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SANAM DRUPDREY

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DRAGON FRUIT for Dragon Country

Trucker turned FARMER

SCHOOLS, a focus for Change

HOTLINES

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General process for Access and Benefit Sharing (ABS)

with regard to using Genetic Resources and associated Traditional Knowledge

Bhutan has sovereign rights over its genetic resources and associated traditional knowledge.

To access these genetic resources and associated traditional knowledge for research and commercial purposes, one must follow the Access and Benefit Sharing (ABS) process which consists of two phases: Scoping Phase and Actualisation Phase.

Scoping Phase

1

User submits access application to the National Focal Point.

User enters into a scoping agreement with the National Focal Point based on mutually agreed terms.

4

User conducts research and development using genetic resources and/or associated traditional knowledge.

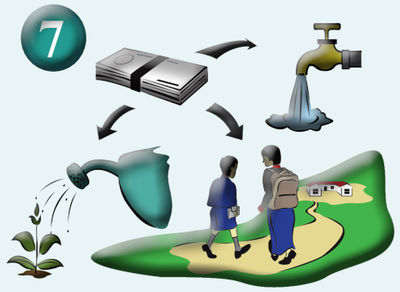
User obtains prior informed consent from the provider of the genetic resources and/or associated traditional knowledge facilitated by the National Focal Point.

Actualisation Phase

5

User enters into the ABS agreement with the National Focal Point or provider of genetic resources and/or associated traditional knowledge where there is a potential for commercialisation.

User benefits from selling the product in the market.



User shares the benefit (monetary or non-monetary) with the National Focal Point and the provider of genetic resources and/or associated traditional knowledge based on the ABS agreement. The benefit is used for community development and conservation of biodiversity.

Source: National Biodiversity Centre

The RNR family would like to wish
everyone a very happy and prosperous
EARTH FEMALE PIG YEAR 2019

May the
NEW YEAR
bring you health,
happiness and wisdom.

LOSAR TRASHI DELEK !

Produced by:
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Foreword

Happy New Year!

Sanam Drupdrey is the stories of the fruits of our hard working and dedicated staff of the Ministry of Agriculture and Forests. It is our own stories, tales of how our agriculture "staff members," researchers, extension officials, livestock and animal husbandry officials are making a difference in the lives of our Bhutanese people. The officials and "staff members" have become the agents of change in the lives of our people particularly those in the backwaters of our country.

Articles and stories shared by the contributors indicate that our farmers are reaping the fruit of development in the Renewable Natural Resources (RNR) Sector.

From growing different vegetables to focusing on winter vegetables, mushroom cultivation, riverine fishery and improved animal husbandry etc., the magazine captures how our extension agents are playing a crucial role in achieving food self-sufficiency, a national goal.

It is also heartening to share through the stories written by our "staff members," the agriculture family is striving hard to fulfil their responsibilities with dedication.

Stories of how improvised Laminar made using local materials to cut cost and ensure farmers get mushroom spawn and how pest management is made eco-friendly are encouraging. It is indicative of how our "staff members" are making best use of available knowledge to help our farmers. I can only urge our "staff members" to explore and tap the potential that they all have.

2018 have been a successful year for the agriculture family. Although the overall growth rate slowed down in 2017, the primary sector (mainly comprising of agriculture) recorded a growth rate of 3.39%, highest after the service sector.

Hydropower and tourism are seen as the drivers of the economy. Agriculture, however is still the mainstay of our country. There had been a lot of concerns expressed on the share of budget allocated to the agriculture sector in the 12th five year plan. The allocated budget, compared to other sectors, may seem little, a lot of development partners encourages the agriculture sector.

The Ministry is also compiling the flagship programmes including highlander's development, organic farming and wood-based manufacturing programmes.

I eagerly look forward to continue working with my RNR Sector to make 2019 another successful year.

Lastly, I wish all my colleagues in the Ministry to come with more success story when we ready the next edition of the Sanam Drubdrey.

Wishing a happy reading to the readers.

