SOLAR DRYING IN LAURI

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An SJI pilot impact area project

The Samdrup Jongkhar Initiative (SJI) and the people of Lauri gewog began their partnership with six Lauri women going to the Barefoot College in Rajasthan, India to train as their gewog's first solar engineers.

With the help of these six solar engineers, the Centre for Appropriate Technology (CAT) at the Jigme Namgyel Polytechnic (JNP) and the SJI conducted field test of two solar dryers in Lauri.

After successful field trails, the SJI secured funds to build 23 solar dryers in Lauri (18) and Serthi (5) gewogs.

This case study looks at the key features of the solar dryer project implemented by the SJI in Lauri gewog.

The Samdrup Jongkhar Initiative

The Samdrup Jongkhar Initiative (SJI), a project under the umbrella of the registered civil society organization Lhomon Society (LMS), was launched in 2010 as a potential model for the country to raise living standards in Samdrup Jongkhar district and beyond in an ecologically friendly way, and to establish food security and self-sufficiency, while fully protecting and enhancing the natural environment, strengthening communities, promoting Bhutan's unique culture, stemming the rural-urban migration tide, and fostering a cooperative, productive, entrepreneurial, and self-reliant spirit.

Since its inception, SJI has focused on four areas of work to achieve this aim: i) organic agriculture, ii) sustainable waste management, iii) appropriate technology, and iv) youth engagement. The intention is to expand the SJI agenda to focus more on economic diversification and new possibilities for sustainable income generating activities identified by the local communities in Samdrup Jongkhar and the government of Bhutan.

The Centre for Appropriate Technology

The Samdrup Jongkhar Initiative is based in Dewathang, which is also home to the Jigme Namgyel Polytechnic (JNP) of the Royal University of Bhutan. It is at JNP that the Centre for Appropriate Technology (CAT)is housed. The primary aim of CAT is to improve the standard of living in the area by providing well-informed technological support to address challenges faced by the rural and agricultural communities. The centre aims to link the academic and agricultural communities, providing curricula for students in rural and agricultural technologies, while researching and finding solutions to the challenges facing rural and agricultural communities.

Lauri

Lauri has 543 households spread over 15 villages and is the last gewog in Samdrup Jongkhar district not yet connected to electricity or road[1]. Besides its remoteness, Lauri also has the highest number of poor in the district[2]. The eleventh plan document of Samdrup Jongkhar states that the 2010 GNH Index for Lauri is the lowest in Samdrup Jongkhar with a score of 0.655[3].

Lauri gewog is home to 4411 people. Maize is the staple crop. Lauri farmers also grow upland paddy, millet, mustard, legumes, buckwheat and potato.[4]

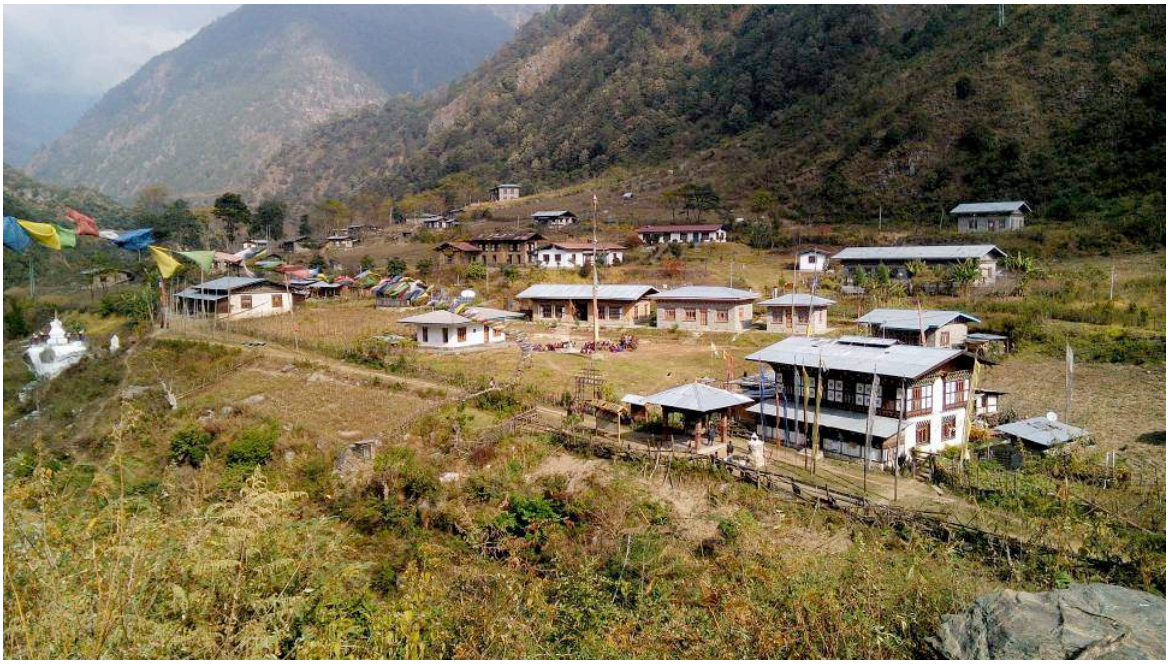
[1] At the time of writing, the formation cutting of the road had reached Patpanadang. From Patpanadang, it is a three hours walk to the gewog centre at Jompa.

