SATNET Asia Technology Validation Study

Jeevatu

Submitted by **Sarah Crestin-Billet**

October 22, 2014

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The Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia (SATNET Asia) aims to support innovation by strengthening South–South dialogue and intraregional learning on sustainable agriculture technologies and trade facilitation. Funded by the European Union, SATNET facilitates knowledge transfer through the development of a portfolio of best practices on sustainable agriculture, trade facilitation and innovative knowledge sharing. Based on this documented knowledge, it delivers a range of capacity building programmes to network participants.

SATNET Asia is implemented by the Centre for Alleviation of Poverty through Sustainable Agriculture (CAPSA) in collaboration with the AVRDC – The World Vegetable Centre, the Asia Pacific Centre for the Transfer of Technology (APCTT), the Food Security Centre of the University of Hohenheim and the Trade and Investment Division of UNESCAP.

This report is an outcome of collaborative research work conducted by SATNET Asia on sustainable agriculture technologies.

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Acronyms

APCTT: the Asian and Pacific Centre for Transfer of Technology
AVRDC ESEA: the World Vegetable Centre – East and Southeast Asia
CAPSA: Centre for Alleviation of Poverty through Sustainable Agriculture
DAP: Diammonium phosphate
ESCAP: the Economic and Social Commission for Asia and the Pacific
EVON: Everything Organic Nursery
FAO: Food and Agriculture Organization of the United Nations
FSC: Food Security Center
Ha: hectare
J-C: Jeevatu-based Compost
J-T: Jeevatu crop Treatments
Kg: kilogram (unit)
l: Liter (unit)
ml: millilitre (unit)
NBB: Nepalese Natural Bio-products Pvt. Ltd
NFI: Nepalese Farming Institute
NGO: Non-Governmental Organization
NPG: Nepal Permaculture Group
NPK: Nitrogen, phosphorus, potassium
NPR: Nepalese Rupee
R: Respondent
SAARC: South Asian Association for Regional Cooperation
SATNET Asia (SATNET): Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia
TID: Trade and Investment Division
TM: Trademark
UN: United Nations
VDC: Village Development Committee

Abstract

In the central Middle Hills zone of Nepal, demographic pressure on arable lands and agriculture intensification have degraded soil fertility (Raut, Sitaula, Aune, & Bajracharya, 2011)(Westarp, Schreier, Brown, & Shah, 2004). Moreover, the misuse of some synthetic pesticides also threatens both human health and the environment (Atreya, 2007). The Nepalese Farming Institute (NFI) has developed a multipurpose microbial inoculant named "Jeevatu" whose function is to improve the soil and plants' conditions through prophylactic and/ or curative actions. Therefore, the present study aims to assess the technical, ecological, social and economic sustainability of the technology, in particular its suitability for disadvantaged farmers and women.

Primary data has been collected by the mean of qualitative interviews of six Jeevatu adopters, seven dis-adopters and two non-adopters located in five districts of the Central Middle Hills and Terai regions. Forteen experts have also been interviewed on aspects in their field of expertise.

The technology is composed of two main technology packages: Jeevatu-based compost which aims to refine compost and Jeevatu crop treatments which are curative and preventive treatments. Both technology packages are recommended for integrated organic farming systems, preferably allowing the on-farm sourcing of some organic matters to make compost.

The efficiency of the crop treatments in different agro-ecological systems still has to be scientifically experimented on different plants because farmers had very diverse results. Nevertheless, some farmers reported that the association of preventive and curative treatments, as well as an early, repeated and long-term treatment of the infected plants or depleted soils can speed up the early growth phase of the plants, improve plant's vigor and soil holding capacity, as well as combat some diseases (e.g. Citrus greening, bottle gourd powdery mildew, tomato late blight).

In Nepal, the technology might not be suitable for disadvantaged populations who currently have no easy access to Jeevatu bottle supply as well as trainings. Moreover, in order to make Jeevatu more cost-efficient, it has to be diluted into large amounts of water and/ or cattle urine. The absence of irrigation systems and stalls to collect urine and manure from cattle might therefore be barriers to the adoption of the technology.

Moreover, although no hazards for health or the environment have been reported and risks of contamination by pathogen species of microbes are low, the product should be controlled and certified by an independent organization. Jeevatu should not be used in some fragile ecosystems or on some commercial crops (e.g. mushrooms). A rigorous follow-up of the treated lands is recommended.

Based on the results of this study, it is advised to conduct further experiments in order to draw conclusions about the sustainability of this technology.

1 Introduction

1.1 Overall context of the mission

Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia ' (SATNET Asia) is a three-year project funded by the European Union (March 2012-2015). It is founded by 6 partner organizations: UN organizations (ESCAP, CAPSA, APCTT and TID), the World Vegetable Centre – East and Southeast Asia (AVRDC ESEA) and the Food Security Center (FSC), a center of excellence in development cooperation at the University of Hohenheim, Germany.

SATNET Asia aims to facilitate engagement, learning and knowledge sharing between various stake-holders that have a stake in agricultural research innovations for development systems in South and Southeast Asia. Its overall objective is to improve food security and nutrition of the poorest and most vulnerable people in South and Southeast Asia by increasing and accelerating the rate of adoption of sustainable and productivity-enhancing agricultural technologies and by improving regional trade in food products.

SATNET Asia is being implemented through five Work Packages:

1. Establishment and coordination of the network
2. Development of a portfolio of best practices for agricultural technologies
3. Identification of options and measures for regional trade facilitation
4. Innovative knowledge sharing
5. Management and administration.

The Food Security Center (FSC) of the University of Hohenheim is the lead organization for the implementation of the Work Package 2: "Development of a portfolio of best practices for agricultural technologies".

As such, it has commissioned an independent consultant to validate "Jeevatu™[1]", one of the identified technologies which has been submitted to SATNET by Dr. Khadga Bhakta Paudel (K.B. Paudel), Director of the Nepalese Farming Institute (NFI), an NGO based in Kathmandu.

1.2 Objective of the mission

Jeevatu is the trade name of a "Mixed culture of naturally occurring beneficial micro-organisms in the form of concentrated liquid suspension" (Gautam, 2011). These microorganisms are possibly acting in a synergistic manner and are non-modified (NFI).

This microbial inoculant has been developed during the last 30 years by Dr. K.B. Paudel, a senior scientist in horticulture from Nepal.

[1] Jeevatu™ is a non-registered trademark. "Jeevatu" will be simply used in the rest of the report.

Dr. K.B. Paudel wanted to take advantage of the unique micro-biodiversity of Nepal to develop an eco-friendly phytosanitary product, accessible to poor farmers and suitable to local conditions. According to Dr. Paudel, foreign phytosanitary products available in Nepal are not efficient enough to combat some local plant diseases.

In 2003, he founded the Nepalese Farming Institute (NFI) to officially undertake the development of Jeevatu. The company affiliated to this NGO, the Nepalese Natural Bio-products Pvt. Ltd (NNB), sources some microorganisms (mostly yeast, mould and some Lactic Acid Bacteria)[2] in the natural environment and produces Jeevatu solutions.

It is believed that the microbes of Jeevatu work by i) increasing nutrient availability ii) predation and hyper parasitism (feeding on pathogens) iii) antagonism, competitive exclusion and micro-bio-stasis (competing for nutrients or space by producing metabolites that kill pathogens or inhibit their growth and movement), iv) rhizosphere competency (blocking pathogen access to roots), v) induced systemic resistance and systemic acquired resistance (stimulating or priming the plant's own natural defense system) (Adhikari, Suraj Raj, Khadga Bhakta Paudel, Kusum Pokhrel, 2013).

According to NFI, Jeevatu has the following advantages:

- Multiple use options – It is effective as a compost improver, a fertilizer (soil amendment), against soil borne diseases (soil amendment), an insecticide or fungicide (foliar application).
- Diversity of crops and agro-ecosystems – Jeevatu is suitable for vegetables, cereal crops, fruit trees and medicinal plants in diverse altitudes and climates (it has been tested in the Karanali zone, in the Northwestern part of Nepal).
- Economy - High return on investment.
- Simplicity - To be understood by any illiterate person.
- Adoptability – Non-poisonous, eco-friendly and to be adopted by any society.
- Availability – Materials required for multiplication of Jeevatu are easily available in any community.
- Diminishing use – If the use of chemicals stopped, the need of Jeevatu would decrease as the microbes continue multiplying in the farming system.

The mission aims to complement and validate the information about Jeevatu provided by NFI and to critically assess the technical, socio-economic and agro-ecological conditions in which Jeevatu is the most suitable, as well as the limits or risks inherent to its adoption. Special attention will be given to small-scale and less advantaged farmers, as well as to women.

1.3 Activities and planning

The following activities were undertaken:

- Attending of the 3-day workshop "SATNET National Training Programme on Best Practices in Integrated Nutrient Management and Jeevatu Based Cost-effective Organic Farming" in Kathmandu

[2] See the laboratory results comprising the microorganisms composition of Jeevatu in annex of this report.

- Field visits and interviews
- Desk review (see the list of References)
- Deliverable preparation

1.4 Deliverables

The present report is a mission report which aims to present the collected information ("Results") and to analyze and discuss them ("Conclusion and discussion").
Two technology fact sheets aim to briefly describe the technology packages.

The names and contact information about the respondents (adopters, dis-adopters and non-adopters) will remain anonymous.

1.5 Description of the technology

Two distinctive technology packages have been developed for agricultural purposes:

- "Jeevatu Based Value added Organic Fertilizer" which is applied in a compost heap to speed-up its fermentation. It will simply be called "Jeevatu-based compost" in the report since this expression is commonly used.
- Jeevatu treatments which are applied on the crops (on the roots or the leaves of the plants) as a fertilizer and/or a pesticide. There are 4 distinctive recommended treatments:
    - **Jeevatu Liquid Manure 1**: It is a fermented solution made of decomposed compost (25 kg), cattle urine (25 l), water (25 l) and Jeevatu (1 l). One part of Jeevatu Liquid Manure 1 can be diluted into 3 parts of water and then drenched twice a week to control plant's nutrient deficiency and various pest problems located in the root zone and under the soil (prophylactic function).
    - **Jeevatu Liquid Manure 2**: It is also a fermented solution made of cattle urine (37.5 l), water (37.5 l) and Jeevatu (1 l). It is used to prevent and treat pest problems above the ground.
      As a prophylactic treatment, 1 part of organic liquid manure should be mixed with 3 parts of water and sprayed twice a week on the plant's leaves.
      As a curative treatment, 1 part of organic liquid manure should be mixed in 1 part of water and sprayed daily until the pest problem is controlled. Then, it should be sprayed as a prophylactic treatment again.
    - **Jeevatu Direct 1**: As a prophylactic spray, 1 part of Jeevatu (0.05 l) should be mixed in 19 parts of water (0.95 l) and can be used twice a week to manage various pest problems on crops.
    - **Jeevatu Direct 2**: As a curative spray, 10% solution (9 parts of water for 1 part of Direct Jeevatu solution) can be used daily till the targeted pest is controlled.

Both packages serve the same purposes: to improve the soil and plants' conditions through prophylactic and/or curative actions. In addition, NFI provides some practical information about how to produce the different treatments which aim to be both effective in terms of results (based on some benchmark and field experiences), but also easily reproducible by the farmers in the farms' environment (NFI).

1.6 Production method of Jeevatu-based compost

Summary of the Jeevatu-based compost solution (NFI):

	Jeevatu based compost
Level of action	Compost
Function	Prophylactic
Recommended composition	Compost (100 kg) + Water (19 l) + Jeevatu (1 l)
Fermenting time	**Fermenting time**: 3 months
Dilution before use	Jeevatu solution (0.5 or 1 part) +Compost (9 parts)

According to NFI, the production of **Jeevatu-based compost** comprises three steps:

1. Make a heap of compost (100 kg)
2. Make a Jeevatu solution: mix Jeevatu (1 l) and water (19 l)
3. Apply 0.5 or 1 part of Jeevatu solution for 9 parts of compost (5-10 % of Jeevatu solution) on the heap once per month during three months. The heap should be covered with a plastic sheet.

As advised by NFI, Jeevatu-based compost can be applied on the soil before ploughing, applied in holes before transplanting seedlings or applied in circular holes around the trees or the plants. The recommended application frequency of Jeevatu-based compost is one time per crop cycle.

Uncovered compost heap, Budhanilkantha

Heap of compost protected from the sun, Chitwan

1.7 Production method of Jeevatu crop treatments

Summary of the solutions to treat crops (NFI):

	Direct Jeevatu 1	Direct Jeevatu 2	Liquid Manure 1	Liquid Manure 2	
Level of action	Leaves	Leaves	Roots/ Soil	Leaves	Leaves
Function	Prophylactic	Curative	Prophylactic	Prophylactic	Curative
Recommended composition	Water (0.95 l) + Jeevatu (0.05 l)		Water/ Urine (25 l/25 l) +Jeevatu (1 l) + Compost (25 kg)	Water/ Urine (37.5 l/37.5 l) + Jeevatu (1 l)	
Fermenting time	No fermentation needed		Fermenting time: 15 to 30 days		
Dilution before use		Direct Jeevatu (1 parts) +Water (9 parts)	Liquid Manure 1 (1 part) +Water (3 parts)	Liquid Manure 2 (1 part) +Water (3 parts)	Liquid Manure 2 (1 part) +Water (1 part)

1. Direct use of Jeevatu (unfermented Jeevatu):

The ingredients should simply be mixed in the same proportions as indicated on the Jeevatu bottles.

Direct Jeevatu solution

Jeevatu Liquid Manure 1 and 2 (fermented Jeevatu):

- Choose an open sunny place and dig a circular pit measuring 1 feet depth and 2 feet in diameter
- Smooth the pit surface with raw cattle manure to increase and balance the temperature.
- Tie a plastic sheet (3*4 feet of 500 gauge thickness) and place it into the hole. Jeevatu Liquid manures will be mixed inside the plastic “bag” and fermented during 15 to 30 days (anaerobic condition). It has to be stirred twice a week (aerobic condition). The plastic sheets to make Liquid Manures are sold together with Jeevatu by NFI or the Jeevatu retailers at a unit price of NPR 7/ unit (NFI).

Pit plastered with cow dung

Preparation and tool to turn it

Observation of the fermentation

Jeevatu Liquid Manure 1:

- Put 25 kg of decomposed compost into the “bag”, pour 1 liter of Jeevatu, 25 liters of cattle urine and 25 liters of water.
- Mix thoroughly and then tie the bag tightly.
- Twice a week, open the bag and stir the mixture thoroughly. After some green algae appear on the surface and no odors come out, the preparation is ready. It takes between 15 and 30 days depending on the temperature.

Jeevatu Liquid Manure 2:

- Put 1 liter of Jeevatu with 37.5 liters of urine and 37.5 liters of water into the bag.
- Mix thoroughly and then tie the bag tightly.
- Twice a week, open the bag and stir the mixture thoroughly. After some green algae appear on the surface and no odors come out, the preparation is ready. It takes between 15 and 30 days depending on the temperature.

Green algae appear on the surface of the bag indicating that the preparation is ready. There are no foul odors anymore.

2 Material and Methods

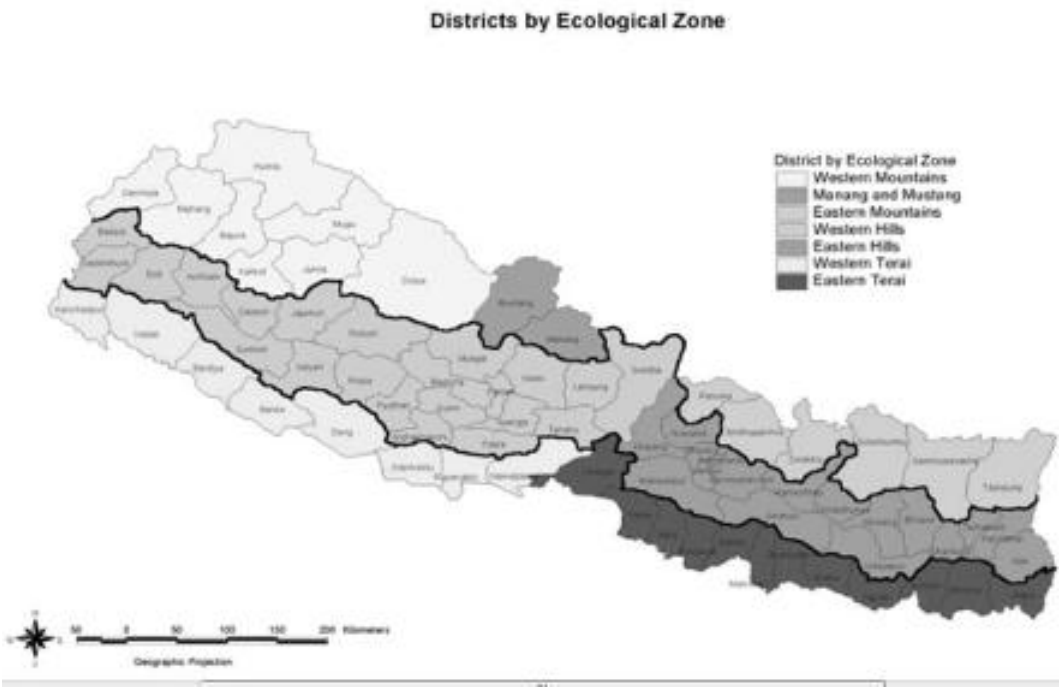
Research has been conducted through face-to-face qualitative interviews of Jeevatu adopters, dis-adopters and non-adopters in various locations of Nepal. Moreover, additional information was collected through interviews with NFI's Director and staff, as well as with diverse Nepalese and international informants considered as experts in fields related to liquid bio-fertilizers. At last, documents reviewing completed this work.

2.1 Interviews with Jeevatu users

2.1.1 Interview locations

Nepal is divided into 3 main ecological belts from North to South: the Mountains in the north, the Hills in the middle and the *Terai* in the south. Each belt also comprises a great variety of geographic, socio-economic contexts and agricultural practices (Tiwary, 2005).

Districts by ecological zone:



In the northern belt: the Western and Eastern Mountains and the Manang and Mustang in the middle; in the Middle belt: the Western and Eastern Hills; and in the southern belt, the Western and Eastern *Terai*. Source: ESAF/ FAO, 2002 (Tiwary, 2005).

Given the limited time, qualitative interviews have been conducted among 15 farmers in the central Middle Hill region of Nepal (in Kathmandu, Kavre, Kaski and Palpa districts), as well as in one farm of the *Terai* zone (Chitwan district).

Both zones grow commercialized crops, especially in the central part (UN, Nepal information platform, 2007) where the majority of the 27.8 million inhabitants of Nepal is concentrated (*World Population 2012*, 2012). Use of pesticides is also most intensive there (Jha R.K., 2008). The use of fertilizers remains very low in comparison with other Asian countries though with less than 20 kg per hectare on average in 2006-2007, which was far below the South Asian average of 115 kg/ ha and East Asian average of 278 kg/ ha ("NARC ' s Strategic Vision for Agricultural, 2011-2013," 2010). Jeevatu has mainly been disseminated in these two zones by NFI through local farmers who retail Jeevatu bottles in their neighborhood, as well as through a few agro-vet shops in the capital (NFI). Therefore, these zones are of great interest and were purposively selected for the study.

