Food Resilience Through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+)

REPORT on the
Training and Learning Visit on
Sweetpotato Silage and Use of Other RTCs Residues for Animal Feeding

1. Background Information

Purpose: Small-scale pig farming is an integral part of livelihood and farming activity in northeast India. The FoodSTART+ scoping study in Meghalaya has confirmed that root and tuber crops (RTCs) are major components of livestock feed in the state. However from time to time, farmers depend on external commercial source for feed especially concentrates. This calls for equipping farmers with better knowledge and skills on technology on animal feed for proper storage and higher nutritional quality to maximize the benefits. The International Potato Center (CIP) and its partners have tested, validated and promoted sweetpotato and other RTCs silage technology in number of countries, including Vietnam, as a valuable innovation for conserving high quality feed to be used during feed scarcity periods. The training and learning visit on sweetpotato silage and use of other RTCs residues for animal feeding would greatly help the Indian participants on knowledge and skills enhancement to further transfer the technology to farming communities of Meghalaya and other north eastern states especially Mizorum, where piggery related livelihoods are abundant. Moreover, Megha-LAMP and FoodSTART+ collaborative workplan have included to conduct activities to validate and promote sweetpotato (and other RTC residues) silage in Meghalaya, India. This training and learning visit is the first activity aiming at exposing Indian participants to basic theory and practicum of silage making and utilization.
Location: Phuc An commune, Yen Binh district, Yen Bai province (site of CIAT RTB project implemented in 2014-2015). Vietnam
Dates: May 11 and 12, 2017
Resource person: Ms. Nguyen Thi Tinh
Participants: Staff of Megha-LAMP investment project; Directorate of Horticulture, Meghalaya; Agriculture Department, Meghalaya; Directorate of Animal Husbandry and Veterinary , Mizorum; and CIP Consultant. Please see complete list of participants in Annex 1.

2. Highlights of the activities

The detailed schedule of the training and learning visit is provided in Annex 2.

2.1. Day 1

A. Visit to farmers who have sweetpotato (SP) vine field before cutting, make SP vine silage and feed silage to fattening pigs, and silage of cassava root and cassava starch residue for fattening pigs

The trainees interacted with the RTCs farm families to discuss about the RTCs production in general and specifically on role of RTCs in animal feed. Four farming families practicing silage from sweet potato and cassava tubers and factory residues were visited. The information on the farming families visited is provided in Annex 3.

RTCs grown in their farms included sweet potato, cassava and taro with rice as the major crop grown. Cassava is a major source of income for the farmers.

Sweet potato variety with higher vegetative growth and tuber yield is cultivated in spring and winter seasons. It is grown both in low and high land production system. Sweetpotato roots are mainly used for human consumption and animal feed while the leaves are mainly used as animal feed. Young green vegetative portion is used for silage making. The leaves are usually harvested in the afternoon of previous day.

Cassava is mainly grown in steep high lands and forest. It is grown as monocrop and as intercrop with forest trees. Cassava is an annual crop with 8-10 months from planting to harvesting. It serves as an important source of food and feed at the household level and as raw material for processing into a wide range of products, both at the household and small-scale processor level, generating employment in the rural sector. Cassava leaves, roots and residues from cassava processing units are used in silage making for animal feed.

Piggery is an important livelihood for farmers, and silage made from sweet potato and cassava were used as feeds. All the farmers visited prepare their own silage from the RTCs.

B. Training on theories of processing and using sweetpotato roots and vines and other materials for animal feeding

Ms. Nguyen Thi Tinh made a power point presentation on processing sweetpotato and other feed materials for ensiling and use for animal feed, and this covered the following areas.