[2] The small area estimation of poverty in rural Bhutan published by the National Statistics Bureau of Bhutan and the World Bank puts the number of poor in Lauri gewog at 1619, the highest in the district.

[3] The 11th plan document published by the Gross National Happiness Commission says poverty incidence is high in the dzongkhag with income measure standing at 21 percent compared to the national average of 12 percent in 2012. On the multidimensional basis the poverty incidence was 32.3 percent in 2010.

[4] www.samdrupjongkhar.gov.bt

Lauri gewog falls under the jurisdiction of Jomotsangkha dungkhag (Lauri, Serthi, and Langchenphu). To reach Lauri from Dewathang, one has to exit Bhutan at Samdrup Jongkhar and travel through the Indian state of Assam. From Samdrup Jongkhar, it is a three-hour taxi ride to Jomotsangkha, the administrative headquarters of the dungkhag .



From Jomotsangkha, the traveler has to hire a taxi or hitch a ride to the trail-head to Lauri. In 2012, this place was Phogcheree.

From Phogcheree, it is a full day's journey on foot to Debtshang for a city dweller, although Lauri residents reach their villages without stopping at Debtshang. From Debtshang it is a matter of four to six hours to reach Jompa, the administrative headquarters of Lauri gewog.

The altitude of Lauri (1800 masl) is favorable for growing vegetables and chilies especially during the monsoon[5]. Many gewogs in Samdrup Jongkhar have to contend with excess precipitation, which impedes vegetable production. In the absence of a road, Lauri farmers have no access to the market. Transporting vegetables to the nearest market at Jomotsangkha is not only time consuming but uneconomical. The earning does not make up for the time and energy spent on carrying the vegetables from Lauri to the market, the nearest one being Jomotsangkha. Lauri farmers say the perishable nature of the produce also limits potential for marketing the vegetables.

In such conditions, Lauri farmers dry their produce for self-consumption, barter and exchange and to offer as gifts to visiting guests and family members residing outside their village.

The visitor to Lauri notices vegetables and non-wood forest produce drying on roofs and on open ground. The visitor also cannot miss the ubiquitous presence of chili. For many Bhutanese in eastern Bhutan, Lauri is synonymous with chilies. Lauri gewog has a chili growing group with 25 members. Dried chilies coming from Lauri can be grouped into three categories. The dried red ones (known generally as *ema kam*) are the most prominent followed by the blanched and dried white known as *shu kam*. Lauri farmers also produce sliced and dried green chilies known as *ho kam*.

While drying vegetables and fruits is common practice in Lauri, Lauri farmers saw solar drying as a better alternative to drying in the open. Farmers observed that open drying leads to mold formation and damage and contamination by birds and animals. Farmers pointed out uniform drying and retention of color and nutrient as some of the advantages of solar drying.They also pointed that since the dryers are covered by UV sheet, solar drying doesn't require their presence thus freeing them to focus on other farm work.

[5] Please refer Annex 1 for a list of produce dried by Lauri farmers

The 'Made in Samdrup Jongkhar' Solar Dryer

One of the first collaborative projects between the SJI and CAT at JNP was studying the potential for application of solar dryer technology in Samdrup Jongkhar dzongkhag, and — if successful — in other parts of rural Bhutan.

In February 2011, the co-directors of the Barli Development Institute for Rural Women in Madhya Pradesh, India were invited to Samdrup Jongkhar to give presentations to JNP staff and students, agriculture officers and farmer representatives on the potential of low-cost solar drying technologies to open new market opportunities for Bhutanese organic produce. Such solar vegetable and fruit drying methods, it was explained, can help extend shelf life, allow access to new markets, and fetch good prices. The demonstration generated an enthusiastic response, in particular from the JNP faculty who promptly proposed to develop locally appropriate solar drying units for Samdrup Jongkhar based on the Barli designs, and train local farmer representatives in their operation and maintenance.