- **The Middle Hills:**

The Middle Hills zone is located between 800 and 1,800 m alt. Only 20% of this zone is cultivated but it represents 42% of the country's agricultural land area. Maize is the most important single crop and livestock keeping is an integral part of farming. But according to the Food and Agriculture Organization of the United Nations (FAO), the Hill and Mountain regions are particularly food deficit and more vulnerable to drought.

The majority of the population lives in Kathmandu, Pokhara and Surket valleys. ("NARC ' s Strategic Vision for Agricultural, 2011-2013," 2010)

- Budhanilkantha, Kathmandu district (3 respondents). This Village Development Committee (VDC) is only 10 km in the North of Kathmandu (1400m alt.). It belongs to the Bagmati Zone of central Nepal. The interviews took place in an area where around 50 vacant flat lands are individually or collectively rent. The interviewed people practice agriculture as a secondary activity and employed staff to grow cash crops (mostly tomatoes and other vegetables). The soil was sandy and lignite if not properly nourished. Access to Kathmandu is very easy.

- Sarada Batase, Kavre district (2 respondents). This VDC is 30km from Kathmandu. It is a temperate hilly region (1500m alt.) which belongs to the Bagmati Zone. There are some terraces and pine forests on the slopes. The soil is sandy and lignite. Agriculture and animal husbandry represents the only source of income of the families. Animal grazing was a common practice. Additionally, one respondent who is developing eco-tourism in Dhuplikhel and also knew Jeevatu but never used it on his crops answered a few questions.

- Pokhara, Kaski district (3 respondents). The respondent's area belongs to the Gandaki zone with Pokhara as capital. It is a plateau in altitude (1300m alt.). It is the rainiest place of Nepal but farmers still face water shortages problems during 3 months of the year (R1 in Pokhara). The soil has a rather good

texture (clay-slit). Agriculture is the only source of income of the respondents. Tourism is also quite developed in the city of Pokhara and there are good road connections.

- Mujhung Dashdole, Palpa district (3 respondents). It is located in a mountainous region (1200m alt.) which belongs to the Lumbini zone. It has a sloppy topography and a sandy and red soil. Agriculture is the only source of income of the majority of the population. Road access to larger cities is difficult.

- **The *Terai*:**

The *terai* represents 23% of the total agricultural area of Nepal. It is located between 60 and 800 m alt. So its climate varies between subtropical and alpine. 41% of its area is cultivated.
It is considered as the "granary of Nepal". The clay and silt soils in this region are the most fertile of Nepal. Most of the *Terai* can be irrigated (56% is irrigated) and crops can be cultivated throughout the year. These conditions permit the cultivation of a large variety of crops such as wheat, rice, vegetables, jute and sugarcane. The city of Chitwan offers a variety of economic activities and easy access to workplaces in India.

- Chitwan district (2 respondents of 1 farm: R1 in Chitwan). The interviewed respondents share an agricultural land which is located on a fertile alluvial plain in the suburb of the Chitwan city (80m alt., lower tropical zone). Additionally, an organic farming trainer from the Nepalese Permaculture Group (NPG) NGO has also been interviewed (NPG in Chitwan).

Locations of the visited farms:

A: Budhanilkantha, B: Pokhara, C: Palpa, D: Chitwan, E: Kavre

- **The Mountains:**

Although no visit could be organized in these regions, some NGO experts answered some questions about the situation of the farmers in this ecological belt[3]. It comprises very remote communities of populations, often minorities, who have the lowest living standards and the highest rates of food insecurity of the country (Tiwary, 2005). Therefore, it is interesting to have their opinion on the suitability of Jeevatu for these populations.

This zone is above 1800 m alt. (7.6% of the population) and culminates on the roof of the world, the Mount Everest (8848 m). Climate is harsh with cool summers, severe winters as well as low levels of precipitations which mostly takes the form of snow. The steepness of the lands, the lack of road access and basic infrastructures, as well as vulnerability towards climate change (Oxfam, 2009) are additional constrains.

Only 5% of the land is cultivable, which accounts for 23% of the total cultivated land area of Nepal. 47% of the Households have less than 0.5 ha while 0.64 ha would be necessary to become self-sufficient for their food (UNOCHA, 2008). Agricultural activities mostly comprise animal raising (yak, sheep) and cultivation is limited to one crop per year or three crops in two years. Vegetables are cultivated as cash crops in a few areas with access to market.

2.1.2 Interviewees' selection

Qualitative interviews were conducted among 15 respondents in the 5 visited locations. In each location, the "Jeevatu retailers" who are either adopters or dis-adopters of the technology introduced one or two Jeevatu dis-adopters and non-adopters in their neighborhood. "Adopters" were using Jeevatu for at least one technology package, "dis-adopters" had completely stopped using it and "non-adopters" had heard about Jeevatu but decided not to use it in agriculture.

Number of interviews for each technology package:

	Adopters	Dis-adopters	Non-adopters	Total
Jeevatu-based compost	6	4		10
Jeevatu crop treatments	7	5		12
			2	2
Total	13	9	2	

Most of the adopters use both packages (9 persons), while only one uses it solely for Jeevatu-based compost (R3 in Budhanilkantha) and one uses it solely for crop treatments (R3 in Pokhara).

Among the two non-adopters, one uses Jeevatu for other purposes than in agriculture (R3 in Kavre) and one knows Jeevatu but hasn't used it yet (R3 in Palpa).

[3] The following persons were briefly interviewed: Dr. Kavya Dashora, senior scientist at CABI who trains marginalized populations about integrated farming practices, Mr. Shrikrishna Upadhyay, Executive chairman of SAPPROS whose organization is implementing various development activities in favor of marginalized communities and is testing Jeevatu and at least, Mr. Jim Danish (EVON in Kavre), Organic Farming trainer at Everything Organic Nursery (EVON) who has recently stopped promoting Jeevatu.

Motivations to interview the adopters (green), dis-adopters (orange) and non-adopters (grey) in the visited locations:

		Type of usage	
Locations	**Preliminary information that have motivated the interviews. Green: adopter, Orange: Dis-adopter, Grey: Non-adopter.**	**Jeevatu-based compost**	**Jeevatu on crops**
Kathmandu (Budhanikantha)	R1: Farmer in a cooperative (6 workers) / **Jeevatu retailer**. R1: Farmer in a cooperative / Jeevatu retailer. This ex-Jeevatu retailer attended the SATNET workshop and raised some concerns about the lack of guarantee concerning the efficacy of the Jeevatu product.	X	X
	R2: Individual farmer. This farmer faced some problems of nematodes on tomatoes. Introduced by R1.	X	X
	R3: Farmer in a women cooperative This cooperative uses Jeevatu-based compost only and is very sucessful.	X	
Kavre	R1: Family farm / **Jeevatu retailer.** Introduced by NFI. This farm located in Sarada Batase was visited by the persons who attended the SATNET Workshop.	X	X
	R2: Family farm. Introduced by R1 in Sarada Batase, this farmer has stopped using Jeevatu despite his		X
	R3: Individual farmer (part-time). This young entrepreneur is interested in experiments about Jeevatu. He never used it on crops or compost yet though, only for other usages (against flies and odors).		
	R4 (expert): Mr. J. Danisch is an organic farming trainer in Patlekhet at Everything Organic Nursery (EVON). He is interested in promoting integrated farming among disadvantaged groups, but stopped promoting Jeevatu.	X	X
Kaski (Pokhara)	R1 (expert): Family farm / **Jeevatu retailer** Mr. Suraj Raj Adhikari is a plant Scientist who did his master thesis about Jeevatu-treated rice.	X	X
	R2: Family farm. Introduced by R1. This farmer failed to cure some diseases, so he stopped using Jeevatu.		X
	R3: Family farm Introduced by R1. This farmer is very successful using Jeevatu on vegetables, but he decided not to treat his citurs trees as originally planned.		X
Palpa	R1: Farmer (family farm) / **Jeevatu retailer**. Introduced by NFI.	X	X
	R2: Farmer (Family farm). Introduced by R1.	X	X
	R3: Non-adopter (Family farm). Introduced by R1.		
Chitwan	R1: One man and one women who are representative of a women cooperative (50 members) and promote Jeevatu.	X	X
	R2 (expert): Mr. Rishi Ram Adhikari is an organic farming trainer at Nepal Permaculture Group (NPG). He promotes Jeevatu for some usages only.	X	X
	Total:	10	12

Several types of organizations and persons have been interviewed for specific reasons:

Family farms: the majority of interviewees (8) were family farms since they are representative of the majority of farmers who use Jeevatu.

Farmer cooperatives: this organizational model is specific and therefore interesting to visit. It was farmers who sometimes shared the same piece of land and also shared some resources or even redistributed the profit of their farm to the members in need in the cooperative (R1 in Chitwan). Two representative persons of women cooperatives have been interviewed since a majority of their members were women (R3 in Budhanilkantha and R1 in Chitwan).

Jeevatu retailers: the majority uses Jeevatu since a long time (6-7 years) since they were first approached by NFI. They also might receive some direct feedback from other users in the community where they sell Jeevatu. They have some interest in promoting Jeevatu, so their reply might be biased.

Experts: 3 "experts" who have used Jeevatu have been consulted. Two of them are organic farming trainers (one adopter and one dis-adopter); they haven't been introduced by NFI: Mr. Rishi Adhikari from NPG (NPG in Chitwan) and Mr. Jim Danish from EVON (EVON in Kavre). One of them is a Plant scientist, Mr. Suraj Adhikari (R1 in Pokhara) who did some experiments about Jeevatu as part of his Master thesis. He also introduced some successful experiences during the SATNET workshop in Kathmandu and is also a Jeevatu retailers.

	Adopter	Dis-adopter	Non-adopter	Total
Cooperatives:	R1 in Chitwan R3 in Budhanilkantha	R1 in Budhanilkantha		3
Family farms:	R1 in Kavre R1 in Pokhara R3 in Pokhara R1 in Palpa	R2 in Kavre R2 in Pokhara R2 in Palpa	R3 in Palpa	8
Jeevatu retailers:	R1 in Pokhara R1 in Palpa R1 in Kavre	R1 in Budhanilkantha		4
Experts:	R1 in Pokhara R2 in Chitwan	R4 in Kavre		3

2.2 Choice of experts

A few persons who had taken part in the workshop "SATNET National Training Programme on Best Practices in Integrated Nutrient Management and Jeevatu Based Cost-effective Organic Farming" or who were found during the field mission have also been interviewed about their field of expertise.

Qualitative interviews were conducted among 14 experts:

- 4 **microbiologists** from NFI, Kathmandu University and RKMV University (Kolkata, India) and Hohenheim University: They can provide some expert's opinion about the working principles of Jeevatu, its manufacturing process and the risks associated with the use of Jeevatu. They can also provide some recommendations in terms of Research protocol and sharing of scientific information.
- 5 **soil, plant and agricultural scientists**: They can provide some information regarding plant and soil problems, as well as agricultural practices.
- 5 **NGO representatives** (3 are integrated farming trainers having experience in Nepal): They can provide some reliable feedback from the field regarding the application and the efficacy of Jeevatu according to various types of usage under various circumstances.

3 Results

3.1 Technical assessment

The technical assessment aims to assess the level of suitability of the technology based on the necessary knowledge, know-how and resources that the Jeevatu technology packages require. It also aims to assess the effects of the two technology packages from the farmers' point of view.

3.1.1 Prerequisites to the adoption of Jeevatu

There are some common prerequisites to the adoption of the two technology packages such as the adoption of an appropriate farming system, having some knowledge about which purposes Jeevatu can serve and what are its advantages or disadvantages.
Adopters, dis-adopters and non-adopters of Jeevatu technology packages were therefore questioned about their agricultural practices, their motivation to buy Jeevatu and to use one or several treatments, the circumstances in which they had adopted it (adoption pathways), the possible disadvantages of this product and the reasons why they stopped using it or never used it.

- **Both technology packages**

The farming system:
NFI doesn't recommend the use of chemicals inputs together with Jeevatu since it would suppress its efficacy. The first condition to adopt any of the technology packages is therefore to completely abandon the use of mineral fertilizers and synthetic pesticides and to adopt an organic farming system.
The use of some organic matters in association with Jeevatu is also encouraged, as well as the combination of two or more Jeevatu treatments (see "1.2 Technical knowledge and know-how").

Most of the Jeevatu-based compost users were already practicing organic farming before adopting Jeevatu. Some were already using other manufactured organic products such as EM® (EVON in Kavre) and Green Planet NPK amendments (R3 in Budhanilkantha).
Most of the **adopters** had already attended an integrated farming course (R1 in Chitwan, R2 in Budhanilkantha), were involved in an organic farming community (R1 in Palpa, R1 in Chitwan) or were organic farming trainers (NPG in Chitwan).
Dis-adopters were either new organic farmers (R1 and R2 in Budhanilkantha) or experienced organic trainers (EVON in Kavre). R1 in Budhanilkantha had just started organic farming with Jeevatu and then other manufactured organic products and R2 in Budhanilkantha only started to grow organic vegetables when he adopted Jeevatu on a virgin land.
Only one of the two **non-adopters** had already some experience and knowledge about Effective Microorganisms (he developed a treatment with EM), but he had only grown organic vegetables since a few months (R3 in Kavre). The other non-adopter, had always practiced organic farming to grow citrus trees (R3 in Palpa).

Some remote population of farmers and some NGOs have never heard about Jeevatu (Dr. Kavya Dashora, CABI). According to NFI, information is spreading gradually in the country but it hasn't reached every places yet, especially in the high mountain ecological zone.

The farms of the respondents were very diverse in terms of integrated farming strategies (crop rotation, mulching, elevated plant-bed, insects traps, greenhouses, etc.).
All the interviewees had previously made some compost even before adopting Jeevatu. They applied it during land preparation, either in association with chemical pesticides and fertilizers (R1, R2, R3 in Pokhara) or with other organic products (EVON in Kavre, NPG in Chitwan) or self-made treatments (R3 in Budhanilkantha, R1 in Chitwan). Only one dis-adopter had no experience yet and bought it from nearby farms (R2 in Budhanilkanha). One adopter was already used to refine his compost (R3 in Budhanilkantha).

For both technology packages, users must also know some basic information about Jeevatu such as its storage conditions and lifespan so that the product remains efficient:

The storage conditions of Jeevatu bottles:
NFI recommends to store the Jeevatu bottles in a temperate place (0-40C). It was not often possible to verify if the respondents had followed this recommendation since most of them had no Jeevatu stock left. Some of them answered that they knew about it and stored it in an appropriate place (R1 in Palpa).

The expiry date:
The expiry date normally indicated on the bottles is only one year when stored in proper conditions. The respondents had never kept bottles for a longer period than one year.
Some respondents complained about the lack of expiry date on the bottles (R1 in Budhanilkantha).

Although it has not been mentioned as a problem, the label of the bottles wasn't written in local language, but in English.

Some remote population of farmers and some NGOs have never heard about Jeevatu (Dr. Kavya Dashora, CABI).

- **Jeevatu-based compost:**

Jeevatu-based compost adopters, dis-adopters and non-adopters were questioned about their motivation to buy Jeevatu, the pathway of adoption and what they believed were the advantages and dis-advantages of this technology in comparison with other technologies or similar products.

- **Adopters:**

Jeevatu practices and background of Jeevatu-based compost adopters:

Only one of the interviewed farmers was using Jeevatu for the sole purpose of refining his compost since 1.5 years (R3 in Budhanilkantha). The other Jeevatu adopters who adopted Jeevatu-based compost, had also adopted Jeevatu to treat his crops.

Adopters were located in the Middle Hills and *Terai* regions. They were small-scale farmers (1 to 4ha) and were either operating a family farm (R1, R2 in Palpa, R1 in Pokhara), an organic farming trainer (R2 in Chitwan) or farmers of a cooperative which was composed of a majority of women (R3 in Budhanilkantha and R1 in Chitwan). In the families, it was always the men who responded since they had decided about the use of Jeevatu and had been informed or trained about Jeevatu. In two of the three cooperatives, women answered the questions alone (R3 in Budhanilkantha) and with a man (R1 in Chitwan).

Information sources:

The adopters had been in touch with NFI members directly (R1 in Pokhara, R1 in Palpa, R1 in Kavre) or had heard about it through a friend or neighbor (R3 in Budhanilkantha, R2 in Pokhara).

Motivations to use Jeevatu-based compost:

Respondents were expecting that Jeevatu-based compost improves the plant's protection and growth (all the adopters), accelerate compost fermenting time (all the adopters) or decrease the quantity of necessary compost (NPG in Chitwan; R1 in Chitwan). No respondent expected Jeevatu to eliminate pathogens and control diseases through the use of the Jeevatu based compost. No respondent wanted to use Jeevatu-based compost to suppress odors.

Two adopters wanted to use Jeevatu as an alternative to the organic manufactured product they were using (R3 in Budhanilkantha; EVON in Kavre).

- "1.5 year ago, I attended the same Jeevatu course as the local retailer and heard about the success of some friends using it, so we decided to use Jeevatu instead of Green Planet (NPK soil amendment). We had also attended a course on Integrated Pest Management (IPM) and other integrated farming practices. We haven't been using it in 2014 but we will." (R3 in Budhanilkantha)

- **Dis-adopters:**

Agricultural practices and background:

Among the 10 persons having experience with Jeevatu-based compost, there were only 3 dis-adopters. Two of them practiced agriculture only as a part-time activity in a farmer cooperative (R1 in Budhanilkantha) or for a catering business (R2 in Budhanilkantha). The other one was an experienced organic farming trainer having used Jeevatu for 3 years (EVON in Kavre).

Information sources: The respondent had heard about Jeevatu from a friend or a neighbor, generally the local retailer (R2 in Budhanilkantha).

Reasons for adopting Jeevatu:

Some dis-adopters had been looking for a product similar to EM® but had actually not tried EM products before (R1 and R2 in Budhanilkantha).

- "We were looking for a similar product as EM® which is a foreign multi-functional product that can be mixed with water and organic manure like Jeevatu. EM® was hard to find, so we wanted a local solution which is fast and organic." (R1 in Budhanilkantha)
- "I wanted to start growing organic tomatoes for my catering business on a virgin land. My friend who attended a course about Jeevatu advised me to use it. I also wanted to try out a locally manufactured organic product. I had attended a 3-day training by the Vegetable Development Center of Kumiltar. It encouraged me to grow organic since its good for people and for the environment" (R2 in Budhanilkantha)
- "We wanted to compare the use of EM® and Jeevatu products for crop treatments and occasionally used it to refine compost. The two products have the same functions and modes of application." (EVON in Kavre).

Reasons for dis-adopting Jeevatu-based compost:

The main sources of dissatisfaction were some mistrust about the Jeevatu product itself, as well as the lack of efficiency or benefits of the association of Jeevatu-based compost and Jeevatu crop treatments. The other reason was the inconvenience of finding Jeevatu supplies.