1. Introduction to some feed materials and purpose of ensiling
2. Use of sweetpotato as animal feed and nutrient content
3. Use of cassava as animal feed and nutrient content
4. Why ensiling and storing feed materials are needed?
5. Characteristics and constraints of some feed materials
6. Chemical composition of feed materials
7. Ensiling the feed materials: Method developed and applied in animal feeding activities of the projects of CIAT and CIP
8. Advantages of ensiling
9. Principles of ensiling: Anaerobic fermentation, Using additives
10. Procedure of ensiling: Chopping materials, Weighing materials, Mixing the ingredients/additive mixture, Putting the mixed material into the bag(s), pressing, closing and writing date and material on the bag, Storing and parking the bags of the silage in cool place
11. Respiration or transpiration phenomenon or process

12. Formulas for ensiling
13. Using silages for animals.

Please refer to Annex 4 for the powerpoint presentation of processing sweet potato and other feed materials for ensiling and use for animal feed.

This was followed by a presentation from Dr. Peter Malsawmtluanga on how banana silage is used for piggery in Mizorum. Please see Annex 5 for the complete powerpoint presentation.

Dr. Malsawmtluanga mentioned that in Mizorum, there is a high demand for pork and piggery is a fastest growing subsector. It was observed that there is deficit in pig feed. Piggery needs unconventional alternate feed sources. Nearly 46 % of households are involved in piggery. Banana forms one of the sources of piggery feed in the form of silage. There are nearly 14 species of Musa found in Mizorum. Silage making in Mizorum involves manual chopping of Musa plant (banana) and kept in silage drums. He also explained the nutrient content of banana silage.

Another presentation were made by Dr. Anantharaman on on CTCRI technologies on Cassava silage. Please refer to Annex 5 for the presentation on cassava silage.

Dr. Anantharaman explained about the ICAR-CTCRI technologies on making of cassava silage and the feed formulation using cassava silage for cows and calves. The cassava feed using factory wastes and its formulation was presented. The impact of cassava silage on the cows and calves in terms of milk yield and weight gained was also mentioned.

2.2 Day 2

A. Practicum on making silage of SP vine

The five trainees were involved in the hands-on training on the following technologies.

1. Procedure of silage making from sweetpotato which involved following operation:
    a. Chopping sweetpotato using a motorized chopper
    b. Weighing the chopped materials
    c. Spreading /raking the materials on the floor
    d. Taking proportionate additives (common salt) and mixing it with chopped leaves
    e. Preparation of the silage bin by putting together partitioned bin insulated with airtight polythene bag sheets
    f. Putting the chopped leaves with ingredients and stamped tightly to push off all the air in the interspace
    g. Close the polythene bag (air tight) and close the bin

2. Procedure of silage making from cassava roots which involved following operation:
    a. Chopping cassava tubers using a motorized chipper
    b. Weighing the chipped tubers
    c. Spreading / raking the materials on the floor
    d. Taking proportionate additives (common salt) and mixing it with the chipped tubers
    e. Preparation of the silage bag by putting polythene bag inside sack
    f. Putting the chipped leaves with ingredients inside silage bags and stamped tightly to push off all the air in the interspace.

g. Close the polythene bag, air tight.

Please refer to Annex 7 for photo on the processing of different silage.

B. Discussions

There were discussions after the theory and practical sessions. The nature of additives, ingredients used and how to make the ration, calculations on the proportion of ingredients, number of farmers adopted the silage technologies, duration of the stored silage, method of feeding the silage were discussed. It was observed that farmers were satisfied with the technologies.

3. Feedback from Evaluation of the Activity

The feedback given by the five trainees from the Evaluation Questionnaire is presented in Annex 8 and the analysis done on the score obtained on each item of evaluation in Annex 9. It may be seen that the mean score of over-all rating is 4.8 and learning expectation met is 4.7 which are well above 4.5 revealing in general all the participants had strongly agreed that the training was effective in gaining knowledge on silage making. All the items had mean score above 4.5 except lecture discussion, duration and time for sessions which had only 4.2 indicating these items need improvements. The duration of visit and theory and practical sessions were felt somehow short which may be increased in the future. The major suggestions offered by the participants are (1) may be arranged for poultry and cattle feeding materials, (2) video on silage preparation may be supplied which will be an effective reference material, and (3) economics and business plan and effect of these silage on the animals. All the participants felt that the silage technologies are very appropriate for implementing in their respective states.