On the initiative of the SJI, and funded by the International Development Research Centre IDRC), a JNP faculty member Mr. Denten Zangpo and six Samdrup Jongkhar villagers from Lauri gewog undertook training in solar drying fabrication and maintenance at the Barli Development Institute in Madhya Pradesh, India during the fall of 2011[6].

At the JNP mechanical engineering department, work started in earnest and the first 'made-in-Samdrup Jongkhar' solar dryer[7] was built in November-December 2011, with support from the IDRC (Annex 2 Fig. 1).

The Barli model and the replica built by CAT were made from metal. Both the structure and trays to hold the vegetables inside the dryers were metal. In order to validate the technical competency of the dryer, the SJI sought the expertise of the National Post Harvest Centre (NPHC) of the Ministry of Agriculture and Forests. The chief post production officer of the NPHC Mr. Pema Dakpa and his colleague Mr. Karma Dorji conducted field tests of the dryer at the JNP campus. Besides providing advice on design modifications, the NPHC said "the solar dryer has proven effective for drying the fresh produce since it has achieved a considerable drying environment during daytime and cooling environments effectively preventing condensation overnight. Further, the dried products retained some color and were free from contamination of mold, dust, and insects and effectively eliminated bird damage."[8]

Although the current design was operational there was some concern about the feasibility including transport of all the metal components to Lauri on foot. Mr. Pema Dakpa recommended fabricating the solar dryer from timber and locally available materials. Also excessive heat loss was noticed through the corrugated iron sheet (used for roofing) used as the base of the dryer. This was modified by laying a bamboo mat as the base. The bamboo base was topped by finely sieved soil and covered by plastic sheet. The roofing sheet was placed on atop the plastic soil, thus providing effective insulation to the solar dryer.

After these updates the solar dryer was recommended for field testing in Lauri so farmers could give their suggestions for improvement and modification.

[6] The six women from Lauri gewog trained for six months at the Barefoot College in Tilonia, Rajasthan with funding provided by the government of India. They went to Barli after their training at the Barefoot College.

[7] More details on the technical aspect of the dryer can be found in the report "Fabrication of Solar Dryer" prepared by three JNP students who were involved in this project.

[8] Annex 3: Solar dryer evaluation report prepared by Mr. Pema Dakpa, Chief Post Production Officer, NPHC

Field Testing of the 'Made in Samdrup Jongkhar' Solar Dryer

With funds from the IDRC, CAT and SJI started work field testing the dryers in Lauri gewog. The structure of the wooden dryer was built at CAT and readied to be taken to Lauri. Three JNP students from the mechanical engineering department, Yeshey Dorji, Tenzin Tashi and Tshering Tenzin (who had worked on the fabrication of the metal solar dryer) were selected to field-test the solar dryers in Lauri. The NPHC agreed to teach proper food drying and packaging techniques to the farmers of Lauri.

In the month of December 2011 and January 2012, a team consisting of the three JNP students, Mr. Karma Dorji (post production officer) of the NPHC and SJI farmer liaison Sherab Dorji started work in Lauri to field test the dryers[9].

In Lauri, the solar dryer team was joined by the six Lauri women who had been trained on vegetable drying at the Barli institute. The prototype solar dryer (wooden) was taken to Gonong village in Zangthey, Lauri. In Lauri village, the team gathered farmers to train them on the fabrication and drying of vegetables. One dryer was built on the farm of Mr. Dorji Dakpa in Lauri village and the second one was built in in Gonong village, on Mr. Tshering Gyamtsho's farm.

Going Beyond the Field Test

With the two solar dryers performing well in the field, the SJI field office in Dewathang started receiving requests from the local government of Lauri and the people of Lauri for more dryers to be installed in their villages.The SJI secured funding from the Rural Economy Advancement Programme

[9] Annex 4 provides the cost breakdown of the solar dryer.

of the Gross National Happiness Commission of the Royal government of Bhutan and the United Nations Development Programme to provide 23 dryers in Lauri and Serthi gewogs.

This new phase aimed to contribute to equitable and balanced socio-economic development and poverty eradication by putting in place a framework that will enable the poor to secure sustainable livelihoods by increasing their productive capacity. The installation of additional solar dryers would further enhance the skills and capacity of the six women solar engineers and local carpenters to construct and maintain such solar dryers, and the high quality of the solar-dried fruit and vegetable products would lead to better marketing possibilities and income generation for the people of Lauri.