Yeshey Penjor

Minister

Ministry of Agriculture and Forests

Editorial

ICTD

Information and Communication Technology Division of the Ministry of Agriculture and Forests is pleased to bring yet another exciting edition of Sanam Drupdrey, Fruits of Labour.

The ninth edition of Sanam Drupdrey or the RNR Magazine highlights some of the activities geared towards achieving the objectives of the 11th five year plan and how they have impacted the production, community and the overall economy. Such successes and experiences helps the RNR staff to plan and understand what works best for the future.

We have an inspiring stories how a trucker turned a successful farmer encourage others to take up agriculture farming and winter green chillies can be a viable source of income for southern farmers.

The magazine covers stories such as how the Tareythang rice farmers are able to get rid of pest, how the protected citriculture can be helpful for citrus growers and how apple tree rootsocks propagation is done by cuttings.

The magazine also highlights some of the locally developed economical technologies such as laminar and greenhouse solar dryer as beneficial alternative options for farmers.

This edition also brings you about Dragon fruit, a lucrative crop; riverine fishery to supplement income, Umling farmers' income and successful SRI practices.

In addition, the magazine covers about the Gangtey-Phobji Ramsar Site, the biggest in Bhutan and market oriented farming including the 2018 highlights among others. The RNR tips highlighting its significance, issues and possible solutions are another interesting feature in the magazine for readers.

ICTD would like to acknowledge all the authors for their valuable contributions in making the Sanam Drupdrey 2019, a successful publication.

ICTD hopes that the magazine would inspire more contributors for its future issues to help those who seek knowledge or information on the farming as well as on the work of the Ministry.

Wishing everyone a very fruitful year ahead.

Contents

Getting rid of pest without pesticides

Ugyen Gyeltshen, Tareythang, Sarpang

The sub-tropical region is the best hotspot and thriving zone for many pests and diseases in crops. The conducive environment favours pest and disease growth and if the infestation is neglected, crop can get completely wiped out within a short span of time.

Every year, most rice growers place a huge demand for pesticides and its usage is heavy to combat pest and disease infestation. Application of chemicals in the field is seen ineffective especially during monsoon since pesticides are completely washed out by heavy downpour. Moreover, heavy rainfall does not favour farmers to spray chemicals comfortably. Thereby multiplication of pest and disease are enhanced and severe damage occurs especially at vegetative stages of paddy. To combat pest damages on paddy, monitor pest, mass-trap and disrupt mating of a great diversity of insect pests, in collaboration with Agriculture Research and Development Centre-Samtenling and Dzongkhag Agriculture Sector, Tareythang gewog initiated installation of pheromone traps against stem borer and fall

armyworm. Pheromone trap for armyworm was set up as per the early warning received from the FAO and National Plant Protection Centre. They stated that the polyhagous-armyworm outbreak in the sub-tropical zone of Bhutan is likely to occur.

Methodology

Trap installation was carried out in in Tashichoeling and Yeozergang chiwogs located at an altitude of 230masl sharing border with Assam. Installation was carried out in two lower altitudes since FAO has warned India to be also extra cautious.

Paddy field sharing border with Umling was also targeted to prevent armyworm's entry in case outbreak happens in Umling. Trap installations started towards the end of August and stretched till October end. Fifteen numbers of trap for armyworm and ten numbers for stem borer covering six acres of paddy field benefiting five households were installed.

Traps with a bait, also called as insect lure was hung approximately 1.5m above the ground and placed apart at the distance of 30m interval. Weekly monitoring was carried out and the total number of different pests trapped was recorded until the harvest of paddy season. The bait was changed after one month of usage.

Observation

Armyworm outbreak exactly occurred as per the FAO warning. Highest number of armyworm outbreak occurred in August and stem borer outbreak was constant throughout the growing season. Functions of pheromone trap became evident and proved effective for many rice growers. Thereafter, other farmers also became enthusiastic and requested for the trap.