4. Recommendation or next steps (if any)

There is a good similarity of the production systems of RTCs and piggery as a source of livelihood of farm families between the learning sites and the Indian states of Mizorum and Meghalaya. The silage preparation from sweetpotato leaves and cassava roots is appropriate to the North eastern states as there is a need for animal feed for their pigs from local resources and availability of RTC raw materials. The technology of silage will be adopted since the technology is economical, feasible and proven. This silage preparation from sweetpotato vines and cassava roots technology may be assessed and transfer in the villages of Meghalaya and Mizorum in the form of action research followed by a greater magnitude of technology transfer. There is a strong feeling from the trainees that they will very likely make use of the knowledge gained on silage making in their localities.

Annex 1 – List of Participants

	Name	***Position***	***Organization***	***Country***	***Email address***
1	Evangel Shanpru	Officer on Special Duty	Megha-LAMP	India	evangelshanpru07@gmail.com
2	Louis Victor Khonglah	Horticulture Development Officer	Directorate of Horticulture,Meghalaya	India	victorkhonglah@gmail.com
3	Merril N. Sangma	Assistant Director of Agriculture Plant Protection	Department of Agriculture,Meghalaya	India	sangmamerril@gmail.com
4	Peter Malsawmtluanga	Veterinary Extension Officer	Directorate of Animal Hasbandry and Veterinary,Mizoram	India	peter2364040@gmail.com
5.	M.Anantharaman	Consultant, CIP	CIP	India	mananthr@yahoo.co.in
6.	Nguyen Thi Tinh	Consultant and Resource Person	CIP	Vietnam	ngthitinh2007@gmail.com

Annex 2 - Program

Day 1 (May 11):

7:00-9:45: Leaving Hanoi to Yen Bai (participants have breakfast before leaving)

9:45-11:45: Visit to farmers who have sweetpotato (SP) vine field before cutting, make SP vine silage and feed silage to fattening pigs. Visit to farmers who have silage of cassava root and cassava starch residue for fattening pigs

12:00-13:45: Lunch and rest

14:00-17:30: Training on theories of processing and using SP roots and vines and other materials for animal feeding *(Venue: meeting room of the commune)*

Day 2 (May 12)

8:00-11:45: Practice on making silage of SP vine *(Venue: house of a farmer)*

12:00-13:30: Lunch and rest

13:30-15:00: Discussion

15:00: Leaving Yen Bai back to Hanoi

Annex 3 - List of farm families visited

Commune: Phuc An

District: Yen Binh

Family	Wife	Husband	Village
1	Ma Thi Ban	Nguyen Van Bao	Cau Trang
2	Ha Phi Thy Duong	Ha Chi Thuc	Dong Tanh
3	Nguyen Thi Thuy	Duong Van Hiep	Dong Tam
4	Ha Thi Thuyet	Nguyen Van Due	Dong Tam

Annex 4 – Presentation on processing sweet potato and other feed materials for ensiling and use for animal feed

PROCESSING SWET POTATO AND OTHER FEED MATERIALS BY ENSILING AND USE FOR ANIMAL FEED

Nguyen Thi Tinh

Technology concluded from projects from 1999-2015
- Project: "Improving Sweet potato and Pig production systems in Vietnam" of CIP;
- Project PRDU: "Participatory Research for Development in Highlands" of CIAT;
- Project SLP: "Using system analysis and modeling tools to develop improved feeding strategies for small-scale crop-livestock farmers in East, South-East Asia" of CIP;
- Master student project from Gates-Mera funds: "Improving feeding systems by producing and using cassava combining with Stylo and other feed materials for small holder pig production in Vietnam" of CIAT;
- 4FGF project: "Food, Feed, Fuel and Fiber for a Greener Future" of CIAT and CIP;
- RTB (Roots, Tubers and Bananas) project of CIAT

1. Objectives: Why processing is needed?

1.1. Feed materials can be processed

- Roots (Sweet potato-SP, cassava root),
- Vine, leaf , plant (SP, groundnut vine, cassava leaf, forage maize-young maize plant in milky stage)
- By-products:

By-product of starch production (residue) of cassava and canna root

By-product of plant production: cassava leaf, groundnut vine, maize stover, especially, green plant of sticky maize after harvesting cobs