Key Outcomes of the Solar Drier Project

While designing and during implementation of the project, enhancing capacity of local communities was given priority. Three 'on the site trainings' on fabrication of the solar dryers were held for carpenters in Lauri and Serthi gewogs. The trainings were attended by more than 30 residents of Lauri gewog. 16 carpenters from Lauri and Serthi gewogs were involved in building the 23 solar driers[10].



Capacity building: Women solar engineers

The key distinguishing feature of the solar drier project in Lauri and Serthi gewogs is the crucial role played by the women solar engineers in the effective implementation of the project[11]. With stipend and tools provided by the project, the solar engineers successfully installed the technical component of the solar dryer and shared their knowledge on proper drying and packaging of produce with the users.


The involvement of the women solar engineers in the project provided a platform to enhance their capacity, created awareness on gender equity by showcasing the technical prowess of the women engineers who provided critical technical backstopping while their male counterparts contributed by fabricating the physical structure of solar driers.

[10] Please refer Annex 2 for the list of carpenters.
[11] Annex 3 provides a list of the solar engineers.

During the project implementation period, the solar engineers had to leave their homes and traveled the length and breadth of Lauri and Serthi gewogs. They reached a total of 23 different locations, in an area of Bhutan that is not connected by roads and electricity. Without them, the project would have had to rely on technical personnel to be brought from outside the gewog, which in turn would have increased the cost of the project activities.

Income generation: Better quality products with the new solar drier

Lauri farmers say solar dried products make ideal gifts for visitors. Lauri farmers send dried vegetables to their relatives living in the urban areas of Bhutan. They also exchange their solar dried vegetables for dairy products with nomad herdsmen who come during the winter months to Lauri gewog.

Some of the first people to acquire the solar dried produce were nomadic herdsmen who migrate to Lauri during the winter months. It is traditional practice in Lauri to exchange their dried vegetables with dairy produce such as cheese and butter. The herdsmen noticed an improvement in not only the look of the produce but also the taste leading to better value and exchange for the Lauri farmers.[12]

The Samdrup Jongkhar Initiative also provided airtight Ziploc bags to see the impact and acceptance of the new packaging method. The SJI was mindful of the environmental impact of plastic packaging. Producing bags from traditional Bhutanese paper was also looked into but emerged too costly at this time. The Ziploc bags made from soft plastic proved too fragile especially when packing dried pumpkins which perforated the bags with their sharp edges. It was also noticed that farmers were using old, torn and used plastic bags to pack their solar dried vegetables.

In light of the above circumstances, the SJI decided to source zip pouch bags from India, which are available at a comparatively cheaper price than the Ziploc bags. The sturdier plastic is ideal for dried vegetables and fruits that have rough edges and sharp points.

[12] Personal communications with one of the first owners of the dryers in Lauri gewog.

The Lauri agriculture extension officer has established contact with businesses in Jomotsangkha to sell solar dried produce from his gewog. Besides Outside of Lauri gewog, dried vegetables and fruits are sold by grocery stores and super markets.

During research to explore market for solar dried produce from Lauri, a supermarket owner in Thimphu (the capital city) highlighted the poor quality of dried produce prepared in Bhutan. He pointed to the stacks of poorly packed dried produce and said “packaging is the key”. He then showed Bhutanese red rice packed inside a sleek packet to stress his point.

While shops have expressed willingness to sell Lauri solar dried produce, another big market that shows potential for solar dried produce is the tourism sector. In communications with key players in the tourism sector, especially the trekking companies, it was revealed that providing fresh vegetables to clients on long duration treks is a big challenge. The best option they have is to take canned produce and the limited varieties of dried produce that is available in the market. Some owners of trekking companies said they would purchase the solar dried produce if they are available in the market. They advised contacting the chefs who go on the treks since the chefs are the ones who purchases provisions.

The Lauri Solar dryer project: More than just a physical structure

Through projects like the solar dryer, the SJI intends to pave the way for a new form of participatory technology development. The IDRC external evaluator described the solar dryer project in Lauri as an outstanding example of partnerships between local communities and experts.