Due to the shortage of traps, designing of trap using locally available fizzy drinks bottles was initiated. Sixteen numbers of local traps were installed in 6.25 acres of paddy field benefiting five households. However, the locally made traps were not as effective as there were so many limitations and so many factors have to be considered to redesign the traps. However, few pests were trapped.

As a result of installing pheromone traps, male species of stem borer and armyworm got trapped resulting in further multiplication, breading and reduced damages incidence. The incidence of dead heart and white head in paddy was also minimised.

Paddy in the field appeared greener and healthy with maximum grain on the spikes. Usage of pesticides were reduced and helped in reduction of environment pollution. Use of chemical pesticides by poor rural grower and exposure to toxicity was also greatly minimised.

Today, to combat pest damages on paddy, farmer in Tareythang prefer pheromone trap installation to chemical pesticides.

Riverine fishery to supplement income

Bikash Rai, RNR-EC Doongna, Chukha

Drukdingsa chiwog may be remote but the remoteness has not hampered the community from progressing. The Rai community in Doongna gewog grows paddy, maize, millet and buckwheat. For cash, they have cardamom and ginger.

Recently, the community has developed a liking for fish, both for supplementing their diet and cash income. This happened after the Drukdingsa Riverine Capture Fishery Management Group was formed in 2017.

Riverine and Capture Fishery is one of the natural resources management strategies. It is the first in Chukha. The group was formed after realising the need for an alternative source of income in the community. The type of fishing ensures the sustainable harvesting of fish from the river without disturbing the ecology.

The group has the user right for 5.5kms on the Pachhu stretch from Chukti in the south to Dakchhalum in the north. It was handed over to the community for a period of five years.

The group was officially launched on 19 May 2017 jointly by Dzongkhag Livestock Sector, Chukha; the Regional Livestock Development Centre-Tshimasham, the NRCR&LF, Haa and the Forest Division, Gaedu on formal approval from the Ministry.

Fishing in Drukdingsa village has changed after they have received the rights for fishing. The community harvest fish and consumed. The surplus catch is sold in other chiwogs for income.

Fish play a vital role in their community not because of the nutrition's source and income generation but also as a valued offering during rituals and festivals.

To ensure sustainability, members are allowed to only cast net and bamboo trap for fishing. This way fish population dynamics in the river ecosystem is maintained.

Members are not allowed to fish during spawning season and during auspicious days or months. As of today, about 1.2MT of fish was caught from the river which generated about Nu.0.300M in total. On average, the fish production contributed about Nu.9,090 per members till date.

Cardamom was the main source of income in the past. However, due to its low production and price fluctuation, fishing has become an important alternative source of income for the community. The formation of the group has also instil in the community, a sense of ownership over fishery resources. It has prevented rampant fishing ensuring the sustainability of the river ecosystem.

Schizothorax richardsonii, *Neolissochilus hexagonalepis*, *Garra gotyla* and *Glyptothorax* are the main species of fishes.

Trucker turned FARMER

Jambay Lhamo, Samtenling gewog, Sarpang

Bishnulal Chhettri, 40 years old popularly known as Deepak is a successful vegetable grower in Samtenling gewog. He is dedicated and engaged in vegetable cultivation all-round the year despite rising dearth of workforce and unpredicted climatic condition.

2014, he remembers to be the year that changed his livelihood from truck driver to a farmer; he was nominated for a study trip to Falakata, India from where his drive for farming gave birth. Understanding the budding opportunity in farming then motivated him to bring his uncultivated land under cultivation.

He recalls Jigme Dorji, the then Dzongkhag Agriculture Officer of Sarpang as an eye opener for him for showing the path to farming by nominating him for the study visit to India to learn on vegetable farming.

He asserts that vegetable cultivation is not difficult but requires determination to continue working every day. Deepak, a former truck driver spends 4 to 6 hours in a day in his field working and monitoring.

Besides vegetables, he produces mushroom spawn and blocks for sale and has also incorporated fruit plant and floriculture in his field.