1.2. Characteristics of the feed materials

Table 1: Characteristics of materials will be processing

Material	Characteristics
SP, cassava root	High water content
SP vine	
Cassava, canna residue	
SP, cassava root	Low protein content
Cassava, canna residue	
Canna residue, maize stover	High fiber content
Cassava leaf and root	High toxic HCN content

Table 2: Chemical composition of materials will be processing

Material	Water content (%)	CP content (% in DM)	CF (% in DM)	HCN content (mg/kg DM)
Fresh SP vine	89.6	17.2	19.0	
Fresh SP root	77.2	4.8	4.0	
Fresh cassava root	56.7	2.5	2.8	315
Fresh cassava leaf	65.7	19.6	14.8	1,380
Wet cassava residue	81.8	2.3	13.6	
Wet canna residue	88.2	2.5	16.6	
Forage maize	78.6	8.6	20.6	
Maiz stover	38.4	7.6	315	

1.3. Advantages of processing and storing

- To store and preserve feed materials to avoide losses causing by rot or weevil attack
- To make use sources of feed materials, by-products for animal feed for long use, solve problems of feed shortage
- To increase nutritive value of feed via ensiling, fermentation such as increase protein from microbes, fiber become more easily digestible, volatile fatty acids (lactic, propionic and acetic acid), reduce most toxic HCN

Advantages of processing and storing (Continued)

- Harvesting, processing and storing of materials (SP, cassava, maize…) can be done at the same time on larger area with large amount and use for long time
- To reduce cash capital for buying commercial feed for animals
- Feeding animals with silage(s) rawly is easy, simple and reduce time, labour and cost of fire wood for cooking feed

2. Processing SP and other feed materials by ensiling

2.1. Principles of ensiling

- Anaerobic conditions:
- Keeping silage in tightly closed plastic bag(s), no whole or scratch
- Reducing maximum air in the silage by strongly pressing

Principles of ensiling (continued)

- Using additives:
- Additives increase dry content of silage
- Additives are nutritives (precursors) for microbes helping early fermentation

Additives: 0.5% salt, cereal powder (maize meal, rice bran, cassava root meal)

Evenly mixing additives with ensiling material

2.2. Procedure of ensiling

- Chopping, grating ensiling material (vine, root, leaf,…)
- Weighing chopped ensiling material or residues (1)
- Calculating cereal powder additive amount basing on formula
- Weighing additive(s) (2)
- Weighing salt (3)
- Evenly mixing cereal powder additive with salt (4)=(2)+(3)
- Evenly mixing chopped material with additive mixture (5) = (4) + (1)
- Putting in bags, strongly pressing, tightly closing, writing date and material on bag
- Storing bags of silage

2.3. Fomulas for ensiling

2.3.1. For ensiling only one material:

- 96.5% SP vine (or GN vine, forage maize, forages) + 3% maize or cassava root meal or rice bran + 0.5% salt
- 99.5% SP root (or cassava root, cassava residue) + 0.5% salt
- 96.5% canna residue + 3% maize meal + 0.5% salt

2.3.2. Ensiling mixture of different materials

Combining root or residue with vine, plant, forages in any proportion depending on their available.

Example:

- Ensiling SP or cassava root, cassava residue with SP vine, GN vine, forage maize

Ensiling formula:
99.5% mixture of materials + 0.5% muối

Respiration (Transpiration): unavoidable process during first 2-3 days after making silage.

Takes place when:

- Microbial population not yet developed
- Fermentation just started
- pH value not yet obtained standard value

Respiration is opposite of photosynthesis:

Carbohydrates (sugars and starch, $C_6H_{12}O_6$) in feed material
↓ O_2 and t°C
CO_2 and H_2O

Therefore root is more strongly respirated

Note: Solving problem of respiration in silage bags:

Often checking silage bags during first 2-3 days after making silage

If much air in the bags and they are like balloons, open bags and release the air from inside, press and tightly close the bags again