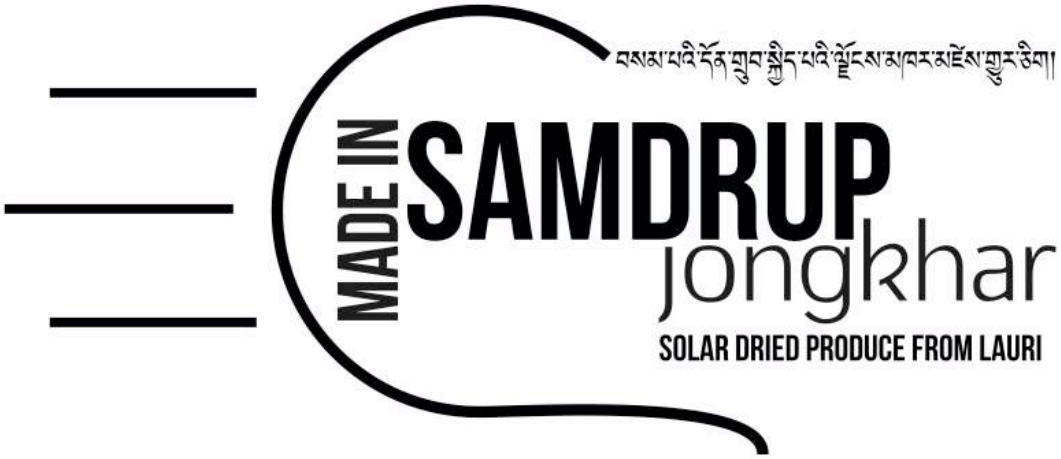
Also described as participatory action research demonstrates the community-based research is a four-way research partnership between a civil society organization like the SJI, the Royal University of Bhutan (and the Jigme Namgyel Polytechnic), government, and community

Since the first trip in December of 2011 to install the first solar dryer prototype, the SJI team has visited Lauri gewog six times. The SJI will continue troubleshooting and supply spare parts, such as CPU fans.

At a farmer's field day held in Lauri in December 2014, the users of the solar dryers brought a wide-ranging variety of products. With farmers continuing their longstanding tradition of drying vegetables with improved technology brought forth by the solar dryers, the supply of solar dried produce is assured. The immediate challenge at hand is to develop a packaging strategy that is low cost, effective and attractive.

Meeting the Needs of Farmers and Consumers

The SJI continues to explore sustainable marketing options for the solar dried produce. A logo has been designed for the solar dried produce from Lauri and Serthi.



In order to improve outreach and training of Lauri , the SJI is planning to post a farmer liaison in Jomotsangkha. This person would work with the women solar engineers and farmer promoters to upscale the solar dryer technology across the three gewogs of Lauri, Serthi and Langchenphu. As recommended by the external evaluator that person would put special emphasis on food safety and on other quality control issues. “S/he would also help local producers make the links with nutrition and markets. Nutrition contributions of this project will be highlighted by ensuring that nutrients are conserved and food is safe, thereby generating quality products.”[13]

When all of these recommendations are implemented in the coming months, the chances of solar dried produce from Lauri sitting in the shelves of supermarkets in Thimphu is not far away.

[13] IDRC Evaluation of SJI by Dr. Julian Gonsalves

Annex 1: List of produce dried by Lauri farmers.

1. Garpa orsha, crow's beak, *Cyclanthera pedata*
2. Tamarillo, tree tomato
3. Wild persimmon
4. Fiddleheads
5. Rubia
6. Star anise
7. Chirata
8. Monkey apple
9. Amdo, *Sechium edule*
10. Pumpkin
11. Pear
12. Tapioca
13. Broccoli
14. Spring onion
15. Coriander
16. Garlic leaves
17. Radish
18. Brinjal/eggplant
19. Red chilies: ema kaam
20. Blanched white chilies: shurkam
21. Green and sliced chilies: hokam
22. Fiddleheads/ wild ferns
23. Thing- Ngey, Geeie, Sichuan pepper, *Zanthoxylum*
24. Bozong, *colocasia*

Annex 2: List of carpenters and locations of solar driers fabricated in Lauri and Serthi gewogs.