- Lack of effectiveness of the association of Jeevatu-based compost and Jeevatu crop treatments to control diseases or improve yield and plant growth:
  - "My neighbor used Jeevatu to refine compost and as a spray to cure nematodes on tomatoes, but it failed to control the disease. He wonders if he will start using chemicals inputs again or not." (R1 in Budhanilkantha)
  - "The effects on crops are slow, that's why we don't know if Jeevatu is efficient or not. We have heard that Jeevatu is good for two or three functions such as compost improvement." "I now use other organic products such as Power Plant for land preparation and Green Planet to help seeds germinate."(R1, Budhanilkantha)
  - "We have used Jeevatu-based compost a few times combined with Jeevatu crop treatments and decided that there were no advantage of using Jeevatu. We now prefer promoting practices which consist of using locally available resources such as plants since we promote practices that are suitable for the most disadvantaged populations." (EVON in Kavre).

- Difficulties to have sufficient supply of Jeevatu:
  - "Before Jeevatu wasn't so often available. So because of the lack of availability, some farmers stopped using it." (R1, Budhanilkantha)
  - "Jeevatu is already hard to find in cities near Kathmandu, so it would be impossible for farmers in more remote areas to get enough supply." (EVON in Kavre)

- Lack of information and guarantee about the product:
  - "They were no expiry date on the product" (R1, Budhanilkantha)

- "If the product is not good, we have no guarantee from the company that they will compensate us." (R1, Budhanilkantha)
- Lack of information about the microbial content of the Jeevatu bottles (EVON, Kavre)

➢ **Non-adopters of Jeevatu-based compost:**

Agricultural practices and background:

Non-adopters were farmers who used normal compost as a soil fertilizer (1 non-adopter of Jeevatu and adopters of Jeevatu crop treatments). R3 in Palpa had heard about Jeevatu through a neighbor (the local retailer). R3 in Kavre used Jeevatu for other purposes than agriculture (repel flies or disinfect the toilets) and had heard about Jeevatu through EVON training center in Kavre district.

Motivation to refuse using it:

The reasons were that the non-adopter was already satisfied with the use of Jeevatu crop treatments alone (R3 in Pokhara), he judged the soil good enough (R2 in Kavre, R3 in Palpa), he continued using chemical fertilizers which is not compatible with Jeevatu after another Jeevatu treatment failed and thus he was not able to start with Jeevatu-based compost (R2 in Pokhara).

Jeevatu crop treatments

➢ **Adopters:**

Agricultural practices and background:

Alike Jeevatu-based compost adopters, typical adopters of Jeevatu treatments on crops are small-scale farmers (1 to 4 ha). Adopters of Jeevatu crop treatments are located in all the visited locations except in Budhanilkantha.

Four adopters decided to stop using mineral fertilizers and synthetic pesticides and to start organic farming after Jeevatu was introduced to them (R in Palpa, R1 in Kavre, R1, R3 in Pokhara). The others had already started immediately with organic farming (R2 in Palpa, R1 in Chitwan, NPG in Chitwan).

Jeevatu was therefore an additional solution to combat pests, prevent and/or cure some diseases. Some of them had attended organic farming training workshops (R1 in Kavre, R1 in Chitwan) or were organic farming trainers (NPG in Chitwan, EVON in Kavre).

Information sources:

Interviewees had heard about Jeevatu through:

- NFI's staff (3 respondents heard about Jeevatu 6 or 7 years ago through NFI staff)
- Introduction by a neighbor who was successful (many users)
- Trainings about organic farming. For instance, Jeevatu is still promoted by NPG.
- Farmer cooperatives. For instance, the women cooperative of Chitwan organizes mandatory meetings once a month to share experiences between the 50 cooperative members.

Level of knowledge about the technology package:

Interviews among adopters and non-adopters showed a partial knowledge of the possibilities and sometimes some confusion between them. Behind the terms "Jeevatu Liquid Manure 1", the respondents sometimes meant Direct Jeevatu 1 (R1 and R2 in Budhanilkantha, R1 in Kavre). Some users of "Jeevatu Liquid 1" and "Jeevatu Liquid Manure 2" didn't know about Direct Jeevatu 1 and Direct Jeevatu 2 (e.g. EVON in Kavre).

According to NFI liquid manure-2 alone can manage the entire pest problems (insect pests, diseases and nutrient deficiencies) of any cropping pattern. This was known by only one interviewee (R3 in Pokhara).

Some information written on the bottles were unknown by some respondents, such as: "adding half urine and half water increases the curative effect of Direct Jeevatu 2".

Reasons for adopting Jeevatu treatments:

- **To use Jeevatu for some of its expected functions:**
  - **Treat a disease or control pest problem:**

Several interviewed people wanted to use Jeevatu to treat trees of the family of citrus (R1 in Kavre, R1 in Palpa and R1 in Pokhara) which were infected by citrus greening (R1 in Pokhara).

One non-adopter of Jeevatu treatments also wishes to use it after he observed that some orange trees are drying out. (R3 in Palpa)

One adopter wished to use it to prevent insects instead of using chemicals (R3 in Pokhara)

  - **Have multiple functions: treat diseases and improve plant's growth** (R1 in Budhanilkantha, R1 in Pokhara, R1 in Chitwan)

- **To find a cheaper alternative to currently used manufactured products:**
  - **Alternatives to the Japanese brand EM®**
    - "In comparison with EM®, Jeevatu can be used for more things and it is 3 times less expensive than EM®." (R1 in Palpa)
    - "I wanted to support a locally-made product." (R2 in Budhanilkantha)
    - "I wanted an equivalent to EM®." (R1 in Budhanilkantha)
  - **Alternative to synthetic pesticides** (R3 in Pokhara)
    - "Jeevatu is much cheaper than chemicals. It can be diluted into water and used longer. (R1 in Chitwan)"

- **To find an alternative to traditional practices:**
    - "I find it convenient because there is no need to find the different plants originally used to make traditional organic pesticides. It saves time (1 to 2 days to collect the ingredients and 2 to 3 days to make the traditional treatment). Furthermore, these plants are becoming difficult to source because of the growing urbanization. These plants are: neem, bocaino, marigold. This was diluted into water (5 to 25 L of water depending on the size of the plant). But the treatment was a bit too strong!" (R1 in Chitwan)

Advantages of using Jeevatu crop treatment:

- **It is healthier than chemicals and good for the environment:**
  - It is good for health and for the environment. Once can even drink it.(R1 in Palpa)
  - It is organic and has positive effects on the environment. (R1 in Pokhara)
  - Although it takes more time than using synthetic pesticides, Jeevatu maintains a healthy environment. (R1 in Chitwan)
  - Non-chemical vegetables can't be eaten immediately (they have to wait 19 days), but with Jeevatu there is no problem. The only problem is that the feeding for animals is still inorganic, so there might be some residues in the manure and in the soil. (R1 in Chitwan)
  - It is also good for the consumers (organic). –NPG in Chitwan

- **The bottles of Jeevatu are cheaper than other available products:**
  - Jeevatu is much cheaper than chemical inputs. It can be diluted into water and used longer. (R1 in Chitwan)
  - It is 3 times less expensive than EM®. (R1 in Palpa)
  - I don't know any other bio-product that can be applied in the same quantity as Jeevatu. It is quite cost-effective. (NPG in Chitwan)

➢ **Dis-adopters:**

Agricultural practices and background:

Dis-adopters were new organic farmers (R1, R2 in Budhanilkantha, R2 in Pokhara) and one was an organic farming trainer (EVON in Kavre). Jeevatu used to be the panacea at EVON (R3 in Kavre); it was used and promoted during 3 years.

Adoption pathways:

Dis-adopters had heard about Jeevatu through NFI's staff (R1 in Budhanilkantha), through a neighbor (R2 in Budhanilkantha and Pokhara).

Reasons for dis-adopting Jeevatu treatments:

- Some people abandoned using Jeevatu after it failed to control some diseases:
  - "We were told that Jeevatu is not suitable with chemical products, so since Jeevatu failed to treat our crops, we used synthetic pesticides and chemical fertilizers again and stopped using Jeevatu." (R2 in Pokhara)
  - "I had a batch of tomatoes seedling that was infected by nematode. The product couldn't cure it after I transplanted it, so I was then forced to let the land fallow during 2 crop cycles. I don't know whether I will use Jeevatu again or not." (Jeevatu 2 applied once a week: 19 l of water + 1 l of Jeevatu) – R2 in Budhanilkantha
  - "We have tried Liquid Manure 1 (15 kg of cow dung, 25 l of water, 0.5 l of Jeevatu) and Liquid Manure 2 (30 l of cow urine, 30 l of water, 1 l of Jeevatu) for one year. But Jeevatu couldn't combat some kinds of fungi on the sponge gourds, so we stopped using it and use synthetic chemicals again." (R2 in Pokhara)
- **Inconvenient to transport**: Some people abandoned the use of Jeevatu (Liquid Manure) on their crops because their field was too distant from the farm (R2 in Kavre) or because of the

steepness of the field (R3 in Pokhara).

- **Water shortage:** Jeevatu-based compost, Liquid Manure 1 and 2, as well as Direct Jeevatu comprise some water. Although water can be partly or fully replaced by urine in certain cases (Liquid Manure 1 and 2), water shortage was another important reason of temporarily abandon of Jeevatu during the winter season in Pokhara (R1, R2, R3 in Pokhara). According to Respondent 1 in Kavre, water shortage is also the main problem for 50 % of the farmers in his area which counts around 200 farmers. Although some users owned 2 to 4 cattles, it couldn't totally meet their needs.
- **Other methods than Jeevatu were sometimes preferred**: For instance, R1 in Budhanilkantha uses other commercial biopesticides and soil germination products which are better trusted. EVON training center has abandoned the use of both EM® and Jeevatu for a self-made treatment made of local plants, cow dung, cow urine and ash ("Gitimal") which is more efficient and less costly.

➢ **Non-adopters:**

Agricultural practices and background:

Non-adopters are both well educated people of the middle class.

R3 in Palpa uses organic treatments (compost and copper) and never experienced any disease on his oranges. He practices organic farming because he finds it healthier (the crops are consumed by his family members only). He heard about Jeevatu from his neighbor, R1 in Palpa.

R3 in Kavre is a new organic farmer who has just started some agricultural activities as a business and to support the development of local communities. He learnt about Jeevatu at EVON training center.

Reasons for non-adopting Jeevatu:

The non-adopters were satisfied with their current organic practices:

- R3 in Palpa never saw the need of using Jeevatu. Since he has just observed that one tree has become yellowish, he wishes to try Jeevatu out to treat it.
- R3 in Kavre uses natural means and experienced huge yields of onions. He is interesting in using Effective Micro-organisms products which he believes could be an interesting and cost-effective alternative to mineral fertilizers and synthetic pesticides. He wishes that this kind of product become more transparent and accessible to a larger public.

3.1.2 Technical knowledge and know-how

We will assess the suitability of the Jeevatu technology packages in terms of production and application methods. Do farmers have the necessary skills, knowledge and resources to make and apply Jeevatu properly? What are the possible barriers or inconveniences? What are the advantages as compared with other technology packages?

Jeevatu-based compost

Most of the interviewees had followed the recommendations; however, particular methods of production have also been reported. No respondent found that the production of Jeevatu

solution was hard or not convenient. But they recognized that it was less convenient than the use of mineral fertilizers (R1 in Budhanilkantha, R1 in Palpa).

Reported alternative methods of production included:

- **A different composition of Jeevatu solution**.
  - R3 in Budhanilkantha used half less water as requested which increases the concentration level.
  - R1 in Palpa produces Jeevatu-based compost as follow: cow dung is added to fermented Liquid Manure 2 (19 l of water and 1 l of Jeevatu or 19 l of water and filtered Liquid Manure 1 when there is no Liquid manure 2 anymore). The compost is made of buffalo and ox dung, grass, left over of animal feed, neem leaves that are used as a bed for cattle because of their bitter taste.

- **A different fermentation duration**
  - Jeevatu-based compost is covered and fermented during 3 to 4 months with regular mixing (R2 in Palpa)
  - It is covered and fermented during 3 to 6 months with regular mixing. (R1 in Palpa)

- **Different compositions of the compost** with generally more manure than vegetal matters and sometimes the inclusion of beneficial green manure (R1 in Palpa, R3 in Budhanilkantha).
- **Different level of humidity** due to uncovered compost heaps (R1 in Budhanilkantha) or on the contrary a good location of the heap (R1 in Chitwan located the heap under the shadow of a tree to keep enough water content).

➢ **Application modes:**

Jeevatu-based compost adopters have also reported the following techniques:

- When ploughing the soil before sowing or transplanting, Jeevatu-based compost was applied in furrows between the crop rows. As compared with the application in circular holes, this was more difficult to manage (R3, Budhanilkantha).
- Seeds can also be first sown in the Jeevatu-based compost heap before ploughing (R1, Chitwan)

Frequency of application:

The recommended application frequency of Jeevatu-based compost is one time per crop cycle. No respondent found it difficult to apply Jeevatu as compared with their previous practices. All the adopters used it at this frequency and continued using it irrespective of the actual soil quality. Only one respondent observed his soil and stopped the yearly compost application after the soil had improved (R2 in Kavre).

Jeevatu crop treatments

Differences between NFI's recommendations and practices:

Only a few interviewees followed the exact recommendations of NFI (R1 in Pokhara, R2 and R3 in Kavre, R2 in Chitwan). The others adapted different aspects:

- **Different compost compositions:**
  - "The compost I use to make Liquid Manure 1 is made of fermented cow dung, straw, orange leaves, kitchen wastes and other organic products such as pine needles. It is turned once a week." (R1 in Kavre)
  - "The compost is made of buffalo and ox dung, grass, left over of animal feed and neem leaves that are used as a bed for cattle because of their bitter taste." (R1 in Palpa)
  - "One tip to succeed is to maintain a good level of moisture and balanced nutrients in the compost." (R1 in Pokhara)

- **Different Jeevatu solution compositions:**
  - As an insecticide, 10 l of water and 10 l of Jeevatu (Direct Jeevatu 2) is sprayed to control the blackening of the stems in tomatoes. (R1 in Kavre) – instead of 1 part Jeevatu and 9 parts water.
  - Liquid manure 1 is made of 0.5 l of Jeevatu, 15 kg of cow dung, and 25 l of water (never urine), Liquid Manure 2 is made of 30 l of cow urine, 30 l of water and 1 l of Jeevatu. (R2 in Pokhara)
  - Liquid manure 1 was made with the quantities of Liquid manure 2: 37.5 l of water, 37.5 l of Urine, 1 l of Jeevatu and already fermented compost. It is done in a closed plastic bag. Liquid manure 2 is made of: water (19 l), Jeevatu (1 l) , OR filtered Liquid Manure 1 (R1 in Palpa)
  - A direct Jeevatu 2 curative treatment is made with the quantities of Jeevatu-based compost (19 l of water, 1 l of Jeevatu) (R1 in Chitwan).

- **Different doses of water or urine to dilute the Jeevatu solution:**
  - In order to make some savings, I multiply Liquid Manure 2 (37.5 l of water, 37 l of cow urine and 1 l of Jeevatu) by adding 3 l of water before drenching on the roots. (R1 in Kavre)
  - Liquid Manure 2 was applied with 5 l of water to repell insects on onions and bamboo.
  - Liquid Manure 2 is made of 5 l urine, 10 l water and 1 l Jeevatu. (R3 in Pokhara)
  - Liquid Manure 1 is diluted in 4 l of water each time we use it. (R1 in Chitwan)

- **Reuse of remaining treatments:**

Some pragmatic considerations such as the remaining of some treatments have sometimes guided the adoption of a treatment: the remaining of Liquid Manure 1 is filtered and used to produce Jeevatu Liquid Manure 2 when there are no more Jeevatu bottles available (R1 in Palpa); the same mixture as to refine compost and prepare the soil before transplanting (19 l of water and 1 l of Jeevatu) is used to treat the crops (R2 in Budhanilkantha).

Opinion about the level of difficulty to produce Direct Jeevatu:

The adopters of this treatment found no difficulty to produce Jeevatu (R1 and R2 in Budhanilkantha, one associate of R1 in Budhanilkantha, R1 in Kavre).

Opinion about the level of difficulty to produce Jeevatu Liquid Manure:

- **Positive opinions:**
  - "It is not so hard to use. It only takes some time at the beginning." (R2 in Chitwan)
  - "I find it convenient because there is no need to find the different plants originally used to make traditional organic pesticides. It saves time (1 to 2 days to collect the ingredients and 2 to 3 days to make it). Furthermore, these plants are becoming difficult to source because of the growing urbanization. These plants are: neem, bocaino and marigold. This was diluted into water (5 to 25 l of water depending on the size of the plant). But the treatment was a bit too strong!" (R1 in Chitwan)

- **Negative opinions:**

Some respondents found Jeevatu Liquid Manure a little bit difficult to produce:

- "Making Jeevatu in a pit is hard work." (R2 in Palpa)
- "It is not so hard to make Jeevatu, but this is true that farmers don't want to work hard. 2 to 3 hours are necessary to make one set of Liquid Manure." (R2 in Chitwan)
- "It is a little bit hard to make: you have to dig a hole and to collect all the ingredients (urine, dung), but this is mostly hard the first time." (R1 in Chitwan)

Many batches should be produced for large areas and repeated treatments:

- "Jeevatu shouldn't suit large farms since many batches are needed to treat the lands, which can be costly." (NPG in Chitwan)

One expert at an organic farming training center (R3 in Kavre) found the production of Liquid Manure not very user-friendly:

- "We couldn't get our staff to do Jeevatu Liquid Manure regularly. It is too tempting to just open another bottle."
- "Our neighbor uses a home-made solution, Gitimal, which is much easier to use. He keeps a small drum of it going. Each week, after using it for spraying, he adds more water and whatever appropriate plants that need to be weeded. This is easy, and something that an average farmer would be willing to do. With Jeevatu, after it is mixed in the pit, it has to sit for a month, so somebody has to keep track of that and in our context, a month gets lost. With Gitimal, it is renewed every week after spraying and simply added to. That's much more user friendly." (R3 in Kavre)

- **Application modes:**

NFI recommends the following application modes:

Direct Jeevatu 1:

- As a prophylactic product to manage various pest problems on crops, spray the direct Jeevatu solution twice a week on the leaves of the plants.

Direct Jeevatu 2:

- As curative spray, 1 part of the solution with 9 parts of water can be sprayed daily till the targeted pest is controlled.

Jeevatu Liquid Manure 1:

- As a prophylactic product, 1 part of Liquid Manure 1 can be diluted into 3 parts of water and drenched twice a week on the roots of the plants.

Jeevatu Liquid Manure 2:

- When used as a prophylactic spray, 3 parts of water are added to 1 part of Liquid Manure 2 and sprayed twice a week.
- When used as a curative spray, 1 part of water is added to 1 part of Liquid Manure 2 and sprayed daily till the pest problems is managed. Then, the treatment is pursued as a prophylactic.

