.
- To ensure that the WDAs established through IBP go on to contribute positively in women's lives, the organizations would benefit from more training in management, including financial management, marketing, and leadership.

8.3 Activities in Madagascar

Biogas has improved lives of those who received digesters through the IBP. Technical skills have successfully been transferred from China to Malagasy technicians. FAFAFI has the capacity and skills to continue construction of biogas digesters and support users. Locally, a demand seems to have been created for biogas. The pilot project has largely fulfilled its mission.

Biogas has been tried as a means of rural development in Africa since the 1960s. Many research articles and reports have pondered why the digesters often have been found to be disused only a few years subsequent to the project through which they were built. Explanations are many – straightforward solutions few.

Through the IBP, technicians under MLC in Madagascar have been able to learn from the Chinese. Some features appear to be critical for the long-term viability of biogas in both countries: 1) appropriate selection criteria for who are eligible for receiving support for constructing biogas, 2) quality of the digester, and 3) availability of technical support for users into the foreseeable future.

Recommendations:

For the short term:

- Supply of accessories for biogas digesters already constructed.
- Continue to provide technical support, even without continued project funding.
- Training of ‘village technicians’ by FAFIFI that could provide local support for biogas users.
- Construct digesters for those willing to pay the full cost of the digester.
- Support establishment of biogas user associations.

For the longer term:

- Look for partners or funding agencies willing to build on the capacity that has already been established in MLC on biogas.

Appendices

Appendix A:

Timetable for the evaluation of the International NMS Biogas Partnership Programme in People's Republic of China.

Appendix B:

Timetable for the evaluation of the International NMS Biogas Partnership Programme in Madagascar.

Appendix A

Timetable for the evaluation of the International NMS Biogas Partnership Programme in People's Republic of China.

Date and place	Program
<u>Monday 8 December</u> Yongshun city Ximi village	<ul style="list-style-type: none">• Drive Zhangjiajie – Yongshun.• Meeting on program and labour division.• Visit 30 m³school biogas digester at Xiqi Township Central School, Ximi village.• Visit woman making an income from Tujia weaving.
<u>Tuesday 9 December</u> Bagu village	<ul style="list-style-type: none">• Visit biogas owners and village maintenance centre for biogas.• Interview members of Women's Development Association (WDA) on biogas digesters, agricultural training, brocade training, hygienic training and camellia upgrading.• Interview with Yongshun County Energy Bureau's biogas technician.• Interview with trained Village Technicians.• Visit WDA's kiwi plot.• Meeting with Yongshun County government representatives and Overseas Friendship Association.
<u>Wednesday 10 December</u> Sicheng village Shuangfeng village	<ul style="list-style-type: none">• Visit Sicheng, village applying for World Heritage status. Guided tour of area and activities.• Interview with Tujia brocade training participants in Sicheng village.• Visit Shuangfeng village, and brocade training centre.• Interview women who had participated in Tujia brocade training, including chairperson and member of WDA.• Cultural show in Shuangfeng.
<u>Thursday 11 December</u>	<ul style="list-style-type: none">• Biogas digester inspection in Hongxing village.

Hongxing village Date and place	<ul style="list-style-type: none">• Interviews with biogas owners. Program
Zhangjiajie	<ul style="list-style-type: none">• Drive Hongxing – Zhangjiajie.• Present the preliminary findings of evaluation for Amity and NMS representatives.

Appendix B

Timetable for the evaluation of the International NMS Biogas Partnership Programme in Madagascar.

Date and place	Program
<u>Friday 30 January</u> Antananarivo Antsirabe	<ul style="list-style-type: none"> • Introduction to the biogas project by the coordinator and the adviser • Drive Tana – Antsirabe • Visiting biogas owners together with technician and FAFAFI coordinator (Antsirabe).
<u>Saturday 31 January</u> Alakamisy village	<ul style="list-style-type: none"> • Focus group with biogas owners (men and women, minimum one from each household. Same number of men and women). • Meeting with women about business training. • Focus group, farmers without biogas.
<u>Sunday 1 February</u> Fianarantsoa	<ul style="list-style-type: none"> • Church • Drive Antsirabe – Fianarantsoa • Meeting with FAFAFI coordinator, Fianarantsoa.
<u>Monday 2 February</u> Maroharona village	<ul style="list-style-type: none"> • Visit biogas owners together with technicians and FAFAFI coordinator • Focus group with biogas owners (both men and women, minimum one from each household. The same number of men and women). • Meeting with women about the business training.
<u>Tuesday 3 February</u> Fianarantsoa Maroharona village	<ul style="list-style-type: none"> • Meeting with synod president, MLC. • Focus group, farmers without biogas (Maroharona village). • Meeting with Chief of Region. • Visit Amboaloboka School and 30 m³ digester. Interviews with FAFAFI technicians.
<u>Wednesday 4 February</u>	<ul style="list-style-type: none"> • Focus group with biogas owners (both men and women, minimum one from each household. The same number of men

Date and place	Program
Talatan' Ampano village Fianarantsoa	and women). <ul style="list-style-type: none"> • Meeting with women about the business training. • Focus group, farmers without biogas. • Debriefing with all FAFAFI staff involved in the project in Fianarantsoa.
<u>Thursday 5 February</u> Antsirabe	<ul style="list-style-type: none"> • Drive Fianarantsoa–Antsirabe. • Visit Tombontsoa agricultural school and 30 m³ digester with generator.
<u>Friday 6 February</u> Antsirabe	<ul style="list-style-type: none"> • Visit biogas owners together with FAFAFI technician. Digesters that were built in 2012. • Debriefing with all FAFAFI staff involved in the project in Antsirabe (biogas technicians and trainings in women business training).
<u>Saturday 7 February</u> Antananarivo	<ul style="list-style-type: none"> • Drive Antsirabe – Antananarivo • Present the preliminary results to Director of FAFITO, NMS representative, Programme coordinator and adviser.