Name of carpenter	Locations of solar driers	Chihog/Tshogpa	Gewog
Mr. Leki Samdrup	Barkalangnang, Woongthi, Dung Joo, Moorshinglangnang	Lauri	Lauri
Mr. Dorji Dakpa	Barkalangnang, Woongthi, Dung Joo, Moorshinglangnang	Lauri	Lauri
Mr. Yeshey Wangdi	Patpanadang	Lauri	Lauri
Mr. Ugyen Thinley	Ramjar	Lauri	Lauri
Mr. Pema Samdrup	Renang	Momring	Lauri
Mr. Leki Wangchuk	Phajo Gonpa	Momring	Lauri
Mr. Pema Zangpo	Dung Juka	Momring	Lauri
Mr. Dhendup Tshering	Paam	Momring	Lauri
Mr. Tashi	Pang Tey	Momring	Lauri
Mr. Tshewang	Serjong, Tashiphug, Tshothang	Gonong	Lauri
Mr. Tsheten Dorji	Betsheling	Dungmanma	Lauri
Mr. Tsheten Tshering	Dungmanma , Meringchhenmo	Dungmanma	Lauri
Collectively built during training session	Jompa Gewog center	Gewog center	Lauri
Mr. Lhundup	Barkalangnang	Barkalangnang	Serthi
Mr. Lhajey	Serthi	Serthi	Serthi
Mr. Tashi Phuntsho	Minjiwoong	Minjiwoong	Serthi
Mr. Rinchen Wangdi	Sueskar	Sueskar	Serthi
Collectively built during training session	Phagchho	Phagchho	Serthi

Annex 3: List of solar engineers involved in the fabrication and maintenance of the solar dryers in Lauri and Serthi gewogs.

Name	Location	Gewog
1. Ms Dorji Pelmo	Lauri	Lauri
2. Ms Tshering Zangmo	Gonong	Lauri
3. Ms Dorji Tshomo	Dungmanma	Lauri
4. Ms Jambay Yangzom	Dungmanma	Lauri
5. Ms Kinzang Choden	Serthi	Serthi
6. Ms Kesang Lhaden	Serthi	Serthi

Annex 4

Solar Dryer Evaluation

(Prepared by the National Post Harvest Centre, Ministry of Agriculture and Forests)

The performance of solar dryer with and without products was evaluated with the help of National Post Harvest Centre, Paro. The parameter used for the evaluation is atmosphere condition such as temperature, relative humidity and absolute humidity inside and outside the dryer using HOBO data loggers as shown in the Fig.1. The data is recorded for every 10 minutes interval and analyzed using the BoxCAR software.