The following special modes of application of Jeevatu on crops were also reported:

As a prophylactic function:

- The solution is applied in different ways:
  - After ploughing and transplanting the tree seedlings on the field, I make a hole around the tree, put the Liquid Manure 1 and cover it with earth (R1 in Kavre)
  - I also apply the Liquid Manure 2 two times a week even when there is no disease on the roots of the plants. (R1 in Kavre)
  - Liquid Manure 1 is used to drench the soil when ploughing. We make a hole, add the cow dung, some soil, add Liquid Manure 1 and mix it all. Then we sow the seeds. (R1 in Chitwan)
  - Liquid Manure 1 is used as a fertilizer and in the seedlings nursery before planting. (R2 in Chitwan)

- The solution is drenched on the roots instead of on the leaves of the crops:
  - I control some insect problems by drenching Liquid Manure 2 on the roots of tomato, cauliflower and cabbage two times a week even when there are no diseases (R1 in Kavre).

As a curative function:

- The frequency of application is intensified when some diseases appear:
  - A direct Jeevatu 2 curative treatment (19 l of water, 1 l of Jeevatu) is used to treat

diseases in case of emergency. It is applied 2 or 3 times a day for 1 week up to 10 days. Then there are fewer insects after 3 weeks (R1 in Chitwan).

- Liquid Manure 2 is sprayed on the roots of the crops 3 times per week. (R2 in Palpa)

Opinion of the respondents in terms of application mode:

- **It is labor intensive:**
  Some farmers think that the fact that Jeevatu is labor intensive, it might be difficult for some farmers to adopt it.
  - Labor time for applying Liquid Manure 1 is about 4 or 5 hours per week and about the same for spraying Liquid Manure 2 for citrus (0.25 ha). The total labor time in the farm is much higher than for chemicals. (R1 in Pokhara)

- **Its use decreases after a while:**
  Several people found that the use of Jeevatu on crops is very intensive at the beginning, but then it decreases since there is a diminishing need to apply daily curative treatments. This was also an advantage of the product promoted by NFI.
  - Applying Jeevatu Liquid Manure represents more work at the beginning (more frequent use) and then it decreases in comparison with the frequency of application of chemicals since the soil is improved and requests less treatments. (R1 in Pokhara, Palpa, Budhanilkantha and Kavre).

3.1.3 Jeevatu effectiveness

Interviewees have applied one or several Jeevatu technology packages on various types of crops in various locations and under different agro-ecologic conditions (see the list of respondents in annex). They have therefore very diverse experiences which can maybe help assess the effectiveness and reliability of Jeevatu in agriculture.

A difficult assessment

Assessing the effectiveness of Jeevatu has been a central question during the interviews. Indeed, it was necessary to make sure that it was the application of Jeevatu itself that had positive impact on the crops. Many other factors often play a simultaneous role, like the use of better and more abundant inputs like compost or the abandon of mineral fertilizer and synthetic pesticides, the use of previous treatments or other practices. As a result, only a few cases could really provide an answer: the six respondents who had adopted Jeevatu since at least three years and had applied the technology packages according to NFI's recommendations (R1 and R3 in Pokhara, R1 and EVON in Kavre, R1 in Palpa and R2 in Chitwan). Unfortunately, three of them were also Jeevatu retailers so their answers have perhaps been biased by some interests.
Moreover, the combination of several Jeevatu treatments in most of the cases made it difficult to assess the effectiveness of the individual treatments.
At last, the answers of the users were very subjective and depended on their previous practices. Five respondents compared the use of Jeevatu with other organic treatments (including 2 with

other manufactured organic treatments: EM®, a compost accelerator and plant protection product similar to Jeevatu and Green Planet, an NPK fertilizers) and 7 compared it with the use of mineral fertilizers and synthetic pesticides (incl. in association with compost).

- **Effectiveness of Jeevatu-based compost**

Among Jeevatu-based compost users, there were only 3 dis-adopters who had stopped using it. The causes was a general dissatisfaction regarding Jeevatu, rather than the lack of efficiency of this product to refine compost, fertilize soils and fight against diseases (R1 and R2 in Budhanilkantha and EVON in Kavre).

Doubts about the effects of Jeevatu on the nutrient content of the soil:
The respondents hadn't noticed any difference with Jeevatu-based compost on the soil and thus on the health of the plants.

- "I ploughed my land with Jeevatu-based compost which had been refined with a solution of 120 bottles of Jeevatu. This land had never been cultivated before and I am not sure whether it had any effect at all on the nutrient content of the soil. I asked the Plant Clinic to come and assess the level of nutrients in my soil but they never had time to come" (R2 in Budhanilkantha)

The respondent who used Jeevatu only to treat le compost, R3 in Budhanilkantha, found that it had equal effects as the use of Green Planet mineral fertilizer, another manufactured organic product which she previously used.

- "The impact on the crops and on the soil was very good: good moisture and texture, more beneficial worms and less pathogens. We only got pest attacks twice such as leaf miner and white flies. This affected about 25 % of the plants."

A faster fermentation time, better soil but no effects against diseases:
As for Jeevatu-based compost, the organic farming trainer at NPG in Chitwan who has been using the technology since three years found that Jeevatu makes covered compost ferment faster and that it can save cow dung and liquid manure. He continues to promote it since he thinks that it can improve the soil's structure. He hasn't heard about bad experiences among the farmers he had trained in the Middle Hills (Palpa) and *Terai* areas. However, this user doesn't believe that Jeevatu can cure soil-borne diseases.

The **acceleration of the compost fermenting time** was also found to be a positive effect by two other respondents. (R3 in Budhanilkantha and R2 in Palpa). The **reduction of the necessary compost quantity** was also found by two respondents to be 25-30 % and 50 %.

Other respondents (e.g. R1 in Chitwan district) also found that the application of Jeevatu-based compost is a good fertilizer.

Effectiveness of Jeevatu crop treatments

As for Jeevatu crop treatments, the following results have been found:

- **General appreciation:**
  - **Increased yield**: this was the case for rice cultivation as compared with the previous mineral fertilizer treatment (R1 in Pokhara, (Adhikari, Suraj Raj, Khadga Bhakta Paudel, Kusum Pokhrel, 2013). This was also the case for R2 in Pokhara who experienced a 50% increase of sponge gourd yields after applying Liquid Manure 2 and compost as compared with mineral fertilizers and compost (see the case study below). However, yield was found to be improved on vegetables, but not on rice (NPG in Chitwan).
  - **Better quality fruits**: longer crop cycles resulted in citrus fruits which were more ripe, had a thicker skin and could be stored for 2 months (R1 in Palpa); "Vegetable are of better quality and taste better"(R2 in Pokhara)
  - **Healthier plants** has been reported by ex-mineral chemical users (R1 in Kavre, R1 and R3 in Pokhara, R1 in Palpa). Four respondents found that the treatment of citrus trees with Jeevatu improved their conditions with greener leaves than non-treated trees (R1, R2 in Kavre, R1 in Palpa, R1 in Pokhara).
  - **Better soil**: "The soil was more porous and there were more earthworms and insects than with chemicals." (R3 in Pokhara). An improved soil structure / water holding capacity was reported by ex-mineral chemical users and some organic farming practitioners too (R1 in Kavre, R2 in Pokhara, R1 in Palpa, NPG in Chitwan).

- **Vegetables and rice growth promotion:**
  - R3 in Pokhara has applied Liquid Manure 2 on various kinds of vegetables and found a faster growth of the plants.
  - Faster growth effect was not so significant for one organic farming trainer (NPG in Chitwan). He thinks that the growth on rice and vegetables was maybe only faster at the initial stage.
  - This opinion was shared by other organic farming trainers at EVON who found that there were no difference with Jeevatu as compared with usual integrated farming practices. "We thought that there was some improved vigor in plants (vegetables, fruit/nut trees and berries) after spraying, but in the long term, no significant difference was observed."
  - An experiment on the roots of chili (R2 in Palpa) gave however impressive results after only one month. But the treatment concerned a very small area and the application dosages weren't clearly explained.
  - But some respondents found that the crop cycles were in the contrary much slower than usually with mineral fertilizers (urea, DAP) and synthetic pesticides (dytamin 45, blytex): "The sponge gourd crop cycle became much longer with Jeevatu on our sponge gourd crops: 7 months instead of 3 months with chemicals." (R2 in Pokhara); "Before the citrus fruits used to fall before they were completely ready" (R2 in Palpa); "In comparison with chemicals, Jeevatu extends the crop cycle of fruits." (R1 in Palpa).

- **Pests control on vegetable crops** (aphids, white flies or other insects):
  - R2 could control whiteflies on orange trees with the application of Liquid Manure 1 (1

time per year) and Liquid Manure 2 (1 time per week).

- However, two organic farming experts at EVON believe that they are no effects of Jeevatu Liquid Manure 1 and 2 on aphids. It failed to treat aphids on tomato crops when the treatment was applied during two weeks, 3 times a week.
- Respondents believed that insects were repelled in two cases, on tomatoes after 1 application per week (R3 in Pokhara) and on lemon trees after 3 applications per week (R2 in Palpa) of Liquid Manure 2.

- **Soil-borne diseases control** (nematodes which are parasites infesting the plant roots):
  - Nematodes on bitter gourds and various kinds of diseases were controlled (R1 in Budhanilkantha and R1 in Kavre). R1 in Kavre used Liquid Manure 1 as a prophylactic and then Direct Jeevatu 2 (10 l of water and 10 l of Jeevatu) as a curative product daily during 10 days and continued during the rest of the cycle with 19 l of water mixed with 1 l of Jeevatu.
  - R2 in Budhanilkantha failed to control an infected batch of tomato seedlings. Nematodes ruined the tomato crops despite the application of Jeevatu-based compost and a frequent treatment with 19 l of water and 1 l of Jeevatu twice a week during 2 months.
  - Powder mellow worms on citrus trees were controlled in 3-4 days by the application of Liquid Manure 2 three times per week (R1 in Palpa).
  - White worms on mustard plants happened to be very well controlled by the application of the solution for Jeevatu-based treatment "in case of emergency" 2 times per week. This treatment was also effective against white lines[4] in Maize when applied 2 or 3 times daily during 7 to 10 days. (R1 in Chitwan)

- **Bacterial and fungal diseases** (Citrus greening, blackening of the stems, fungal disease such as late blight on tomato and potato which affects the leaves)
  - Two organic farming trainers at EVON believe that Jeevatu has no effect on fungal diseases.
  - One farmer in Pokhara (R2) also failed to control early and late blight on tomato despite the application of Liquid Manure 1 and 2 daily.
  - Various fungal diseases could be controlled in Pokhara (R1 and R2) thanks to a frequent application of Liquid Manure 1 and 2 (1 time per week) except during winter time. Diseases were controlled after 3 or 4 days on bitter gourd, bottle gourds and cucumber crops, as well as in one week on rice crops (application 1 or 2 times per week of Liquid Manure 1 before flowering and Liquid Manure 2 after the problem appeared.
  - During the dry season in Chitwan, various kinds of diseases were also prevented on Cauliflower, potatoes and tomato crops, whereas during the monsoon season, bitter gourd and pumpkin crops were protected. Liquid Manure 2 had been applied at the beginning of the disease daily. Jeevatu-based compost and Liquid Manure 1 had served as prophylactic treatments.
  - The blackening of the stems (black rot, bacterium *Xanthomonas campestris pv. campestris*) was controlled one time on cauliflowers (R1 in Budhanilkantha)

[4] Possibly caused by the maize white line mosaic virus

- It was also controlled in one week in Kavre (R1) after the application of Direct Jeevatu 2, followed by a prophylactic treatment (19 l water + 1 l Jeevatu).
- More impressive was the control of citrus greening also called Citrus Huanglongbing (HLB) caused by the bacterium *Candidatus* Liberibacter on citrus trees in Pokhara. While the zone was infested, a frequent and repeated spraying (1 or 2 times per week) of Liquid Manure 2 during three years from December to May controlled the disease. The general conditions of the trees were improved and retrieved an equivalent yield as before (R1 in Pokhara).

Several adopters also mentioned that Jeevatu could **suppress odors** and therefore used it to wash toilets (R3 in Kavre and R1 in Palpa). It was also used to **repel flies** (R3 in Kavre).

3.2 Economic assessment

Respondents have been interviewed about their expenses and incomes as compared with their previous practice. Two case studies (see in Annex) present a more detailed economic situation of farmers for the use of Jeevatu-based compost and Liquid Manure 2 (R1 in Budhanilkantha and R3 in Pokhara).

3.2.1 Jeevatu-based compost

- **The variable costs:**

  - **<u>Jeevatu bottles:</u>Unit cost and total cost per hectare:**

For farmers who are autarkic in compost and water and don't employ external workers, the purchase of Jeevatu bottles is the main expense. One Jeevatu bottle of 1 l costs NPR 100 (USD 1.015[5]).

For previous users of the Japanese brand EM® (EVON in Kavre) which costs NPR 900/ l, Jeevatu represented a saving of NPR 800 per bottle and a saving of NPR 3,375 for one crop cycle of one hectare (about 3.75 Jeevatu bottles are applied).

The study didn't precisely assess the amount of savings due to the replacement of chemical inputs by Jeevatu since their functions are not comparable.
For information, the prices of alternative fertilizers in Nepal are as follow (R3 in Kavre):
Vermicompost: NPR 175/25 kg (NPR 7/kg)
Potash: NPR 1680/25 kg (NPR 67.2/kg)
Urea: NPR 1258/25kg (NPR 50.32/kg)
DAP: NPR 2300/25 kg (NPR 92/kg)

Jeevatu purchasing would be more costly than using traditional plant solutions (EVON in Kavre).

  - **Distance to buy Jeevatu bottles and related costs:**

When Jeevatu is not distributed to the farm by NFI and not sold in farmers' neighborhood, the trip to buy Jeevatu bottles can require up to one or two traveling days (R1 in Palpa).

The cost should also comprise transport costs to deliver or buy Jeevatu bottles which are also higher to reach remote areas from the production site in Kathmandu.

  - **Frequency of Jeevatu purchasing:**

The respondents bought Jeevatu one time per year.

[5] http://www.oanda.com/currency/converter/ - Sept. 1st, 2014.

- **Compost:**
  - **Costs associated with the production of compost:**

When raw material is not sourced locally, already-made compost is bought from somewhere else. For some respondents, the proportion of compost bought outside could be up to 75%. Transportation and labor costs must therefore be added:

- "75% of the compost we use is bought from farms which are far away since it is much cheaper than nearby." (the cost per ton is NPR 1.5 instead of NPR 7 when bought 10 km away). "We make 15 trips a year to get compost from farmers (in about 30 km distance from the farm). We have to hire people to transport about 3 tons of compost per trip." (R1 in Budhanilkantha)
- "75% of the compost we use comes from outside (10 km away from the farm). We pay someone to make about 20 trips per year. Three tons of compost per trip costs NPR 4,500 and NPR 90,000 totally per year." (R3 in Budhanilkantha).
- Straw comes from another district. (R1 in Chitwan).
- Straw supply comes from Chitwan, which is about 150 km away (R1 in Kavre).

- Some people had to invest in the purchase of **cattle** to produce manure by themselves (R1 and R2 in Budhanilkantha). The ownership of two cows was sufficient to supply enough manure for the production of compost for a regular application of Jeevatu-based compost combined with Liquid Manure 1 and 2 on a total area of 0.35 ha (0.1 ha of vegetables in rotation with rice crops and 0.25 ha of citrus) (R1 in Pokhara).

- **Water:**

Water is generally free. The only constraint encountered by one adopter in Budhanilkantha was the necessity to have regular power supply to pump water since the production of Jeevatu-based compost requires some water.

- **Labor:**
  - **Daily rate:**

When staff is hired at the farm, the main expense is labor cost. The daily wage rate reported by the respondents was between NPR 250 and NPR 1000 (NPR 300 for most of the respondents).
Generally speaking, only a few people hired staff daily to work on their farm (R1, R2 and R3 in Budhanilkantha only). The others worked by themselves or with their family members and occasionally hired staff for harvesting.

  - **Labor requirements:**

In addition to the general tasks, the following tasks are related to the adoption of Jeevatu-based compost:

- *Collecting and/or preparing the ingredients to make Jeevatu solution*: Jeevatu bottles, compost (and/or straw, other organic wastes, manure), water.
- *Production*: Jeevatu solution making and compost heap turning once every two weeks during 3 months. This labor time can be decreased in comparison with normal compost making if the use of Jeevatu accelerates the fermentation time (R1 in Palpa said it reduces the necessary time up to 2/3).
- *Treatment*: It is generally practiced during the land preparation phase. For instance,

ploughing can take 12 man-days/ 0.25 ha/ year for citrus trees (R1 in Pokhara).

Possible growth margin:

- *From an increase in yield*. Only one respondent was in this case.
  - "Yield of vegetables and cardamom have increased." A cumulative use of Jeevatu-based compost and Liquid Manure 2 on citrus/ orange has increased the yield from 50 kg to 70 kg (R2 in Palpa).

Economic assessment according to NFI's recommendations and estimations:

J-based compost for 1 ha of vegetables:

	Unit	1 crop cycle (NFI)			4 crop cycles		
		Amount	Rate (NPR)	Total	Amount	Rate (NPR)	Total
Inputs:							
Compost (100 kg)	kg	10,000	2	20,000	40,000	2	80,000
Jeevatu (1L)	L	95	100	9,500	380	100	38,000
Water (19L)	L	1,805	0	0	7220	0	0
216 sq feet of Silpauline sheet	Piece	1	7	7	1	7	7
Total:				**29,507**			**118,007**
Labor:							
4 times Heap turning	man/day	12	300	3,600	48	300	14,400
Compost application	man/day	5	300	1,500	20	300	6,000
Total:				**5,100**			**20,400**
TOTAL COSTS				**34,607**			**138,407**

The use of additional organic wastes:

According to R1 in Kavre, some wastes that are difficult to ferment can be used (pine needles, any wastes). This could represent some savings as compared with the production of normal compost and particularly fit high altitudes where there are fewer vegetal matters from the crops and also where compost ferment slower due to low temperatures.

3.2.2 Jeevatu crop treatments

Variable costs

The economic impact of this technology package depends on many factors:

- **The type(s) of treatment(s)**: The most common combination of treatments was Liquid Manure 1 and Liquid Manure 2 (7 respondents) and sometimes after Jeevatu-based compost was applied (5 respondents). Respondents had also sometimes adopted other treatments (see the list of respondents in Annex).

- **Labor**:
  - About 2 to 3 hours are necessary to make one set. (R2 in Chitwan)

- Labor time for applying Liquid Manure 1 is about 4 or 5 hours per week and about the same for spraying Liquid Manure 2 for citrus (0.25 ha). The total labor time in the farm is much higher than for chemicals. (R1 in Pokhara)
- Labor costs remain unchanged as when using mineral chemicals. Jeevatu treatment totally takes about 3 man/days for one cycle of sponge gourd (1 type of treatment once a week during 3 months) on 0.1ha. – R3 in Pokhara

- **The area to be treated**: One single crop occupied between 0.05 and 0.25 ha. Many respondents used Jeevatu on one or two pieces of land.