The global concern of going organic has not spared to ignite the light of concern that he makes his own compost and bio-pesticides as he grows his vegetables purely natural. He thinks globally but works locally and takes agriculture farming to a different level in his own way. Concern to keep crops free of diseases (wilt and collar rot) is the main struggle in the field as he says insect pest can be controlled by bio-pesticides and setting traps, disease is usually difficult to control.

"However, I am glad and encouraged that I get fair amount of input and technical advisory support from the Dzongkhag Agriculture Sector, gewog administration and Agriculture Research and Development Centre (ARDC)-Samtenling," says the enthusiast.

No feeling is above the feeling of being able to produce your own food and farming pays significantly well if one is determined to dirty his hand religiously claims Deepak.

Besides getting to reap his hard work, the frequent visit by dignitaries, outsiders and the people nearby to his field and receiving numerous phone calls from people in and outside area enquiring availability of vegetables and mushrooms product is encouraging him to pursue further.

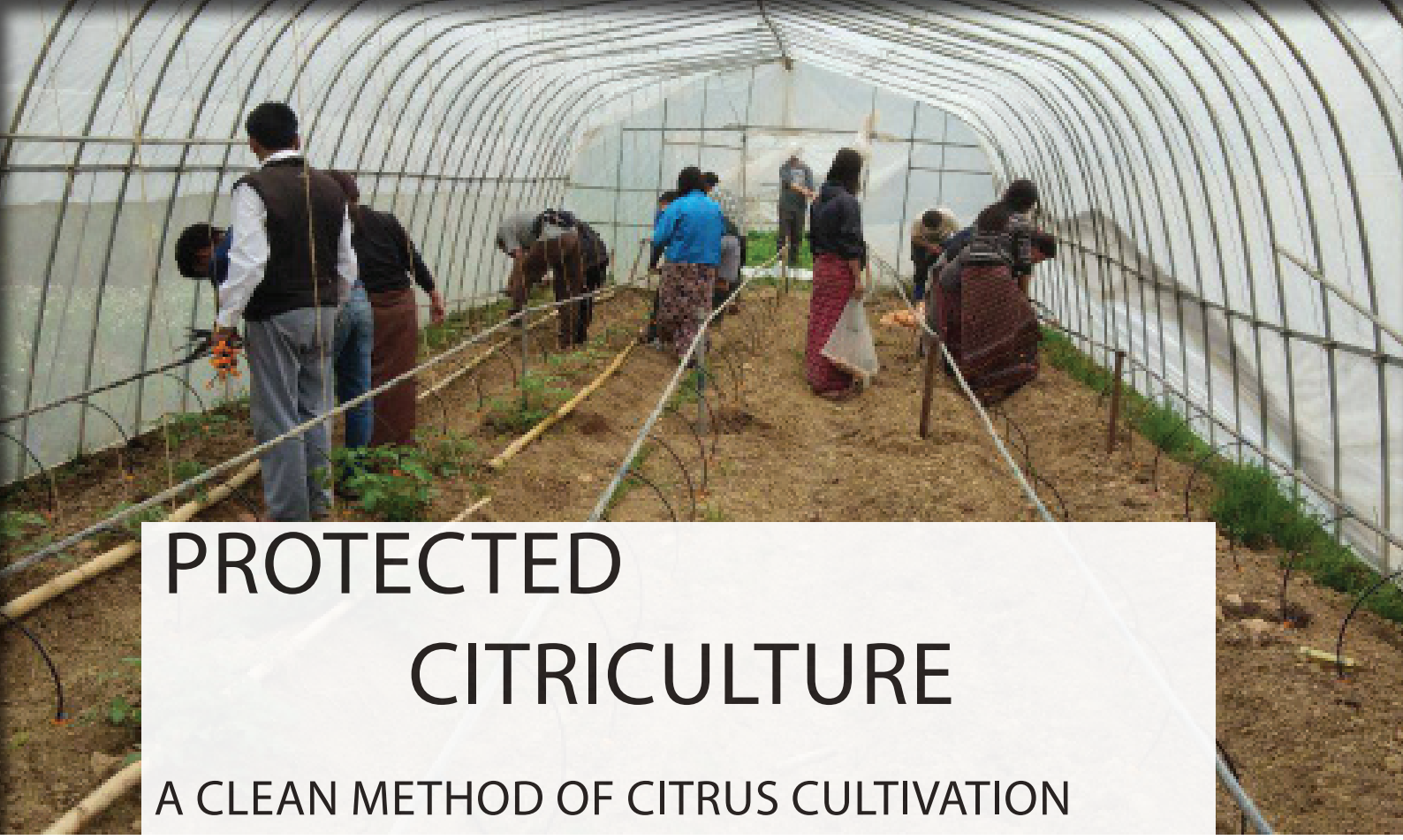
He had earned about Nu.4,21000 through sale of seedlings, vegetables and mushrooms last year from 1.6 acres of land. However, his mere accomplishment doesn't