3. Using silages for animals

3.1. Notes for using silages to feed animals

- *When can silage be fed to animals?* At least 14 days after making silage
- *How long can silage be stored for?* Depending on anaerobic condition (at least for 9 months).
- *When can animals be fed with silage?*
Pigs after live weight of 18-20 kg or age of 2.5 months
Cattle, buffaloes after age of 6 months.
- *Method of feeding the pigs with silage*
Silage + Compound feed + Water ---> Rawly feeding 3 times/day

- Silages are only processed and stored roughages
- Silage of root and residue are protein poor feed (silage of SP and cassava root, cassava and canna residue)
- Silage of vine, leaf, plant, forage are energy poor feed (silage of SP and GN vine, cassava leaf, forage maize, forages)
- Therefore, need to supplement rations with protein or energy sources to balance rations for higher weight gain, shorter fattening time period, more fattening cycles and higher economical efficiency.

3.2. Ration for fattening pigs:

50% of silage + 50% compound feed

3.3. Using silages for cattle and buffaloes

Silages for cattle and buffaloes: silage of cassava root, cassava residue, cassava leaf and stem, canna residue, forage maize, maize stover, grasses

Completely tethered:

Day: Silage + Compound feed (Maize meal, cassava root meal, rice bran + mineral or lime powder) + Fresh grass
Night: Dried rice straw

Partly tethered:

Day: Grazing
Night: Supplementing with silage, compound feed and dried rice straw

Compound feed for cattle or buffaloes:

75% maize meal + 20% rice bran (or cassava root meal) + 5% lime powder

Daily compound feed amount = 10-15% of silage amount

Feeding way:

Evenly mix compound feed with silage,
Feeding 2-3 times/day

Practices will be done

Ensiling SP vine with maize meal and salt
Ensiling cassava root with salt

Annex 5 - Presentation on Banana Ensiling for Pig Feed in Mizoram, India

CONCEPT NOTE OF MUSA ENSILING FOR PIG FEED IN MIZORAM INDIA

PETER MALSAWMTLUANGA
FoodSTART+ Hanoi Vietnam Participant

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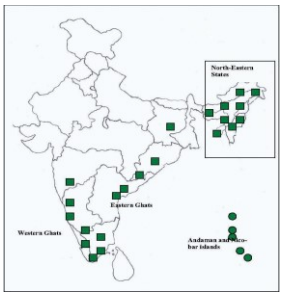

Areas of India where Wild Musa are found

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Just few kilometres from CIP Meghalaya or MeghaLAMP

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MIZORAM?

- Total Area – 8142 Sq. Km (0.64%)
- Population – 1,097,206 million
- Gross domestic product: 1.1 billion
- 2157 above sea level
- Internationally Bounded by
- Myanmar and Bangladesh

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SILAGE for Piggery?

- High Pork Demand
- Piggery – fastest growing agricultural sub-sector
- Feed deficit
- 70% of total investment
- Need for unconventional alternate feed resources

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Species of Musa found in Mizoram, India

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PIGGERY IN MIZORAM

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PIGGERY IN MIZORAM

-7633.783 US TON

- 45.55 % of the household involved

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Varieties of Musa found in Mizoram

Cultivar (Local name)	Scientific name
Changthir	Musa balbisiana
Balhlakual (Amrit Sagar)	Musa acuminata
Changpui	Musa paradisiaca
Saisu	Ensete glaucum
Banria	Musa paradisiaca
Lawngbalhla	Musa paradisiaca
Changkha	Musa paradisiaca
Changvandawt	Musa ornata
Lairawk	Musa paradisiaca
Banthur	Musa paradisiaca
Kawlbalhla	Musa paradisiaca
Changpawl	Musa paradisiaca
Banpawl	Musa paradisiaca
Balhlasen	Musa paradisiaca

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Musa Ensiling in Mizoram

Manual chopping of Musa plant for ensiling

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Musa Ensiling in Mizoram

Silage drum containing Musa silage

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Musa Ensiling in Mizoram

Pig Feed Ready Musa Silage

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Nutrient Composition

Banana leaves contain about 15 percent DM and 10−17 percent CP, while pseudo stems contain 5−8 percent DM and 3−5 percent CP.
The NDF and ADF vary between 50−70 percent and 30−40 percent, respectively.
Banana leaves contain 8 percent polyphenols, but very few condensed tannins (Marie-Magdeleine *et al.,* 2010).
Constraint low crude protein content
Azzolla addition in silage