- **The type and number of crops treated**: The respondents mostly used Jeevatu on two distinctive crops (e.g. R1 on Pokhara treated 0.25 ha of perennial trees and 0.1 ha of vegetables). The quantities and treatment frequency could differ from NFI's recommendations (see the case study in annex).

- **The origin of the inputs:** In some cases such as for respondents interviewed in Pokhara and Palpa, farmers are autarkic for the supply of raw materials to make compost.
  Otherwise straw can be quite costly to make compost. "One carriage of straw costs NPR 7000 in Kathmandu and NPR 2000 in Chitwan. One truck of straw from Chitwan to Kathmandu costs NPR 10,000. The total cost of Paddy straw is NPR 20,000-28,000/acre." (NPR 8,094-11,331/ha) – R3 in Kavre.
  Jeevatu is 9 times less expensive than EM® which is used in the same conditions as Jeevatu (EVON in Kavre). The number of bottles bought per year: it varied between 60 and 120 bottles per year according to the respondents.

- **The type of manpower**: no respondent had to hire additional labor to take care of Jeevatu-related activities. An increase in yield had sometimes resulted in an increase in man days during harvesting time (R1 in Pokhara).

- **The conditions before adopting Jeevatu**: some farmers decided to buy some cattle (R1, R2 in Budhanilkantha) and to develop more integrated organic practices after Jeevatu was introduced to them (some members of the Chitwan cooperative).

Case study:

According to NFI Liquid Manure 2 can provide enough nutrients to the crops and protect it against pests. The presented case study (see annex) shows that this at least brought higher yield to one respondent in Pokhara at a relatively low cost. Apart from normal labor, seeds and compost costs, the treatment's main expenses are Jeevatu bottles and labor to treat the crops.

In this case, water and urine quantities have largely been decreased by the user as compared with NFI's recommendations, but since they are costless for the user this doesn't appear in the calculation of the total variable costs (see the table below).

In Nepal, organic vegetables and fruits are not sold at a higher price than chemical treated

vegetables and fruits, therefore this doesn't result in higher gross value.

New estimations according to NFI's recommendations and user's practices:

		0.1 ha					0.1 ha		
NFI recommendations	Unit	Amount	Rate (NPR)	Total	R3 in Pokhara	Unit	Amount	Rate (NPR)	Total
Inputs:					**Inputs:**				
Jeevatu (1L)	L	6	100	600	Jeevatu (1L)	L	6	100	600
Water (37.5L)	L	225	0	0	Water (10L)	L	60	0	0
Urine (37.5L)	L	225	0	0	Urine (5L)	L	30	0	0
Water to dilute (76L)	L	456	0	0	Water to dilute (16L)	L	96	0	0
Plastic sheets	L	1	55	55	Plastic sheets	L	1	55	55
Total:				**655**	**Total:**				**655**
Labor:					**Labor:**				
Solution production	man/day	0.25	300	75	Solution production	man/day	0.25	300	75
2/week treating	man/day	5	300	1,500	1/week treating	man/day	5	300	1,500
Total:				**1,575**	**Total:**				**1,575**
TOTAL COSTS				**2,230**	**TOTAL COSTS**				**2,230**

Gross margin:

Between the different users, the main factor that impacted their gross margin was the efficacy of the treatment. In some cases the investment failed or doubled the time to grow one crop cycle reducing the number of cycles and we assume the total yield (R2 in Pokhara).

Costs:

Compost costs were integrated into only one treatment, Liquid Manure 1, but this expense seems necessary anyway in an organic farming system.

Regarding the number of Jeevatu bottles per treated hectare, the findings show very diverse and sometimes unbelievable situations.

Indirect gross value:

NFI had also calculated that an improved biomass would increase the revenues from the sale of straw, but this wasn't the case among interviewees. Other indirect sources of income could come from the introduction of husbandry and the sale of dairy products, manure and urine.

Labor time for one crop cycle of sponge gourd (3 month) on 0.1 ha:

Labor time (hour)	Jeevatu 1	Jeevatu 2	L. Man. 1	Liquid manure 2	
Level of action	Leaves	Leaves	Root/Soil	Leaves	Leaves
Function	Prophylactic	Curative	Prophylactic/C	Prophylactic	Curative
Collect & Prep.					
Jeevatu	0	0	0	0	0
Compost			6		
Water*	0	0	0	0	0
Manure					
Urine*			0	0	0
Labor:					
Digging a hole			1	1	1
Mixture making	0.5	0.5	1	1	1
Mixture turning			1	1	1
Treating	24	24	24	24	4
Total hours:	**24.5**	**24.5**	**33**	**27**	**7**
Total man/days:	3.06	3.06	4.13	3.38	0.88

Hypothesis (based on NFI's estimations):

Crop duration (week):	12
Fermenting time (week):	12
Cultivated area (sqm):	1000
Spraying time (hour/time):	1
Frequency of spraying/week:	2
Liquid Manure 2 application:	4 days as a curative treatment

* Water and Urine collect are comprised in Mixture making.

Compost time comprise the time necessary to collect the inputs on-farm (manure, straw…).

3.3 Social assessment

The SATNET analytical framework comprise the study of some specific social aspects: minimum land area required for adoption, share of female adopters, risks of disturbance of the neighborhood, persons involved (as proxy for workload) and the payment of persons (as proxy for employment creation potential). In addition, the impacts of Jeevatu on health have also been reported since this was found to be an important criteria of appreciation.

3.3.1 Land area required

- **Jeevatu-based compost**

The minimum requested land area to adopt Jeevatu-based compost might be as small as the area necessary to stock compost. A cultivated land area would also be needed to source the ingredients for compost (straw and other organic wastes), but they can be bought from outside the farm. This was the case for suburban adopters (2 adopters in Budhanilkantha).

- **Jeevatu crop treatment**

As for Jeevatu crop treatments, there is no minimum land area required. It can be used on small agricultural areas such as kitchen gardens (R3 in Palpa) or even in urban gardens (one women uses Jeevatu on her rooftop garden in Kathmandu).
The smallest land area has been found in Palpa where Jeevatu was used on one square meter of chili (R3 in Palpa).

3.3.2 Share of female adopters

The representative of a women cooperatives in Chitwan (R1 in Chitwan) has testified about the interest and regular use of the technology by women.
“There are as much female as men who adopt, produce and apply Jeevatu.” (R1 in Budhanilkantha)
The two women cooperatives in Chitwan (R1) and Budhanilkantha (R3) adopted Jeevatu-based compost.

3.3.3 Risks of disturbance

The practice doesn’t disturb neighbors or the close community. (R1, Budhanilkantha)
According to all the respondents, there are no risks of disturbance in the community. It could reduce some organic wastes which otherwise couldn’t ferment well such as pine needles (R1 in Kavre).
The technology is also sometimes used to disinfect the toilets (R1 in Palpa, R3 in Kavre) and repel flies (R3 in Kavre).

3.3.4 Persons involved (workload)

- **Jeevatu-based compost**

The workload to produce and apply Jeevatu is similar to other organic products used to refine compost, such as EM® (R1, Budhanilkantha) and Green Planet (R3, Budhanilkantha).
The adoption of Jeevatu-based compost instead of normal compost represents a small additional workload to prepare the Jeevatu solution and spray it. This never resulted in the employment of additional labor among respondents.

- **Jeevatu crop treatment**

R1 in Pokhara needs as much as 160 men/days per year to treat 0.25 ha of infected citrus trees with Liquid Manure 1 and 2 (two treatments of each per week require 8 to 10 hours work per week). In comparison, he only needed 120 men/days when treating the trees with synthetic pesticides.

3.3.5 Payment of persons involved

No respondent stated that additional people were employed because of the adoption of Jeevatu-based compost or crop treatments.

3.3.6 Impact on health

- **Jeevatu-based compost**

No positive or negative impacts on health were noticed by the interviewees. No changes in diet were observed for the farmers and the community. All the respondents thought that Jeevatu doesn't represent any risk for human health since it is organic.

- **Crop treatments**

Some interviewed adopters who used chemicals inputs before have noticed some improvements on the health of their family or themselves when using Jeevatu:

- The children are less often sick than when using mineral fertilizers (urea and DAP). (R1 in Kavre)
- Improved health of farmers (no headaches when spraying, better energy, less colds) than compared with the use of urea, DAP and potasse as fertilizers, calcium carbonate as a fungicide and rogor as an insecticide – R1 in Pokhara

But one adopter hasn't noticed any difference when using Jeevatu instead of synthetic pesticides (R3 in Pokhara)

Some Jeevatu adopters have simply seen a better taste and quality of their food:

- The quality of the food (vegetable and rice) is improved (R1 in Kavre)
- Vegetables taste much better (R2 in Pokhara)
- Food can be consumed immediately, we don't need to wait for 19 days after treating (R1 in Chitwan)

Respondents who already practice organic farming haven't noticed any difference on their health (R1 in Chitwan, R1 in Budhanilkantha). No respondent stated that Jeevatu helped them diversify their diet.

4 Environmental assessment

The SATNET Asia analytical framework comprises the study of three environmental aspects: the impacts of the technology package on natural biological processes, the local biodiversity, energy use and water.

4.1.1 Impact on local biodiversity

No respondent found that one of the Jeevatu technology packages had negative effects on the environment.

Some respondents found that Jeevatu maintains a healthy environment, mostly users who used chemical inputs before, but also organic farming practitioners (NPG in Chitwan, R1 in Chitwan, etc.).

Three farmers who used chemical inputs before have seen a lot of improvements after they stopped using mineral fertilizers and synthetic pesticides and started Jeevatu instead:

- "The quality of the environment has improved: increased population of bees, no pollution in the soil and better taste of water, fruits and vegetables." (R1 in Pokhara)
- "The quality of the soil seems improved in comparison with chemicals: more animals, more earthworms (with chemicals it was not porous and with no humus)." (R1 in Palpa)

The farmer who started cultivating a fallow land with Jeevatu didn't see any impact of Jeevatu on the local biodiversity: "It is not sure if the product had any effect on the soil and biodiversity." (R2 in Budhanilkantha)

One organic farmer who used only compost before hasn't seen any positive effect of Jeevatu on the soil biota:

- "Application of Liquid Manure 1 and 2 had no effects on the population of earthworms or other beneficial worms." (R2 in Kavre).

Adopters who previously used other manufactured organic compost accelerators haven't seen any difference in the soil, flora and fauna after the application of the Jeevatu-based compost (R1 and R3 in Budhanilkantha, R4 at EVON in Kavre).

4.1.2 Energy use characteristics

Jeevatu-based compost doesn't request the use of energy, except in certain cases for the following actions:

- Electricity to pump water and make Jeevatu-based compost when such a system is installed

(R1, Budanikantha)

- Fuel for transportation (of Jeevatu bottles, already made compost or straw (R1, R3, Budhanilkantha).

The application of Jeevatu on the crops was done manually (with a hand pump).

4.1.3 Water use characteristics

Water use was equivalent with or without Jeevatu (R1, R2, R3, Budhanilkantha)

According to NFI, Jeevatu does not pollute water and has therefore a positive effect on water sources when it replaces chemical inputs. No respondents had noticed any difference about this aspect.

“No change in the quality of the nearby water sources was noticed.” (R3, Budhanilkantha).

Water is used for the preparation of some of the treatments and it is possible to make more use of the Jeevatu solution by diluting it into water or urine. Water can be replaced by urine, but although some users owned 2 to 4 cattles, it couldn’t totally meet their needs.

Some adopters managed to decrease the necessary quantity of water for Liquid Manure 2 and to obtain excellent results. One respondent used almost 5 times less liquid than recommended (see the economic case study).

5 Discussion

5.1 Technical assessment

There are a few uncertainties regarding the technical conditions of use of Jeevatu:

1. **Is the use of Jeevatu completely non-compatible with mineral fertilizers and synthetic pesticides?**

Some interviewed microbiologists at Kathmandu and Hohenheim Universities believe that the presence of mineral fertilizers and synthetic pesticides could indeed kill some microbes contained into Jeevatu, diminishing its effectiveness (Dr. Gauchan, Dr. El-Hasan, personal comunication). One respondent (R1 in Chitwan) has also heard about a farmer who failed to have positive results with Jeevatu after he used the same manual pump as for the application of synthetic pesticides.

But some proves about the non-compatibility of Jeevatu with chemicals inputs should be found since it wasn't supported by any scientific research. Moreover, we have found that some other Effective Microorganisms products can be compatible with mineral fertilizers. A study has even shown that EM[6] had positive impacts on yield and growth of cotton at the condition that it was associated with either organic or inorganic nutrient sources (Khaliq, Abbasi, & Hussain, 2006). Another study conducted in South Africa (Ncube, Mnkeni, & Brutsch, 2011) on tomato crops demonstrated that EM combined with mineral fertilizers improved the yield with the highest number of fruited plants observed when EM was applied together with mineral fertilizers. But it was not conclusive about its effect on plant growth and biomass. At last, better yield and growth results were achieved with a combination of EM and NPK amendments on Maize (Baloyi, Du Preez, & Kutu, 2014).

2. **What are the best Jeevatu solution compositions and associations?**

The recommendations in terms of composition that are advised by NFI have not been developed following a very scientific protocol and might not be optimized.

According to the experience of some respondents, the sole replacement of mineral pesticides and fertilizers might not be sufficient to control diseases and provide enough nutrients to the soil (R2 in Pokhara). This is in line with the experience of some authors (Dr. Y. G. Khadka), (NARC), (Poudyal, 2010), (Tshering, 2012).

Moreover, although no respondent reported that they had been advised about it, the compost quality that is included into Jeevatu Liquid Manure 1 or associated with any of the treatments might also have some crucial impact on the efficiency of Jeevatu. Thus, Dr. Higa who first developed Effective Micro-organism (EM) solutions and then commercialized them under the Japanese brand name EM®, suggests that green organic matters best suit EM. They can ferment the organic matters and thereby release nutrients and nutrient rich organic acids which can be utilized by the plants (Higa, 2000).

At last, the maximum level of dilution of Jeevatu before applying it is not well known. One NGO is

[6] In this case Effective microorganisms (EM) was a mixed culture of beneficial microorganisms including a predominant population of lactic acid bacteria (Lactobacillus sp.) and yeast (Saccharomyces sp.), and a small proportion of photosynthetic bacteria Rhodopseudomonas sp.), actinomycetes and fermenting fungi

therefore trying to determine what would be the threshold after which Jeevatu would not be efficient anymore (Mr. Upadhyay, SAPPROS).

3. Is Jeevatu really suitable in any agro-ecological context?

The following problems have been reported as barriers to the adoption of Jeevatu crop treatments:

Water scarcity has forced some respondents to temporarily stop using Jeevatu crop treatments during winter even in Pokhara district, one of the rainiest parts of Nepal (in Pokhara and Kavre districts).

Straw supply was rare and expensive in peri-urban zones of the central Middle Hills and Terai (Kathmandu, Chitwan and Kavre districts). Indeed, compost is very expensive in a radius of 20km around Kathmandu because straw is abundantly used in the mushroom plantations. As a result, compost is often rich in animal manure but poor in plants. However, straw is very abundant in Chitwan district and would cost 75% less than in Kathmandu district (R3 in Kavre). But straw supply should not be a problem for some mountain communities who let their cattle graze in the forests (Mr. Upadhyay, SAPPROS).

Manure supply: Although it wasn't mentioned by any respondent, the supply of manure might also be a problem in Chitwan where manure is used as a fuel combustible (Dr. Y.G.Khadka). This problem might become worth with the decrease in cattle ownership and forest land area ("NARC ' s Strategic Vision for Agricultural, 2011-2013," 2010). Manure might also not be collected by some farmers who let their cattle graze freely.

The respondents facing a deficit of organic matters could buy already-made compost from other farms to refine it (three cases in Budhanikantha). But this is perhaps not a very sustainable option since it may reduce the capacity of other farmers to meet their own compost needs and it is costly. It also increases the carbon footprint of the technology package since fuel is consumed to transport the already-made compost.

The mission couldn't assess the required quantity of raw materials per hectare of cultivated land for each Jeevatu treatments including for compost making, but this should be an important parameter to assess the capacity of some farmers to adopt Jeevatu. Some recommendations in terms of crop rotation strategies and mixed farming system (introduction of some cattle) should also probably be associated to the technology packages so that the farmers can become autarkic, rendering the technology more cost-effective.

4. Should Jeevatu treatments be repeatedly applied and in the long term?

According to NFI, Jeevatu has to be applied repeatedly (twice a week) and even daily as a curative treatment in order to increase the effectiveness of Jeevatu.

A study also proved that a repeated and long-term application (5 years) of EM is necessary (Javaid & Bajwa, 2011). This can be supported by some principles about the inoculation of microorganisms into the soil. For instance, the so called plant growth-promoting microorganisms (PGPMs), must be able to: (i) colonize a plant's root system; (ii) survive and multiply in microhabitats associated with the plant's root surface, at least for the time needed to express their benefits to the plant; and (iii) promote plant growth (Dias & Antunes, 2014).

Another reason is that microorganisms that are not genetically modified have a very short life span when they are taken from their natural habitat. Moreover, their mobility is extremely reduced, which decreases their capacity to spread in the environment (Gautier, n.d.).
According to NFI, the duration of the treatments might decrease or even stop after a certain period of time. Only one dis-adopter (R2 in Kavre) had stopped the use of Jeevatu after he found his soil good enough although he had only used Jeevatu for 1 year on citrus trees. It is likely that the duration of treatment depends on the plant and soil's conditions (Dr. Ali, RKMVU).

The urgency to treat the crops and the soil might therefore affect the choice of the farmers in favor of Jeevatu. A repeated and long-term treatment also means a greater consumption of Jeevatu treatments and higher and long-term use of labor. This suggests that labor shortage during some periods of the year and the cost associated with labor might be barriers.

5. What are the effects of Jeevatu under various agro-ecological conditions?

Feedback from the field shows that the respondents had various level of trust towards various functions of Jeevatu according to their experience. Some believed that Jeevatu is only successful to improve the general plant and soil conditions, but is not useful to repel insects or cure some diseases, whereas some had different opinions. An interviewed expert would only chose Jeevatu for its capacity to cure some root-rot and soil-borne diseases, but according to him Jeevatu won't be able to control any foliar disease and insects (Madhu Sudan Paudyal, consultant at EVON in Kavre).

As per one crop type, some different results can be found: R1 in Pokhara had very positive results on the yield of rice, but NPG in Chitwan had seen no improvement. As per location (climate and soil are similar), R2 in Pokhara had very positive results on sponge gourds, whereas his neighbor had very bad results. The lack of satisfactory results have resulted in the dis-adoption of the product by several farmers (all the dis-adopters except R2 in Kavre).