He is immensely concerned and he also wants his neighbour and others to develop vegetable cultivation. Thus, he visits others' field to advice, share knowledge and experience. Selflessly, he apportions his resources such as seed, seedling and agriculture inputs to those needy one.

He says, "Life has become much more easy and pleasant due to the advancement of smart phones. My favourite applications are Google, YouTube and Messengers". He makes best out of smart phone learning on latest innovation, downloading videos and sharing it to his associates.

His undying strength of learning different technologies and ready to adopt personality is an added advantage to agriculture sector which makes technology dissemination effortless. Furthermore, he is preparing to purchase land and develop an exemplary organic vegetable farm.

"I would install numerous fabricated poly-houses and cultivate varieties of vegetables making it available round the year. In due course, I am going to hand over the vegetable farming to my son," he says smilingly.



PROTECTED CITRICULTURE

A CLEAN METHOD OF CITRUS CULTIVATION

Dr. Tshering Penjor, Sonam Gyeltshen, Lhap Dorji, Geley Namgay and Birkha Bahadur Tamang, ARDC-Wengkhar

Citrus is one of the most important horticultural commodities serving as the source of livelihood and employment for more than 60% of the rural population. It is grown in more than 14 Dzongkhags with an annual average production of more than 41,000MT.

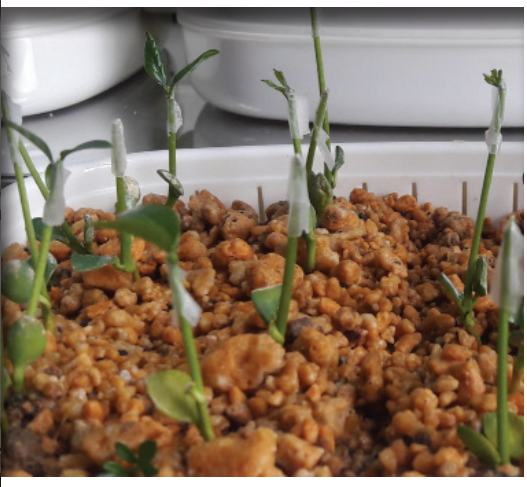
However, most of the orchards are now reported to be declining due to the wide spread incidence of Huanglongbing (HLB, ex-greening) disease compounded by poor orchard management practices. Apart from that, the incidence of fruit flies (*Bactocera spp.*) in the citrus growing belt has led to drastic decline in production in the recent past.

Towards this, the Department of Agriculture (DoA) through National Plant Protection Centre promoted and implemented different management practices to manage HLB and fruit fly problems.

Nonetheless, most of these practices were either found difficult to practice in our context or ineffective due to various technical and social reasons.

In view of this, the need to explore other alternatives to sustain the declining citrus industry was felt necessary. In this regard, the studies conducted elsewhere have reported "Citrus Under Cover Production System (CUPS)" or "Protected Structure" as viable option to protect citrus trees from devastating pest and diseases such as HLB and fruit flies.

Hence, the Agriculture Research and Development Centre (ARDC)-Wengkhar with financial support from DoA initiated "Protected Citriculture" with the primary



objectives to study citrus production under protected condition as an effective strategy to overcome major pests and disease problems and maintain disease-free mother plants.