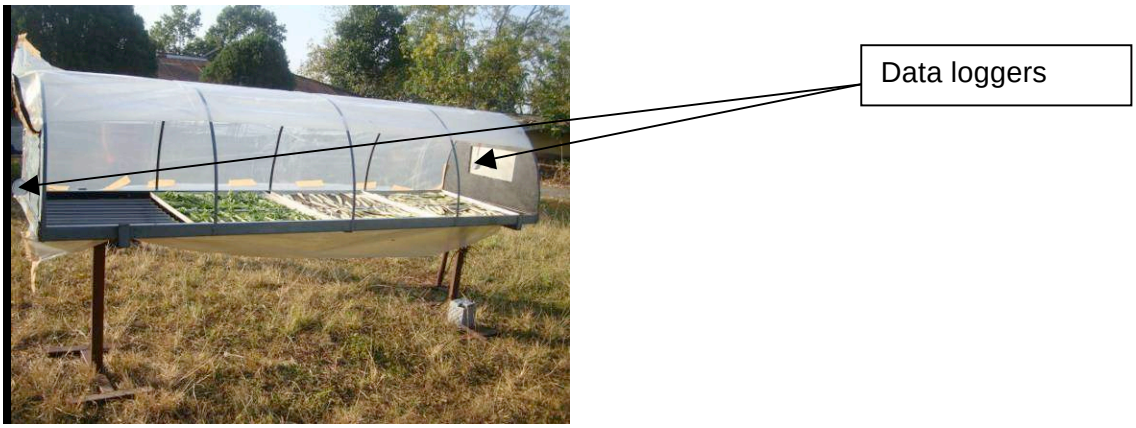
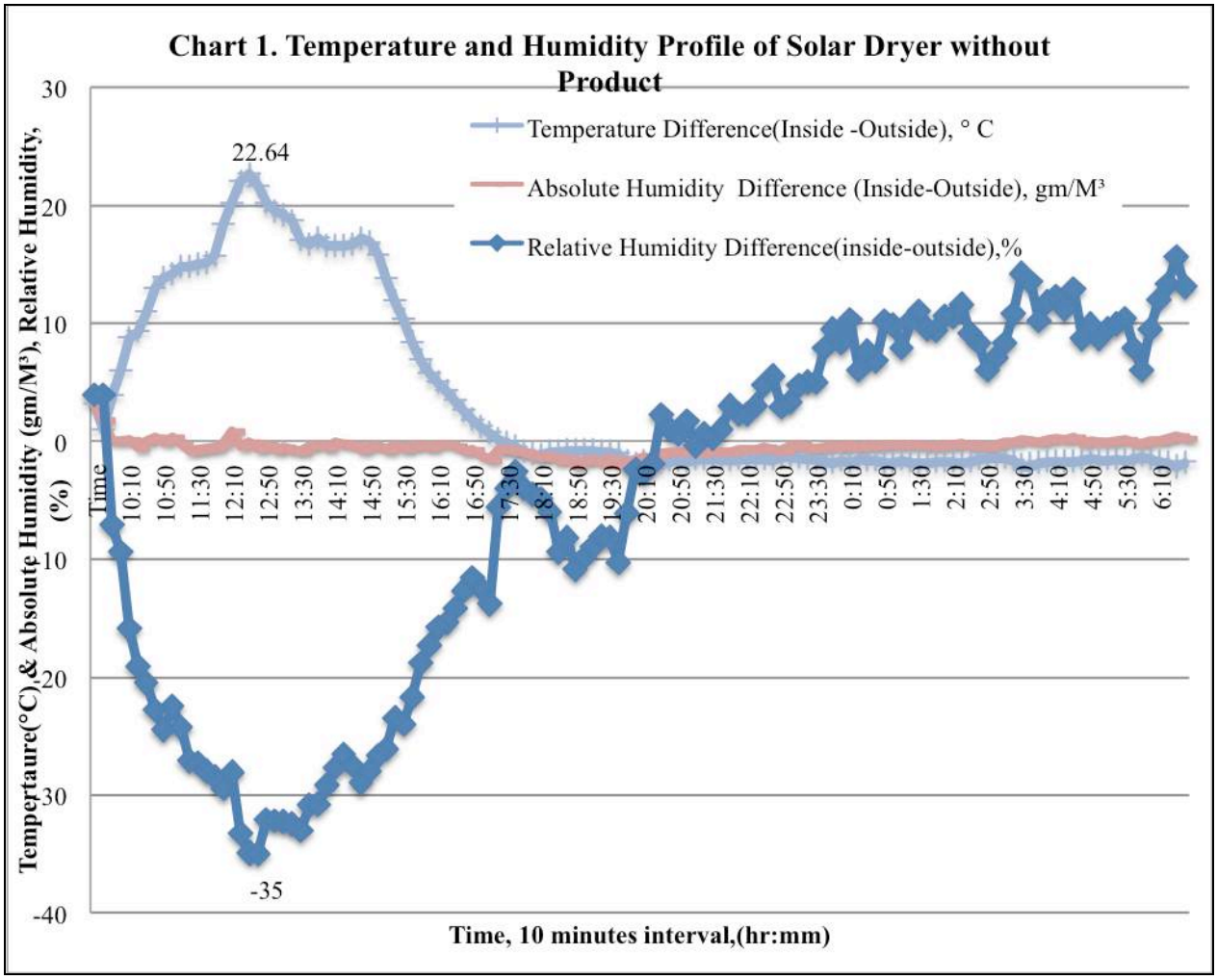
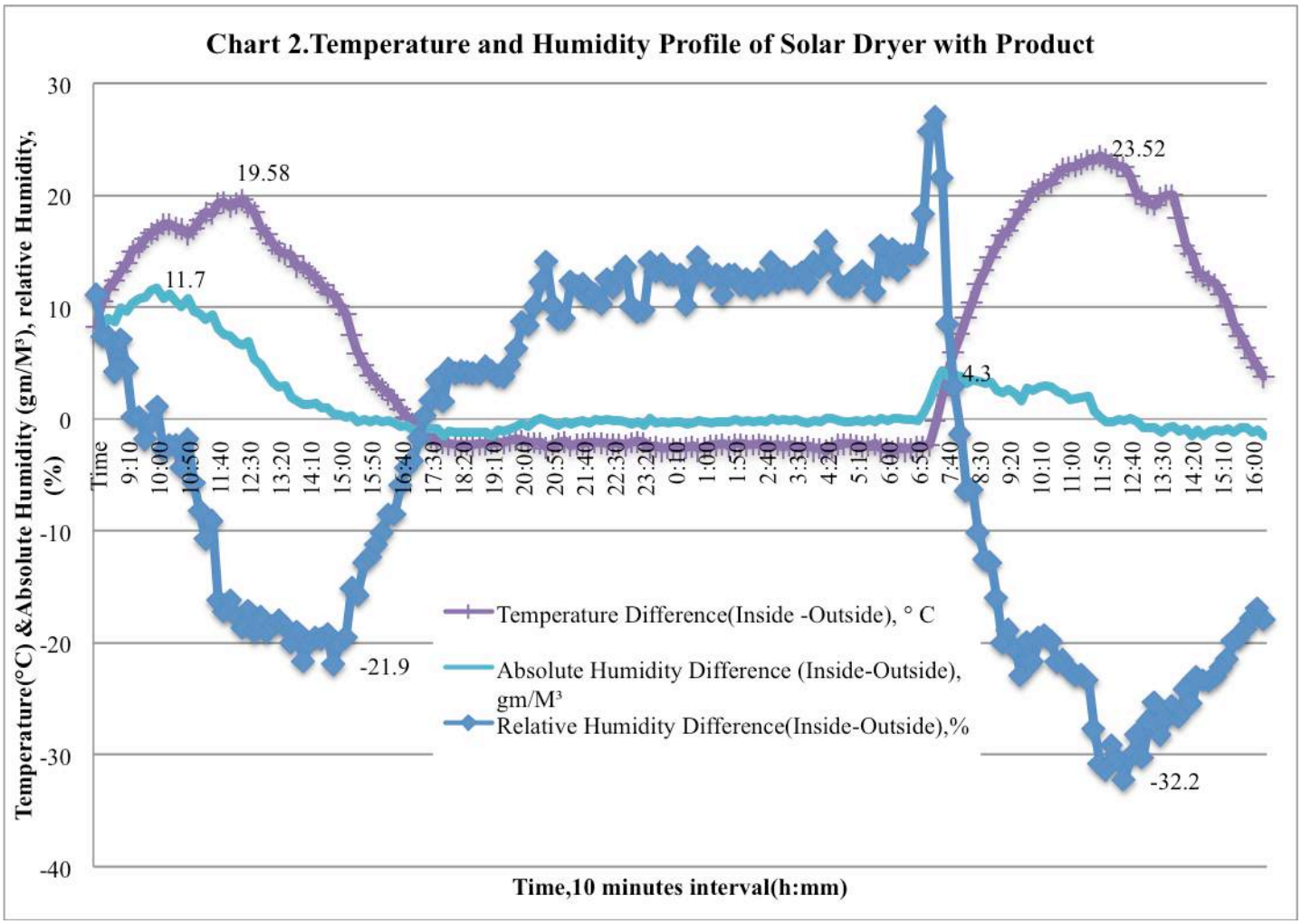