According to these results, Jeevatu might be efficient under some very specific conditions and also depending on some other external factors which were difficult to assess. Indeed, soil type, source and amount of soil nutrients, as well as crop types might affect the capacity of the microorganisms to survive in the environment (Javaid & Bajwa, 2011) and the benefits of microorganisms on plants and soil can be very specific to certain taxa, as well as to some plant-microorganisms combinations (Dias & Antunes, 2014).

It is also very unlikely that a unique product can solve all the problems encountered by the farmers. For instance, EM® has developed several types of treatments having different compositions and functions (EM1, EM2, etc.) (Higa, 2000).

A review of the different laboratories and greenhouse experiments conducted by NFI and NARC has shown that the followed protocols do not allow to draw clear conclusions (See the description of some experiments in annex). Some experts have also confirmed that several steps should be undertaken (See the recommended scientific protocol in annex) (Dr. Ali, RKMVU, Dr. Gauchan, Kathmandu University).

6. What are the best storing conditions?

According to NFI, Jeevatu needs to be stored under temperate temperatures. Indeed, it might contain some mesophilic bacteria which mostly live in topsoil and can't survive under extreme temperatures conditions (less than 0°C and more than 40°C). It must also be conserved no longer than 2 years according to NFI. Indeed, microorganisms can't remain alive very long once taken out of their environment (Gautier, n.d.).

However, a visit in a dealer shop and discussions with NFI staff raised some doubts about the conditions of storage of the bottles from the manufacturing unit to the consumers.

5.2 Socio-environmental assessment

7. Is Jeevatu completely safe for the environment and human health?

Although some laboratories have concluded on the safety of Jeevatu for the environment (see the Laboratory results in annex), the introduction of this microbial solution into the environment might still comprise some risks.

Some taxas of microorganisms can be harmful to the environment and human health (Rahme et al., 1995). The biological method used to identify the microorganisms present into Jeevatu cannot prevent against the risk of introducing such taxas. Inoculated in the soils or sprayed in important quantities, they could affect the environment, animal and human health (Dr. Dhurva Gauchan, University of Kathmandu; Dr. Abbas El-Hasan, Hohenheim University). These risks are however limited given the short life span of inoculates and their low mobility. As for genetically-modified microorganisms, a rigorous control is however necessary (Gautier, n.d.)..

The method used by NFI to determine the nature of the microbes contained into Jeevatu was commonly used 30 years ago, but is no more sufficient. Nowadays, molecular tests are requested to analyze the exact nature of the microorganisms: either a DNA analysis or an electronic microscope analysis (Dr. Dhurva Gauchan, University of Kathmandu).

In Nepal, only a DNA analysis could be done given the level of equipment of Kathmandu's laboratories. It should be done according to Good Laboratory Procedures (GLP)[7] to ensure the quality of the tests (Dr. Dhurva Gauchan, University of Kathmandu).

The presence of *Aspargillius spp*. in the microbial analysis of Jeevatu from the Tribhuvan University (2012) could indicate that the production of Jeevatu had not been done under GLP conditions (Dr. Abbas El-Hasan, Hohenheim University) since *Aspargillius spp*. is common and widespread in the environment (Bennett, 2010).

Several genus of microbes used in Jeevatu could be species that are harmful to plants, animals

[7] In the US and in OECD countries, as well as in a few other countries, national authorities also ensure the protection of the consumers by requesting medicine, food and chemical products manufacturers to follow Good Laboratory Practices (GLP). GLP is a guideline generally adapted to national regulations to ensure the quality and reproducibility of Laboratory experiments. These comprise minimal procedures regarding the organisational processing process and conditions under which non-clinical health and environmental safety studies are planned, performed, monitored, recorded, archived and reported.
In developed countries, product-oriented directives additionally regulate the production of biocides and eco-products (EC Ecolabel). – Wikipedia.

and/or humans. These genus are: *Aspergillus spp., Pseudomonas, Trichoderma, Azotobacter and Bacillius* (Dr. Abbas El-Hasan, Hohenheim University).

Dr. Dhurva Gauchan from the University of Kathmandu worries that Jeevatu contains some species of Trichoderma that could destroy cultivated or wild mushrooms. Indeed, *Trichoderma koningiopsis DC3* has been reported to be harmful to some edible mushrooms (Kim et al., 2013). *Trichoderma aggressivum* forma aggressivum is also an aggressive coloniser of mushroom composts in North America. In large quantities it could damage commercial plantations of mushrooms (J.W. Woodhal, J.E. Smith, P.R. Mills, 2009). Human infections have also been reported caused by *Trichoderma longibrachiatum*, which is an allergen to humans with an often fatal outcome (Molnár-Gábor et al., 2013).
To illustrate this risk, we can also take one *Aspargillius* specie such as *A. flavus* which is better known to be responsible for the production of aflatoxin. *Aspargillius* can cause both veterinary and human "Aspergillosis" which entails minor or life threatening diseases. Aspergillosis has been reported from all species of domestic animals and many wild species. (Bennett, 2010).

8. Can Jeevatu threaten the local biodiversity?

According to some studies, the long term and repeated use of EM with organic manure can enhance the soil's quality (Hu & Qi, 2013). It can therefore regenerate some unfertile lands and enhance biodiversity.

However, if the microbes contained in Jeevatu do not already exist in the soil into which they are introduced, they could affect the naturally occurring microbial diversity either by outcompeting the local population or by mutation, thus affecting food webs (van der Heijden, Bardgett, & van Straalen, 2008).
Recent studies have shown that many microbes have restricted biogeographic distributions (e.g. Peay et al. 2007) suggesting that variations in the composition of microbial communities can impact ecosystem functioning. (van der Heijden et al., 2008)
Recent studies point to the importance of microbial diversity because different microbes perform different functions in ecosystems, contributing to decomposition, by associating with different plant species, and facilitating plant productivity by supplying different limiting nutrients.

Compared with the use of some mineral fertilizers and synthetic pesticides which diminish the soil biodiversity, the introduction or re-introduction of microbial biodiversity would certainly improve soil fertility, as it would be the case in very unfertile lands.
However, as compared with the use of some local plants which are sourced locally, Jeevatu would probably cause more disturbance to the local ecosystems. Some ecosystems of Nepal are rare and fragile, especially in high altitudes.

Environmental and health risks could however probably be minimized if the places of origin of the natural microorganisms proved to be generally free of any dangerous strains. This had been done in Great Britain, for instance (J.W. Woodhal, J.E. Smith, P.R. Mills, 2009). Exotic strains could however be introduced through trans-border activities (J.W. Woodhal, J.E. Smith, P.R. Mills, 2009).

9. Does Jeevatu represent no hazard for health?

No allergy or negative effects have been reported from the use of Jeevatu. The laboratories have also reported no presence of E Coli and Salmonella in the analyzed samples and concluded that the product was safe for human health.

More thorough analyzes should probably be conducted in order to validate these conclusions. Indeed, some species of microbes which are contained in Jeevatu could cause some allergies or other effects detrimental to human and animal health (see "environmental risks") (Molnár-Gábor & et al., 2013). If any risks were found, they should be mentioned on the bottles and some precautionary recommendations should also be provided.

10. Is Jeevatu a very-low carbon technology?

The users don't need to spend any energy. Indirect energy consumption is however needed to collect and transport raw materials, Jeevatu bottles and to pump water in certain cases.

At a global scale, the product doesn't require a lot of energy to be produced (NFI) and it allows the shift from some imported fossil fuel mineral fertilizers to a low carbon and local technology. The transport and distribution of Jeevatu all over Nepal and abroad should be taken into consideration in the global carbon footprint of the product though. The technology has therefore a higher carbon footprint than the local natural treatments traditionally used by some communities.

5.3 Economic assessment

Is Jeevatu affordable for the most disadvantaged populations?

The adoption of Jeevatu was considered to be economically interesting for several interviewed farmers. This is in line with a study conducted in 2005 in the central mid-hills (Atreya K., 2005). According to this study, farmers' willingness to pay for safer pesticides would range from as low as NRP 1500 per year to as high as NRP 50,000 per household.

However, some experts (at EVON and CABI) doubt of the economical suitability of Jeevatu for the most vulnerable farmers of Mountains areas, simply because the bottles are too expensive for them and also because there is a rich tradition of using local plants. Further socio-economic assessments should be conducted.

The case study, as well as the responses of other interviewees also reveal that NFI has based its model assuming that all the ingredients are found on-farm which is not always the case. Other "hidden costs" would also comprise the training time, the fuel and time spent to purchase Jeevatu bottles, electricity used to pump water, water costs, etc. Such costs should be taken into account in order to measure the economic sustainability of the technology.

Is Jeevatu sometimes superficial and over-used to improve compost?

The presented case study (See in annex) is a women cooperative in Budhanilkantha in the Kathmandu district. It depicts farmers who have the ability to collectively purchase large quantities of organic matters and are skilled to grow organic vegetables. Having experience of using another compost accelerator and NPK soil amendment (Green Planet), they appreciate

using Jeevatu which they believe can also “bring some nutrients to the soil”. The respondent also reported very positive effects of the technology package such as a better soil quality, enhanced biodiversity and a better control of pests (see 3.1.3. Jeevatu Effectiveness). They could result in better yield and a higher sale price of the land.
But given the small quantities of Jeevatu used to treat very large volumes of compost, the action of Jeevatu itself is questionable and should be analyzed.

Can the use of Jeevatu help reduce the amount of compost?
According to two Jeevatu retailers and one organic farming expert, the saving could amount from 25 up to 50%. These numbers correspond to some information provided by NFI, but have however not been verified through measurements, in particular taking into account the needs for nutrients supply. Moreover, adopters would not always automatically reduce the amount of compost they apply after refining it (R3 in Budhanilkantha).

6 Conclusion

6.1 Technical sustainability

The Discussion chapter of the present report reveals that there is a need to conduct thorough scientific studies about Jeevatu to validate its efficacy and reduce its risks for humans and the environment.

Beyond that, the interviews conducted in Nepal have provided some detailed information about the technical conditions and possible barriers to its adoption.

The results of the study show that:

- **Information and training should be reinforced**: Jeevatu adopters had been able to learn about Jeevatu through various means: NFI, local retailers, word-of-mouth and organic farming training centers and a few agro-vet shops in Kathmandu area.
  The interviews also revealed that most of them had a partial level of knowledge of the technology (its different functions, compositions, application modes, lifespan and storage) which resulted into different practices and opinions about the technology.
  Due to some misunderstanding about Jeevatu, the lack of fast results was one of the main reasons for stopping the use of Jeevatu (R1 in Budhanilkantha, Ms. Amrita Paudel at NFI).
  The interviewees had also various levels of practice of organic farming and were therefore more or less able to adopt the technology, since Jeevatu is best suited for integrated farming systems. The lack of knowledge about plants' diseases or the soil conditions can also be a limit since the choice of the appropriate treatment and treatment frequency rely on a capacity to detect soil and plants' problems. Some adopters might also over-use Jeevatu whereas their land doesn't require it.
  In order to limit the risks of failure of the technology and reduce its cost, the Jeevatu trainings should comprise some more complete training and advices.
  They should also suit those who have little experience about integrated farming practices such as poor farmers who live in remote areas (Tiwary, 2005), (Dr. Kavya Dashora, CABI and Mr. Upadhyay, SAPPROS) and women who are traditionally more confined to domestic tasks and less able to attend trainings (Atreya, 2007).
  NFI, other NGOs and specialized training centers might therefore disseminate the technology in priority in order to ensure the transmission of more accurate and complete information. The illiteracy of some farmers[8] might not be a problem, but some illustrated documentation could be used to help the farmers remember the different Jeevatu compositions.
  Additionally, some farmers might also need some support to optimize their organic farming system through the investment in cattle, greenhouses or efficient irrigation systems, for instance (Mr. Upadhyay, SAPPROS).

[8] Literacy Rate (15 years and over) is 72.96% for men and 48.34% for women (UNESCO, Institute for Statistics, 2010)

At last, the scenario taken as reference when talking about the effects of Jeevatu should also be properly presented.

- **Jeevatu solutions can be produced under the conditions of most of the farms in the Middle Hills and *terai* zones of Nepal**: The respondents who mostly had an integrated agricultural system on a small land area (0.1-4 ha), were able to source all or part of the necessary ingredients to use Jeevatu (cattle urine and/or water and compost) on-farm and/or outside the farm. Some respondents experienced some difficulties though.
-

The land area was not a constraint for the adoption of Jeevatu, but as earlier mentioned land steepness can be an issue. Some farmers (R3 in Pokhara and R2 in Kavre) couldn't apply Jeevatu on their trees since the frequent transport of Liquid Manure to the lands were rendered difficult by the steepness of the land and its distance with the farm.

It is therefore recommended to introduce Jeevatu where cattle, water and compost materials are available and their use to make Jeevatu solutions don't compete with other uses (fuel, mulching, etc.) and when cattle urine and manure are easy to collect.

In Nepal, many districts of the Middle Hill and Mountain areas face some drought and irrigation systems are insufficient, lands are steep and animals are not kept in stalls (Tiwary, 2005). These aspects are therefore constraints to the adoption of Jeevatu.

- **But one major barrier is the lack of Jeevatu bottles supply**:
  More importantly, the lack of convenient supply of Jeevatu bottles has been cited as a major inconvenient. The reasons behind this problem haven't been assessed and is of course a key element to the dissemination of the technology.
  It is quite unlikely that people from the most remote places are able to get frequent and sufficient supply of Jeevatu bottles due to the lack of road access and scattered households. The products having a short life span, the stocks should be often renewed which might raise the total cost of the product to unbearable prices.

- **Jeevatu is not hard to make and apply, but it might request a different labor organisation:**
  Jeevatu solutions were not found to be hard to produce and no adopter had to hire additional labor to use Jeevatu. But labor constraints to produce it (long fermenting time), to transport it and to apply it repeatedly might still be barriers to its adoption. Beyond this time spending, one should also consider some indirect labor costs due to some additional activities such as cattle raising and compost making.

- **The efficiency of Jeevatu should be ensured and certified:**

Storage under appropriate temperate temperatures is perhaps a greater challenge in the Mountain zone where there are extreme conditions.
Regarding the lifespan of Jeevatu solutions, some scientific experiments need to be conducted to

certify the lifespan of the bottles.
At last an external certification organization should certify the production process (standardization) and commercialization modes of Jeevatu to ensure the quality of the product.

6.2 Economical sustainability

- **Jeevaty based-compost:**

The main variable costs related to the Jeevatu-based compost technology package comprise the purchase of Jeevatu bottles, compost, water and labor. The main savings come from the replacement of other treatments by Jeevatu and a possible reduction of compost needs from 25 to 50%.

- **Jeevatu crop treatments:**

The type and number of treatments as well as the frequency of treatment definitely impact the total costs. Variable cost also comprise Jeevatu bottles, compost, water and labor. The reasons for the respondents to choose some kind(s) of treatment have not been clearly identified though.

It is likely that they differ depending on different situations and parameters such as the compost quality, the soil condition and the agro-system (number of crop cycles per year, types of plants, etc.).

When additional incomes were generated, it was thanks to an increase in yield (up to 50%).

The conomic sustainability of Jeevatu depend on the efficacy of the treatment.

6.3 Social sustainability

The social impacts directly or indirectly associated with Jeevatu comprised:

- **Impacts on health:**

As a result of the abandon of synthetic pesticides, some respondents have reported some positive impacts on their own health and on the health of their family. In a country where the annual costs of illness due to pesticide use is estimated to be USD 16.8 per household (Atreya K., 2005), the replacement of mineral chemical by organic practices would have great benefits. If Jeevatu is completely safe, it could be an interesting solution in this regard.

- **Impacts on food:**

The use of Jeevatu instead of mineral fertilizers has also improved the taste of food and the ability of farmers to consume their food without any risk right after it is harvested (R1 in Chitwan).

Although no respondent diversified its diet after adopting Jeevatu, the introduction of some new crops and husbandry in the farming system could provide additional possibilities to the farmers to diversify their income and diet. This should be further assessed especially in the more food

unsecured places.

Since organic food is not sold at a higher price, it means that more people have access to chemical-free food. This can be considered as healthier than chemical application since the doses are often not respected and numerous cases of poisoned persons have been reported in the country.

- **Risks of disturbance:**

No risks of disturbance of the closed community have been found. Indeed, as it is mentioned by NFI, the technology rather contributes to improve the local environment for the community: less foul odors of compost heaps and reuse of organic wastes. This can therefore contribute to a cleaner environment with less risks of pathogens development. In the communities which practice slash and burn, Jeevatu could be a good way to reuse crop residues and avoid air pollution.

- **Impact on labor (workload):**

If Jeevatu replaces the activities of plants pick-up generally done by women but doesn't represent additional time to treat the crops, it can give them additional time to do other activities (R1 in Chitwan).
Some social assessment should be done to assess how the abandon of these activities might impact the social cohesion of the communities and the life of women.

- **Impact on communities' resilience capacity**

The studies has shown that the interviewed women had some knowledge about plant treatments and that some organic farming centers (EVON in Chitwan) were now promoting this instead of Jeevatu.
The loss of some knowledge within the communities and their higher dependence toward manufactured products (EVON in Chitwan) might contribute to the loss of some indigenous knowledge and increase the vulnerability of the communities.

- **Impact on the local socio-economic activities:**

Jeevatu trainings and sharing of experience might also create new social activities although these activities already existed to support general organic farming practices (R1 in Palpa, R1 in Chitwan).
It might also create new occasions to meet some people from Kathmandu and to take advantage of the distribution of Jeevatu to develop some socio-economic activities.

6.4 Environmental sustainability

- **Impact on natural resources conservation:**

The effects of the two technology packages on the land's biota was sometimes negative (less insects attacked the crops). No difference have been observed as compared with other manufactured organic products. The people who just shifted from chemical inputs to Jeevatu have however seen some positive effects (more worms were found in the soil, increased bee population).

Generally speaking, the adoption of Jeevatu as a lever to adopt integrated and/or organic farming system is positive for the environment. But it can only be sustainable at the condition that farmers durably succeed with their new practice and don’t start using chemical inputs again.

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Annex

- **List of respondents**
- **List of experts**
- **Economic case studies**
- **Laboratory results**
- **Experiments**
- **Scientific protocol to assess Jeevatu**

1 List of respondents and description of their experience with Jeevatu

When the Jeevatu treatment is not the same as recommended by NFI (pink), it is described below for each specific treatment.