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ADVANTAGE

- Reduction in the feed cost which is a major problem for the farmers.
- Minimixing of labour/ man-power thus enabling the farmer to rear more number of pigs
- Better utilization of non-conventional feed source

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FUTURE PROSPECT

- Formulation of suitable Standard Operating Procedures for better production which could be taken up by the farmers.
- Identification of suitable additives
- Prolonging of the keeping quality of the ensiled musa
- Analysis of the nutritive content before and after ensiling
- Formulating optimal inclusion level in the pig ration.

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THANK YOU

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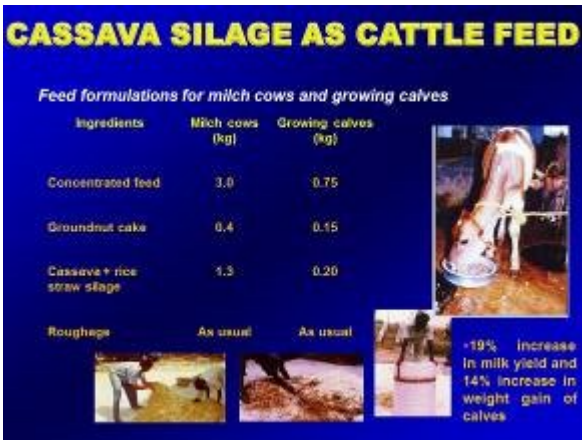
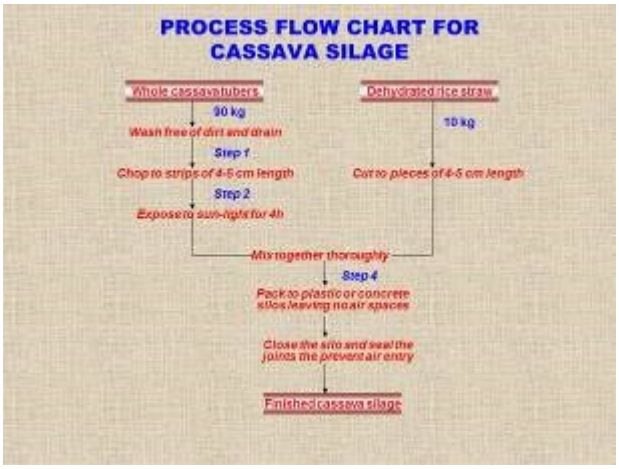
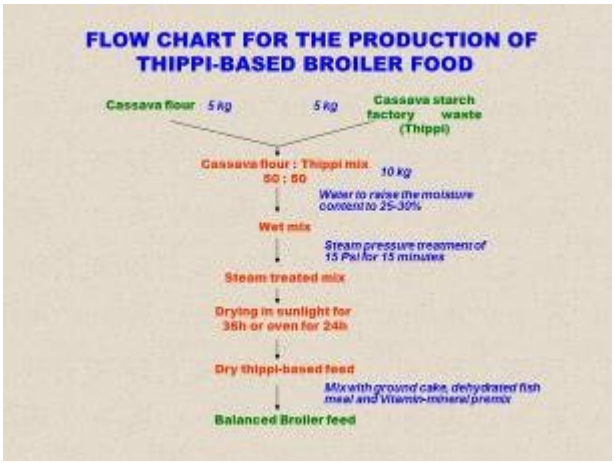
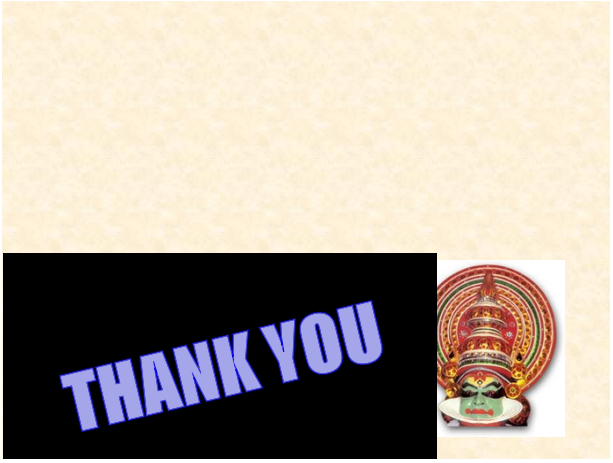
Annex 6 – Presentation on Cassava ensiling