Fig1. Solar dryer with products



During the day time as shown in Chart 1, the inside temperature is higher than the outside and t temperature difference was as high as 22.64^{o}C. Likewise, the inside relative humidity is lower than the maximum difference was as high as 35%. The higher inside temperature and lower relative humidity i condition for drying. During the nighttime, the inside temperature was lower and relative humidity was hi of air flow/draft, created by the battery powered exhaust fan, was a suitable condition for cooling. humidity of inside and outside conditions remained more or less the same as expected in both day an there was no product to produce additional moisture.



From Chart 2, the inside temperature is higher than the outside and the maximum temperature difference was as high as 19.58^{o}C during the first day and 23.52^{o}C during the second. Likewise, the inside relative humidity was lower than outside and the maximum difference was as high as 21.9% during the first day and 32.2% during the second. The temperature and relative humidity differences were lower in the first than in the second day because the product had absorbed the heat produced by the dryer and consequently released the moisture. During the second day, the products were almost dried as confirmed by the absolute humidity condition where it was only 4.3 gm/M^3 compared to 11.7gm/M^3 in the first day. During the nighttime, the inside temperature was lower than the outside had cooled the product and negligible absolute humidity difference had shown clearly that the dryer had not experienced condensation. In short, the solar dryer has proven effective for drying the fresh produce.

Annex 4

Cost of constructing the ‘Made in Samdrup Jongkhar’ solar dryer

Particulars	Qty	Amount (Nu.)
CGI Sheet 10'X50 mm and above	1	1200
Solar panel	1	2500
Dry cell battery	1	2500
Timber and bamboo		3000
Drying trays inside	6 - 8 Nos	1500
Labor charge	4 days	1200
CPU fan	1	50
Voltage controller	1	500
Voltage controller fuse	5	100
UV plastic sheet	10 meters	1500
Flexible wire	5 m	250
Red oxide	1 L	180
Black paint	1 L	180
GI wire nail	1/2 Kg	50
Fevicol (adhesive)	1 Kg	150
Ordinary plastic	5 meters	400
Total		Nu. 15260