Legend:

Green: adopter

Orange: dis-adopter

Grey: non-adopter

Adopter Type	Sex M/F	Age	Jeev. Exper. (year)	General description	J-based compost Water (19L) Jeevatu (1L)	Direct Jeevatu 1 Water (950ml) Jeevatu (50ml)	Direct Jeevatu 2 Water (9 parts) Jeevatu (1 part)	Liquid manure 1 Compost (25kg) Water/Urine (25L/25L) Jeevatu (1L)	Liquid manure 2 Liquid manure 2 (76L) +Water (3L)	Liquid manure 2 Liquid manure 2 (76L) + Water (76L)
Chitwan										
R1	M/F	50	0.5	2 associate Farmers in a cooperative (50 members) +: J-C prevented white lines on maize, repeled white moths on mustard	Adopter: - In case of emergency. 2 or 3 times a day for 1 week up to 10 days.			Adopter: Liquid Manure 1 + Water (4L)	Adopter	Adopter (Cauliflower, potatoes, tomato, bitter gourds, pumpkin)
NPG	M	40	3	Organic farming trainer (20 organic farmers in the neighborhood seem to be satisfied) +: Prevented sucking insects -: Failed to control yellow rust and insects.	Adopter			Adopter: - Used in nursery before planting. - In veg.	Adopter	Dis-adopter

Adopter Type	Sex M/F	Age	Jeev. Exper. (year)	General description	J-based compost	Direct Jeevatu 1	Direct Jeevatu 2	Liquid manure 1	Liquid manure 2	Liquid manure 2
					Water (19L) Jeevatu (1L)	Water (950ml) Jeevatu (50ml)	Water (9 parts) Jeevatu (1 part)	Compost (25kg) Water/Urine (25L/25L) Jeevatu (1L)	Liquid manure 2 (76L) +Water (3L)	Liquid manure 2 (76L) + Water (76L)
Budhanilkantha										
R1	M	39	0.5	Farmer in a cooperative (6 workers) Jeevatu retailer	Dis-adopter (tomatoes, veg.)	Dis-adopter (tomatoes, veg.) - Water (7L) - Jeevatu (1L)				
R2	M	32	1.5	Individual farmer (1 entrepreneur, 3 workers)	Dis-adopter (tomatoes, veg.)	Dis-adopter (tomatoes, veg.) - Water (19L) - Jeevatu (1L)				
R3	F	35	1.5	Farmer in a women cooperative (part-time adults and 5 full-time employees)	Adopter (tomatoes, veg.) - Water (10L) - Jeevatu (1L)		Non-adopter: - Self-made organic treatment			
Kavre										
R1	M	52	7	Family farm (3 adults, no children) Jeevatu retailer +: controlled the blackening of the stems of tomatoes, nematodes on various vegetables	Adopter (vegetables, citrus trees)	Adopter: - Water (19L) - Jeevatu (1L)		Adopter: (tomato, cauliflower and cabbage)		Adopter (tomato, cauliflower and cabbage)
R2	M	45	1	Family farm (2 adults, 3 children) +: Good soil composition, repel insects, improve citrus trees - : No control of fungal disease on potatoes				Adopter (orange trees, potatoes)	Adopter (orange trees, potatoes)	Dis-Adopter
R3	M	24	0	Individual farmer (part-time, educated)						
EVON	M		3	Organic farming trainer	Dis-adopter (vegetables, fruit/nut trees and berries)				Dis-adopter (vegetables, fruit/nut trees and berries)	Dis-adopter

Adopter Type	Sex M/F	Age	Jeev. Exper. (year)	General description	J-based compost Water (19L) Jeevatu (1L)	Direct Jeevatu 1 Water (950ml) Jeevatu (50ml)	Direct Jeevatu 2 Water (9 parts) Jeevatu (1 part)	Liquid manure 1 Compost (25kg) Water/Urine (25L/25L) Jeevatu (1L)	Liquid manure 2 Liquid manure 2 (76L) +Water (3L)	Liquid manure 2 Liquid manure 2 (76L) + Water (76L)
Pokhara										
R1	M	32	5	Thesis about Jeevatu use on rice / Jeevatu retailer / Family farm (6 adults) +: Improved the condition of Citrus trees infected by citrus canker. Controlled pests/fungals on vegetables.	Adopter			Adopter (bittergard, bottlegard, cucumber and rice)	Adopter (bittergard, bottlegard, cucumber and rice)	Adopter
R2	M	41	1	Farmer (Family farm / 2 adults, 3 children) +: Quality improvement of vegetables compared with chemicals: -: No control of fungals on sponge gourds				Dis-adopter - Cow dung (15kg) - Water (25L) - Jeevatu (0,5L)	Dis-adopter - Cow urine (30L), - Water (30L), - Jeevatu (1L)	Dis-adopter:: - Cow urine (30L), - Water (30L), - Jeevatu (1L)
R3	M	40	3	Farmer (Family farm / 1 full-time adult and 3 part-time people) +: 50% yield increase of sponge gourd					Adopter: - urine (5L) - water (10L) - Jeevatu (1L)	
Palpa										
R1	M	56	6	Farmer (family farm with 4 adults) / Jeevatu retailer +: powder mellow, worms that attack roots were controlled, healthy citrus	Liquid Manure 2 + Cow dung (veg.)			Adopter	Adopter: Water (19L) Jeevatu (1L) OR filtered Liquid Manure 1	Adopter
R2	M	50	1	Farmer (Family farm / 2 full-time adults) +: Jeevatu reduced the damages caused by insects.	Adopter			Adopter: Liquid Manure 2 on the roots 3 times/week (chili, citrus/orange, potatoes).		
R3	M	50	0	Farmer (retired educated family, self consumption)	Non-adopter: normal compost instead (orange)	Boro paste (copper sulfite)				

2 List of experts

Contact persons	Profession	Organisation	Type	Motivation
Dr. K.B. Paudel Maitidevi, Kathmandu, Nepal P.O.Box: 20751 Tel.: +977-1-4428019 Mobile: +977-9841343059 Email: kbpaudel@nfi.org.np, kbpaudel@hotmail.com	Chief (plant) Scientist, CEO	NFI - Nepalese Farming Institute	Institute/ Company	Has developed Jeevatu - History, mode of production, ambition in terms of Research and dissemination. Is developing partnerships with private and institutional organizations in Nepal and within the SAARC region.
Ms. Amrita Paudel Maitidevi, Kathmandu, Nepal P.O.Box: 20751 Tel.: +977-1-4428019 Mobile: +977-9841509540 Email: paudel_amrita@hotmail.com	Agronomist	NFI - Nepalese Farming Institute	Institute/ Company	Follows-up some field experiments about Jeevatu. Promotes Jeevatu among farmers all over Nepal.
Dr. Hari Datt Joshi, microbiologist Maitidevi, Kathmandu, Nepal P.O.Box: 20751	Senior Microbiologist	NFI - Nepalese Farming Institute	Institute/ Company	NFI's biologist since 2 years. Was interviewed about the process of production of Jeevatu.
Mr. Suraj Raj Adhikari Paluwa Nepal, Kaski Tel.: 9846562290 Email: adhikarisr@gmail.com, adhikarisr@gmail.com	Plant Scientist, integrated farming practicioner	NFI - Nepalese Farming Institute	Institute/ Company	Did his Master thesis about the effect of Jeevatu) treatment on rice production (2013). Practices integrated farming. Is a Jeevatu retailer in Pokhara district.
Dr. Kavya Dashora 2nd F., CG Block NASC Complex DP Shashtri Marg Opp. Todapur Village, PUSA New Delhi, 110012, India Tel.: +91-(11)25 841906 Email: k.dashora@cabi.org Website: cabi.org	Senior scientist, Integrated farming trainer	CABI	NGO	Trains farmers in remote regions of Nepal about integrated farming practices. Is familiar with the "Plant clinics".
Dr. Md. Nasim Ali Integrated Rural Development and Management Ramakrishna Mission Ashrama, Narendrapur Kolkata 700103, West Bengal, India Tel.: +91- 3472-245224 Mobile: 0 94759 44498 Email: nasimali2004@rediffmail.com, nasimali2007@gmail.com	Microbiologist	RKMVU - Ramakrishna Mission Vivekananda University	University	Microbiologist. Has developed plant/soil treatments from organic matters based on Indian traditional practices. Was interviewed about the steps necessary to scientifically validate the technology.

Mrs. Sanu Kesharay Bjracharya Soil Scientist Soil Science Division Khumaltar, Lalitpur P.O.Box: 5459, Kathmandu, Nepal Email: sk_bracharya@hotmail.com	Soil Scientist	NARC - Nepal Agricultural Research Council	Public Research Center	Is undertaking grenhouse experiments about Jeevatu (commissionned by the Ministry of Agriculture of Nepal).
Mr. Shrikrishna.Upadhyay 400/28 Prashuti Ghrha Marga Thapathali, Kathmandu, Nepal GPO Box No. 8708, Kathmandu Tel.: +977-1-4244913/4242318/4232129 Email: shrikrishna.upadhyay@yahoo.com, sapprosnepal@hotmail.com Website: www.sappros.org.np	Executive Chairperson	SAPPROS Nepal - Support Activities for Poor Producers of Nepal	NGO	Is conducting Development projects about Jeevatu in very remote areas of Nepal. His NGO is currently testing Jeevatu as part of Integrated farming practices.
Mr. Rishi Ram Adhikari Lekhanath-10 Kaski, Nepal Tel.: +977-1-4252597, 9855061026 Email: rishidjj@gmail.com Website: http://npg.org.np/	Organic Farming Trainer	NPG - Nepal Permaculture Group	NGO	Has been using and promoting Jeevatu as part of integrated farming practices since more than 3 years in Kaski and Chitwan districts. Has also experience using the Japanese brand EM.
Dr. Dhurva Gauchan, Institute of Biotechnology, Dhulikhel, Kavre, P.O. Box: 6250, Kathmandu University Tel.: +977-9841 4838 39 Email: dhurva.gauchan@gmail.com	Microbiologist	Kathmandu University	Private Non-for profit University	Is knowledgeable about the possible harms that microbial inoculants can cause. Knows the context of scientific Research in Nepal.
Mr. Jim Danish (ZORO Co-Director) Patlekhet, Kavre Tel.: 9849058840 http://www.everythingorganicnursery.com/	Organic Farming Trainer	EVON - Everything Organic Nursery	Organic Farming Training Center	Has been using and promoting Jeevatu during 3 years in Kavre district, but has shifted to traditional practices instead. Knows the situation of farmers in remote places. Has conducted some experiments about Jeevatu and the equivalent Japanese brand.
Madhu Sudan Paudyal (Consultant) Senior Plant Protection Officer, Nepal Department of Agriculture	Organic Farming Expert	EVON - Everything Organic Nursery	Organic Farming Training Center	Has conducted some experiments about Jeevatu.

3 Economic case studies

3.1 Jeevatu-based Compost

Calculation of the gross margin of a successful Jeevatu-based compost adopter (R3 in Budhanilkantha):

Tomatoes and vegetables crops – 1 ha (1 year, 4 crop cycles) – Budhanilkantha

Respondent 3 in Budhanilkantha is one of the members of a women cooperative. The cooperative has been created 2 years ago (this is the 3rd year) by 10 women who had some free time beyond their activity in Kathmandu. They invested each NPR 100,000 at the beginning and rent a land of about 1 ha (as per our estimation). Their main crop is tomato which they grow three times a year (3 to 3.5 month per crop cycle). They also grow other types of vegetables from December to January.

According to this respondent, in terms of variable costs and efficiency Jeevatu is similar to their previous practice: the use of a different manufactured organic compost accelerator, Green Planet, in terms of expenses, labor time and gross value.

1 ha vegetable crops, Budhanilkantha		Green Planet			Jeevatu-based compost		
Inputs	**Units**	**Amount**	**Rate (NPR)**	**Total**	**Amount**	**Rate (NPR)**	**Total**
GROSS VALUE:							
Yield of tomatoes (3 crop cycles)	kg	35,000	48	1,662,500	35,000	48	1,662,500
Yiels of vegetables (1 crop cycle)	kg						
TOTAL GROSS VALUE:				**1,662,500**			**1,662,500**
VARIABLE COSTS:							
General activities							
Total paid labor in the farm	Man days	5	250	1,250	5	250	1,250
Land rent	Lump sum			300,000			300,000
Sub-Total :				**301,250**			**301,250**
Fertilizing/Compost accelerator treatments							
60 tons of Straw collection (75%)	Trips	20	4,500	90,000	20	4,500	90,000
20 tons of Straw from the farm (25%)	kg	20,000	2	30,000	20,000	2	30,000
Manure (750kg/week)	L	36,000	7	252,000	36,000	7	252,000
Organic compost accelerator	L	24	250	6,000	60	100	6,000
Water (10L water/1L Jeevatu)	L	600	1	600	600	1	600
Sub-Total:				**378,600**			**378,600**
Pesticide treatments							
Milk, water, cow urine				0			0
Sub-Total:				**0**			**0**
TOTAL VARIABLE COSTS:				**679,850**			**679,850**
Gross margin				**982,650**			**982,650**

- Gross value:

The total yield is 35 tons per hectare. There is no increase of yield after using Jeevatu. The yield pattern has not changed (3 cycles of tomatoes and one cycle of various vegetables). The unit sale

price is also unchanged. The gross value from vegetables was not estimated by the respondent.

- Variable costs:

General activities:

Labor: the number of people employed to undertake all the activities on the farm including compost preparation and application has remained unchanged. The 5 staff (women) undertake all the activities related to fertilizing and plant treatments: cattle raising, manure, urine and vegetal wastes collecting, milking, home-made insecticide production, etc.

The 10 associates are also women who sometimes come on a voluntary basis to work in the farm.

The compost fermentation lasts for 3 months. It is well covered by a plastic sheet. Every month it is turned one time and J is added to it if it hasn't fermented.

The compost application mode is done carefully either by digging holes before ploughing or by making gulls between plant rows. Tomatoes plants are planted on a plant bed to retain water.

Land rent is shared among the 10 associates of the cooperative.

Seeds: the cost of tomato seeds (3 crop cycles) and vegetable seeds (1 crop cycle from December to January) was not estimated by the respondent. It could be around NPR 300 for 4 crop cycles (R2 in Budhnilkantha).

Fertilizing/Compost:

Straw: 20 tons of straw are used per crop cycle, which is 80 tons per year. 25% of the straw comes from the crops residues or is collected on the land and 75% is bought from nearby farms. 20 trips are needed and cost NPR 4,500 each.

Manure: Beyond straw, one major cost is manure. The unit price is NPR 7 per kg which is expensive since it is not collected far away from the farm or produced by the 3 cows (25% of the needs).

Organic compost accelerator: Green Planet is more expensive than Jeevatu (NPR 250 a bottle of 1L) but a smaller quantity is necessary. Therefore, the respondent thinks that the price is equivalent to Jeevatu bottles.

Jeevatu bottles are bought 30km away at a dealer shop in Kalimati. About 60 bottles are bought every year which amounts to NPR 6,000 (USD 60.9) for 4 crop cycles on 1 hectare of land. Therefore, it corresponds to 15 bottles per hectare for 4 crop cycles (NPR 1500) and about 3.75 bottles for one crop cycle of one hectare (NPR 375).

A plastic sheet is sold together with Jeevatu (NPR 7/ unit). It was bought the previous years and reused.

Despite a less diluted solution as requested, Jeevatu hasn't speed-up the fermentation time of compost. It is however believed that it has improved its quality (more nutrients).

Water: The Jeevatu solution is almost 2 times less diluted than what is recommended by NFI: 10L of water for 1L of Jeevatu. 600 Liters of water are used per year exclusively for Jeevatu-based compost preparation.

Other organic wastes (free): chicken manure, extraction of mustard oil, flowers wastes.

Other treatments:

Organic pesticide: a home-made organic pesticide is produced (Cow urine, milk, water) to combat pests. It is applied two times per week to control leaf minor/white flies or white

worms. The crops have only been infected by diseases 2 times (leaf minor and white flies affected about 25% of the tomato plants).

- Gross margin:

The annual gross margin was estimated by the respondent to be around NPR 900,000 which is what has been approximatively found. It remains unchanged between the two practices.

A very rich and humid soil.

A high heap of compost.

Conclusion and discussion:

- Gross value :

The total yield is relatively good (35 tons per hectare)[9] compared with Indian standards, but is perhaps excellent as compared with the average yield of tomato per hectare in Nepal. The respondent seems very satisfied.

It was however difficult to know which role had played Jeevatu in the treatment though. Indeed, the soil of this farm was very rich already and the workers were apparently working very hard to collect manure and make a high heap of compost. The compost was not only made of straw and manure sourced locally, but also of various organic wastes (leaves from flowers, etc.) and extracts of mustard oil. They had apparently good knowledge about Integrated Farming Practices (elevated plant-bed, etc.) and made their own organic insecticide.

- Variable costs of the Jeevatu treatment:

According to NFI, 1 l of Jeevatu with 19 l of water should treat 100 kg of compost.

Compost material:

According to NFI's experience and estimations, the total amount of compost material for 1 hectare of 4 crops cycles of vegetables should be only 40 tons (half of what was used).

Moreover, the compost is enriched by green manure, which improves its quality. At least, good

[9] Yield is between 20 and 30 tons per hectare in India.
http://www.indiaagronet.com/indiaagronet/horticulture/CONTENTS/vegetable_culture.htm

farming practices and the application of another pesticide have improved the plants' resistance to diseases.

Jeevatu:

The nutrient content of the soil after applying Jeevatu was not verified. The quantity of Jeevatu per ton of compost is a lot inferior to what NFI recommends for 4 crop cycles of 1 ha: 60 bottles instead of 380 bottles.

Water:

Although Jeevatu was diluted almost twice more as advised (10:1 instead of 19:1), the total quantity of water for the treatment is very low: 600L for 80 tons of treated compost instead of 7000L. The respondents have however not mentioned the quantity of water and urine spent for normal watering.

Without any precise study, it is difficult to say if Jeevatu was very effective or if the sole supply of organic compost and pesticides have maintained good soil and crops quality.

Straw and manure:

In its calculation, NFI hasn't estimated the cost of straw and manure purchase and transport which amount to 90,000 and 252,000 respectively. Even if the quantities applied were doubled as compared with the real needs, these expenses have to be taken into consideration. Lower costs can be found if the matters come from further areas (R1 in Budhanilkantha) such as NPR1.5/kg of already-made compost.

Labor and land rent:

Labor is quite abundant too as compared with the total area.

Labor and land rent were possible thanks to the organizational system (cooperative).

3.2 Jeevatu Crop Treatment

Gross margin calculation for 1 crop cycle of Sponge gourd treated with Liquid Manure 2 - 0.1 ha (Jan-March) – Source: R3 in Pokhara.