Annex 7 - Selected photos of the learning visit

Sweetpotato field	Cassava field

Piggery shed	Theoretical class

Presentation by Resource person	Trainee

Presentation by another Trainee

Hands on training of Cassava silage making

Hands on training of Sweetpotato silage making

Group photo of the trainees who are charged with new knowledge with a farm family

Annex 8 - Feed back of trainees on Evaluation Questionnaire

Evaluation items	Megha LAMP-Meghalaya, India	Directorate of Horticulture, Meghalaya, India	Department of Agriculture, Meghalaya, India	Directorate of AH and Vet, Mizorum, India	CIP consultant, India
A. Content and organisation					
1. The learning has enhanced my knowledge and skills	Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
2. The topics were relevant for my job	Strongly agree	Neutral	Strongly agree	Strongly agree	Agree
3. The methodology facilitated my learning					
a. Lecture-discussion	Strongly agree	Disagree	Strongly agree	Agree	Strongly agree
b. Practicals	Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree
c. Field visits	Agree	Agree	Strongly agree	Strongly agree	Strongly agree
4.The training design was well structured	Strongly agree	Disagree	Strongly agree	Strongly agree	Strongly agree
5. The time allocation for the learning visit was appropriate					
a. Overall duration of the visit	Strongly agree	Neutral	Strongly agree	Agree	Agree
b. Time allocation per session	Strongly agree	Neutral	Strongly agree	Agree	Agree
B. Training delivery and logistics					
6. Resource persons provided expert inputs to the training	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
7. The training shared useful learning materials	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
8. Venue and training facilities were adequate	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree
9. Accommodation and food were adequate	Strongly agree	Strongly agree	Strongly agree	Strongly agree l	Strongly agree

10. Transportation were properly arranged	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
C. General					
11. The learning visit has met my expectations	Strongly agree	Neutral	Strongly agree	Strongly agree	Strongly agree
12. Overall, how would you rate the learning visit?	Excellent	Good	Excellent	Excellent	Excellent
13. What aspects of the learning visit could be improved?	On business plan and cost of production	More practical sessions	Perfectly alright	Nil	Project proposal models on this. Economics and impact on health and weight gained
14. Other comments? Suggestions for next learning visit?	May be arranged for Poultry and cattle feeding materials	Start /stop time could be revised	Excellent keep it up	Thailand or India	Video on silage preparation may be supplied. Duration may be increased.
15. **Only for staff of implementing agencies of IFAD investment projects** - How likely you are going to use the acquired knowledge for the implementation of the IFAD investment project?	Very likely	NA	Indirectly connected Very likely	Very Likely	Indirectly connected Very Likely

Annex 9 - Analysis of Trainees feedback

Evaluation items	Mean Score
A. **Content and organisation**	**4.48 (Average mean score)**
1. The learning has enhanced my knowledge and skills	4.8
2. The topics were relevant for my job	4.6
3. The methodology facilitated my learning	
a. Lecture-discussion	4.2
b. Practicals	4.8
c. Field visits	4.6
4.The training design was well structured	4.4
5. The time allocation for the learning visit was appropriate	
a. Overall duration of the visit	4.2
b. Time allocation per session	4.2
B. Training delivery and logistics	**4.9 (Average mean score)**
6. Resource persons provided expert inputs to the training	5.0
7. The training shared useful learning materials	5.0
8. Venue and training facilities were adequate	4.8
9. Accommodation and food were adequate	5.0
10. Transportation were properly arranged	5.0
C. General	**4.7(Average mean score)**
11. The learning visit has met my expectations	4.6
12. Overall, how would you rate the learning visit?	4.8
Over all rating	4.8