		Chemicals			Jeevatu LM2		
	Unit	Qty	Rate	Total	Qty	Rate	Total
VARIABLE COSTS:							
General activities							
Labor from the farm (no wage):							
- Nursery Manageme	Man/day	50	300	15,000	50	300	15,000
- Animal Care	Man/day	15	300	4,500	15	300	4,500
- Land preparation	Man/day	60	300	18,000	60	300	18,000
- Transplanting	Man/day	2	300	600	2	300	600
- Irrigation	Man/day	12	300	3,600	12	300	3,600
- Weeding	Man/day	12	300	3,600	12	300	3,600
Sub-total (A):				**45,300**			**45,300**
External labor:							
- Harvesting	Man/day	10	300	3,000	13	300	3,900
Sub-total (B):				**3,000**			**3,900**
Inputs:							
- Seeds	kg	0.5	7	4	0.5	7	4
- Compost	kg	0	0	0	0	0	0
- Feed for animals	kg	0	0	0	0	0	0
- Water/Land	L/sqm	0	0	0	0	0	0
Sub-total (C):				**4**			**4**
Total A+B+C:				96,604			98,404
Total B+C:				**3,004**			**3,904**
Crops treatment							
Labor:							
- Treating	Man/day	3	300	900	3	300	900
Sub-total (D):				**900**			**900**
Inputs:							
- Chemicals	kg			750			
- Jeevatu (1L)	L				6	100	600
- Urine (5L)	L				180	0	0
- Water (10L)	L				360	0	0
- Dilution (16L)	L				546	0	0
- Plastic sheet	piece				1	55	55
Sub-total (E):				**750**			**655**
Total D+E:				**2,550**			**2,400**
Total costs (A-E):				99,154			100,804
Total costs (B-E):				**5,554**			**6,304**
GROSS VALUE							
- Crop sales	kg	100	80	8,000	150	80	12,000
Total Gross Value				**8,000**			**12,000**
GROSS MARGIN							
Gross Margin (A-E)				(91,154)			(88,804)
Gross Margin (B-E)				**2,447**			**5,697**

This farmer (R3 in Pokhara) has been using **Jeevatu Liquid Manure 2** since 3 years.

- Previous mineral chemical treatment: potassium (1kg), urea (10kg) and DAP (10kg)
- Current Jeevatu treatment: for 1 liter of Jeevatu, 10 liters of water and 5 liters of urine. It is then "multiplied" or diluted into 16 liters of water before spraying.

In both cases compost was used during land preparation. Both treatments were applied at the same frequency one time per week during the full crop cycle.

- Additional gross value :

The use of Jeevatu has resulted in an increase of 50% in yield of Sponge gourds (150kg instead of 100kg) at a constant unit price of NPR 70 to NPR 90 (NPR 80 in average). The total gross value for mineral fertilizers (chemicals) and Jeevatu treatments were NPR 8,000 (USD 81.2) and NPR 12,000 (USD 122) respectively.

- Variable costs:

<u>General activities:</u>

Labor:

The major activities on farm (nursery management, animal care, land preparation including compost application, transplanting, irrigation, and weeding) are done by 2 adults. They don't receive any salary, so the cost associated to these activities has just been mentioned using an indicative cost per man day of NPR 300. The variable costs have remained the same between the two types of treatments (NPR 45,300 or USD 460).

The variable costs that can account as a charge for the family are for crop harvesting. The total labor cost has increased due to an increase in yield (from 10 to 13 man days). The labor costs amount to NPR 3,900 or USD 40.

Inputs:

Inputs comprise about 0.5kg of seeds amounting to USD 4 and other inputs which are sourced on farm: compost, feed for animals and water for irrigation. Land use is free since the family is the owner. These inputs were used in the same quantity with mineral fertilizers.

General costs:

The general costs for the mineral chemical and Jeevatu treatments amount to NPR 3,004 (USD) and NPR 3,904 (USD 40) respectively. This difference is due to an increase in harvesting costs.

<u>Crop treatments:</u>

Labor:

Labor was estimated to a total amount of 3 man days for one treatment per week for 3 months (2-3 hours each time during 12 weeks). The treatment time is equivalent to chemical application. If this labor time had to be paid, it would represent a total cost of NPR 900 (USD 9).

Inputs:

According to the respondent, the total cost of mineral fertilizers amounted to NPR 750 (8 USD). This is NPR 95 more than the total cost for Jeevatu treatment (USD 0.9). 6 bottles of

Jeevatu (NPR 100/unit) were used (NPR 600 or USD 6) and a plastic sheet to make the Liquid Manure ferment is NPR 55. The sheet can be reused and should not be an expenditure for the next treatments. Water and urine are free of charge.

Total treatment costs:

The total cost for treatment is higher than for Jeevatu in the case of mineral chemicals due to higher input costs (NPR 2,550 and NPR 2,400 or USD 26 and USD 24).

Total costs:

The total costs are higher in the case of Jeevatu treatment due to higher harvesting costs. If the general activities are done internally by the farmers, total costs amount to NPR 5,554 and NPR 6,304 (USD 56 and USD 64).

Gross margin:

Gross margin is NPR 2,447 for mineral fertilizers and NPR 5,697 for Jeevatu treatment (USD 25 and 58). If the unit sale price is NPR 80, the minimum yield to cover the variable costs should be 69.4 kg with mineral fertilizers and 79kg with Jeevatu Liquid Manure 2.

Discussion:

- Gross value :

Yield: Such an increase in yield (+50%) could be the result of the abandon of mineral fertilizers and of the use of Jeevatu. Further research field experiments and analyses would be needed to explain it and draw conclusions.

Gross value: The sale of the fruits was not translated into higher gross value. A finest accounting would be necessary to see if more fruits of higher grade were sold.

- Variable costs:

Variable costs associated with Jeevatu Liquid Manure 2 treatment (NFI's estimations* vs. user's):

		0.1 ha					0.1 ha		
NFI recommendations	Unit	Amount	Rate (NPR)	Total	R3 in Pokhara	Unit	Amount	Rate (NPR)	Total
Inputs:					Inputs:				
Jeevatu (1L)	L	6	100	600	Jeevatu (1L)	L	6	100	600
Water (37.5L)	L	225	0	0	Water (10L)	L	60	0	0
Urine (37.5L)	L	225	2	450	Urine (5L)	L	30	0	0
Water to dilute (76L)	L	456	0	0	Water to dilute (16L)	L	96	0	0
Plastic sheets	L	1	55	55	Plastic sheets	L	1	55	55
Total:				1,105	Total:				655
Labor:					Labor:				
Solution production	man/day	0.50	300	150	Solution production	man/day	0	300	0
2/week treating	man/day	1	300	300	1/week treating	man/day	3	300	900
Total:				450	Total:				900
TOTAL COSTS				1,555	TOTAL COSTS				1,555

*Estimations based on NFI's application form for 1treated hectare with Liquid Manure 2.

Labor:

The labor time to apply Jeevatu, 0.25 man days (NPR 75 or USD 0.76) should be added for the production of Jeevatu solution (2-3 hours for one batch). According to the respondent, it was possible to only produce one batch for one treated crop cycle.

In our case study, the user only spread Jeevatu treatment once per week instead of twice a week as recommended. Moreover, the spraying time estimated by NFI seems insufficient. It should be between 5 and 6 man days if one spraying takes 1 hour and if we assume that there were a fast curing time of the diseases (only 3-4 days of daily curative treatment). The total labor cost would then be NPR 1,650 (USD 16.7).

Inputs:

The total amount of Jeevatu bottles is equivalent to the estimations of NFI. The quantities of urine and water applied to ferment and then dilute Jeevatu are much lower than NFI's recommendations though: about 200 liters instead of 900 Liters. NFI has estimated that 1 Liter of urine would cost NPR 2, whereas the respondent doesn't pay it.

Labor and inputs costs can be different according to the types of diseases that the crops can have, the distances to collect them, etc.

Conclusion:

New estimations according to NFI's recommendations and user's practices:

		0.1 ha					0.1 ha		
NFI recommendations	**Unit**	**Amount**	**Rate (NPR)**	**Total**	**R3 in Pokhara**	**Unit**	**Amount**	**Rate (NPR)**	**Total**
Inputs:					**Inputs:**				
Jeevatu (1L)	L	6	100	600	Jeevatu (1L)	L	6	100	600
Water (37.5L)	L	225	0	0	Water (10L)	L	60	0	0
Urine (37.5L)	L	225	0	0	Urine (5L)	L	30	0	0
Water to dilute (76L)	L	456	0	0	Water to dilute (16L)	L	96	0	0
Plastic sheets	L	1	55	55	Plastic sheets	L	1	55	55
Total:				**655**	**Total:**				**655**
Labor:					**Labor:**				
Solution production	man/day	0.25	300	75	Solution production	man/day	0.25	300	75
2/week treating	man/day	5	300	1,500	1/week treating	man/day	5	300	1,500
Total:				**1,575**	**Total:**				**1,575**
TOTAL COSTS				**2,230**	**TOTAL COSTS**				**2,230**

Total costs:

If water and urine remain free of charge for the users, NFI's treatment and the users' both amount to NPR 2,230 (USD 22.3).

Gross margin:

A minimum yield of 28kg should be produced to cover the variable costs of the treatment. If harvesting and input costs for general activities are added (see the gross margin calculation), this amounts to 77kg.

4 Laboratory results

According to NFI, Jeevatu is composed of several bacterial microorganisms, fungi and yield that are mixed in a water solution. The genus of microbes are: *Azotobacter spp., Yeast, Pseudomonas spp., Trichoderma spp., Lactobacillus spp., Aspergillus spp., Bacillus spp., Penicillum spp., Proteus spp.* (Adhikari, Suraj Raj, Khadga Bhakta Paudel, Kusum Pokhrel, 2013)

The presence of some of these microbes have been confirmed through a standard plate count method by the laboratory of the Tribhuvan University. However, the Ashta Scientific Research Service Pvt. Ltd, Dillibazar, Kathmandu (Ashta Laboratory) has only confirmed the presence of part of these microbes (see the table below). The laboratory also found that the major microbial families were yeast and mold.

Nature and total count of microbial populations contained in Jeevatu:

Microbes	**Microbial family and Characteristics**	**Laboratory count (cfu/ml) (Ashta Laboratory)**	**Presence of the microbe (cfu/ml) (Tribhuvan University)**
Yeast and mold spp.	Fungus	2.1×10^5	Confirmed
Bacillus spp.	Lactic acid bacteria	9.8×10^4	Confirmed
Azotobacter spp.	Free-living, N fixing bacteria	4×10^3	Confirmed
Lactobacillus spp.	Lactic acid bacteria	3×10^3	Confirmed
Pseudomonas spp.	Photosynthesis bacteria	2×10^3	Confirmed
Trichoderma spp.	Plant Growth Promotion fungi	Not confirmed	Confirmed
Penicillum spp.	Fermenting fungi	Not confirmed	Confirmed
Proteus spp.	Genus of Gram-negative proteobacteria	Not confirmed	Confirmed
Aspergillus spp.	Fermenting fungi (mould)	Not confirmed	Confirmed
Total count:		**2.7×10^7**	

The role of the three major families of microbes are[10]:

Yeast – Like lactic acid bacteria, they use fermentation—feeding off of the extra sugars made by the photosynthetic bacteria—to produce a variety of vitamins, enzymes and antimicrobial substances that help the other microorganisms and plants.

Lactic acid bacteria - They metabolize sugars using a form of fermentation that produces lactic

[10] en.wikipedia.org/wiki/

acid as a waste product. Similar bacteria have been used for centuries to make products such as yogurt and cheese. These bacteria break down organic material in the soil, and the lactic acid produced is said to lower the soil's pH (i.e., increases its acidity), which inhibits the growth of certain harmful bacteria.

Photosynthetic bacteria - Like plants, they use photosynthesis to convert the sun's energy into sugars. These extremely efficient bacteria produce more sugars than they need, and the excess can be used by other EM and plants. In addition, they can convert nitrogen gas in the air into a form that plants can use (nitrogen fixation), and detoxify some of the harmful waste products from putrefactive bacteria.

Discussion about the total microbial count:

The Tribhuvan University also did a microbial count of Jeevatu in different Medias in order to confirm their density and hereby their capacity of action. This count number seems a little bit low since the highest density was found with 24 x 10^5 cfu/ml in plate count agar, while a higher density (10^7 or 10^8) would have been expected (Dr. A. El-Hasan, University of Hohenheim).

In comparison, Javaid used an EM solution which consisted of mixed culture of microorganisms including a predominant population of lactic acid bacteria (1 × 10^8 cfu mL-1) and yeast (2 × 10^6 cfu mL-1, and a small proportion of photosynthetic bacteria (1x10^3 cfu mL-1) (Javaid & Bajwa, 2011).

Van Egeraat (1998) found about 10^7 micro-organisms/ mL of EM1 (Effective Micro-organisms®). Most of them were lactic acid bacteria. Yeasts also formed a major component of EM1, while all other mentioned micro-organisms were, if present at all, present only in very low concentrations (van Vliet et al., 2006).

The exact nature of the species of microbes contained into Jeevatu hasn't been identified and characterized yet (Dr. K.B. Paudel, NFI). The genus of microorganisms were identified through biological tests which are described in Bergey's Manual of systemic Bacteriology Vol. I, II, III and IV (1986) (Dr. Hari Datt Joshi, microbiologist at NFI).

According to NFI's microbiologist, the synergic and beneficial effect of the captured microorganisms is ensured through the control of a minimum density of microorganism's population in the product. This is obtained through a dilution plate count method. Moreover, the natural microorganisms are sourced for each batch of Jeevatu production since the company can't cultivate them (Dr. Hari Datt Joshi, microbiologist at NFI). According to NFI, the microorganisms are naturally present in different ecological zones of Nepal. The company hasn't revealed the exact place of origin of these microorganisms though.

The laboratory of Tribhuvan University also concluded that Jeevatu is organic and not harmful to the environment: "Above mentioned microbes are in natural form and safe to the environment. During the sample examination process E.Coli and Salmonella were not found. The submitted product sample analysis indicated that it do not contain any harmful bacteria and fungal agent, hence it can be used for organic farming."

5 Experiments

Documented experiments:

There are only a few documented experiments about the efficacy of Jeevatu for different usages on various crops. However, the scientific protocols followed for these experiments do not provide reliable conclusions; they have not been peer-reviewed or published in international journals.

The Nepal Agricultural Research Council (NARC), has brought some support to NFI for two experiments:

1. A first experimentation was conducted from 2008 to 2010 as Dr. K.B. Paudel was employed there as a Scientist. It concerned the effectiveness of Jeevatu Liquid Manure 1 (25kg of well decomposed compost, 50L of water, 1L of Jeevatu) to control pests and diseases on tomato crops and improve the total yield. It was conducted on the tomato crops of 5 farmers in Kavre district (Middle Hills region). Unfortunately, the conditions of experiment were insufficiently controlled and some of the farmers didn't apply Jeevatu repeatedly. Only the results from the first phase of experiment were rather positive about the efficacy of Jeevatu, but the differences with other treatments were not significant. The report explains this because in all plots some Jeevatu-based compost was first applied. According to NARC, the quantity of nutrients supplied by this technology package was insufficient (Nepal Agriculture Research Council, 2010).
2. In 2013, NARC has also been commissioned by the Ministry of Agriculture of Nepal to conduct an additional experiment. It is done by NARC staff inside greenhouses in Lalitpur, near Kathmandu,. This experiment aims to compare the effects of Liquid Manure 1 and Liquid Manure 2 on various physiological aspects of radish crops. The results from two crop cycles will be combined. Only a few parameters will be measured (plant diameter), but no test such as of the nutrients content of the soil before and after the experiment will be done. The Ministry of Agriculture will use the conclusions of this experiment to decide whether Jeevatu can be listed among agricultural technologies recommended by the Ministry or not.

A Master thesis (Adhikari Suraj Raj, Khadga Bhakta Paudel, Kusum Pokhrel, 2013), conducted with the contribution of NFI compared the effect of a combined use of Jeevatu-based compost (15 tons/ha/year), Liquid Manure 1 and 2 treatments with the use of mineral fertilizers[11] on paddy rice crops. The benefit of using Jeevatu was obvious: the yield has doubled in the Jeevatu-treated plot as compared with the control plot. Other analysis also demonstrate the positive effect of Jeevatu on the quality of rice.

In 2012, an experiment was conducted in Lalitpur (Kathmandu) on non-organic ginger crops (Poudyal, 2010)

Seed rhizomes were first deepen into a solution of 19L of water and 1L of Jeevatu during 30 minutes. Then, the plantation was treated with Jeevatu-based farm yard manure and chemical fertilizers (DAP, urea, etc.). Finally, soft rot diseases still appeared on 6 clumps. They were

[11] In chemical based plot, we used NPK fertilizer with compost manure without Jeevatu. In per 0.05 ha plot we used the 10 kg urea in three times (plantation, / one month/ 2 month); 5 kg DAP in plantation time and 3kg potash in plantation time of paddy. (Suraj Adhikari).

therefore regularly treated with various Jeevatu treatments. The following treatments were applied: T-1 (1 part Jeevatu with 19 part water), T-2 (1 part Jeevatu based organic liquid manure with 2 part water), T-3 (1 part Jeevatu based organic liquid manure with 3 part water) and control T-4 (only ordinary water). Fermented Jeevatu Liquid Manure 1 was produced as follow: Compost 25 kg, ordinary water 50 liter and 1 liter Jeevatu. The soft rot was found completely cured on 4 out of 6 infected clumps after 10 times soil drenching (drenching at the frequency of twice a week). This experiment mixes several treatments and the number of experiments is also too limited. Therefore, it doesn't lead to very clear conclusions.

Experiments in other SAARC countries:

One experiment comprising the use of Jeevatu that was conducted in Bhutan could be found on the Internet. It concluded that spraying Jeevatu on crops of broccoli didn't prove to control aphids, whereas other types of biological treatments were effective (Tshering, 2012).

Field experiments:

NFI has also conducted other experiments sometimes with the support of NARD at some ZECS sites. But no precise and scientific analysis have been carried out. These experiments as well as some feedback from Jeevatu users constitute however a first basis to conduct further research and conclude about the circumstances under which Jeevatu is the most effective.

For instance, as presented by Mr. Suraj Raj Adhikari during the SATNET workshop, Jeevatu successfully controlled the following diseases on certain types of crops:

Crop type	Disease
Mandarin	Citrus greening, collar rot
Bitter gourd, bottle gourd	Powdery mildew
Tomato	Late blight

However, Jeevatu was used in tomato aphids in IPM experiment in summer of 2011 at Chetana Kendra Banepa (3 times spraying was done for 2 weeks) by Madhu Sudan Paudyal, a Senior Plant Protection Officer at the Nepal Department of Agriculture, but it completely failed to control the aphids.

Two new experiments that will be further documented by NFI are currently ongoing (Ms. Amrita Paudel):

- Citruscline (since March 2014 in Kirtipul)
- Rice cultivation experiment in the *Terai* (Bara). NFI let the Dept. of Horticulture do the treatments and NFI visits the site once a week.

6 Scientific protocol to assess Jeevatu

In order to validate the effectiveness of Jeevatu, the following steps should be undertaken (Dr. Ali, RKMVU).

Technical assessment:

1. Identify and characterize species of microbes of the Jeevatu solution (biochemical and molecular)
2. Measure the growth of microbes along different time periods
3. Identify their type of action
4. Make quantitative and qualitative survey of the number of nutrients fixed by the microbes
5. Identify the role of bacteria on pest/disease control (antagonists/pathogens...) and prove their efficacy experimentally
6. Conduct a plant growth regulators test (types and quantity)
7. Find out the effect of different concentrations of jeevatu on the growth of the plants in different places, seasons and types of crops.
8. Conduct comparative experiments (between the action of J. and the available alternatives)

Validate it in terms of crop yield, soil health, others...

Sustainability Assessment:

Additionally, a socio-economic assessment can be done in order to validate the viability, the acceptance of the product by the farmers and some environmental and health impacts.