For this, a double-door greenhouse measuring 50 x 5m dimension with an amplified height covering an area of 250m^2 was constructed. The plants were planted 1.5m apart within the row accommodating a total of 64 plants in an area of 250m^2 under protected structure.

As some of the existing citrus varieties in the germplasm block of ARDC-Wengkhar were found HLB positive, a clean lot of seeds imported from Australia by National Citrus Program was used to raise disease-free rootstock seedlings. The seedlings of rootstock variety C-35 were raised in laboratory and isolated greenhouse condition. Subsequently, 64 healthy and vigorous seedlings were transplanted in the protected structure. Alongside, budwood production through shoot tip grafting (STG) was initiated to screen out graft-transmissible diseases and produce clean plants.

Further, in order to speed up the process, the budwood from the shoot tip grafted plants were approach grafted onto the vigorous rootstock seedlings.

Upon attaining the graftable size, the clean budwood from STG plants will be grafted onto the rootstock plants that are already being planted in the protected citriculture structure.

In order to ensure proper growth of citrus plants under protected structure, efficient water management is crucial. Therefore, the automated drip irrigation system has been installed in the protected structure to reduce the risk of disease spread and minimise nutrient loss.

The irrigation system has been automated by installing and configuring the Raspberry pi based irrigation controller to function on local area network.

The pipelines within the structure were buried 30-40cm underground to maintain water temperature and connected with drip emitters having 2.2 litres per hour flow rate to provide required volume of water to each plant.

Currently, the irrigation schedule has been programmed to irrigate the plants twice a day for 20 minutes, once each in the

morning and afternoon. The whole system is powered by 40watt solar panel charged through 18AMPH capacity lead acidic batteries.

Although it may be early to report about the viability of protected citriculture in our context but past studies conducted elsewhere clearly suggests "Protected Citriculture" as a viable alternative strategy to overcome biotic and abiotic problems confronting conventional citrus production system.

Nevertheless, a detailed study to determine the economic viability of protected citriculture as opposed to conventional method of open field cultivation is already underway at Wengkhar.

Meanwhile, the ARDC-Wengkhar is pursuing rigorously to provide "Protected Citriculture" initiative as a viable alternative strategy to revive the declining citrus industry thereby attracting more youth into farming and diversify the source of income.

Furthermore, the promotion of such technologies would enhance farmer's resilience to the impacts of climate change and help achieve the country's goal of going organic.

DRAGON FRUIT for Dragon Country

Tsheten Khandu and Chinta Mani Dhimal
ARDC-Samtenling

If all goes well, in a few years, the Land of the Thunder Dragon will be exporting Dragon fruits.

The Agriculture Research and Development Centre (ARDC)-Samtenling have introduced Dragon fruit (*Hylocere undatus*) in its demonstration orchard in the station. Out of three types of Dragon fruits, the centre is trying out the red colour fruit with white colour flesh. Researchers are confident given that the characters of the fruit crop are found to be quite suitable in Bhutanese climatic conditions.

At Samtenling, an area of about 0.20 acres has been readied using concrete post and the planting materials from ARDSC-Lingmethang in 2018. Pits size of 60cm x 60cm x 60cm were dug and farm yard manure was mixed with top soil and refilled. A spacing of 2m was maintained between plant-to-plant and row-to-row and square system of planting method is applied. It is expected to start fruiting from 2019 and depending on the success, it will be further multiplied and promoted to farmers' field.

Dragon fruit is a lucrative crop which can be an asset to small-scale plantation. It is a perennial fruit crop with fast returns, yielding fruits from the second year of the plantation and full production starting from the fifth year after planting.

With its regular bearing characters, it gives early income to growers. It is well suited to dry land areas and can be cultivated mixed with other crops in multitier or agro-forestry technology. Dragon fruit belonging to the cactaceae family is native to south and central America. It is called by different names in different countries. It is commonly called as strawberry pear, red pitaya, red pitahaya, night blooming cereus, belle of the night, queen of night, conderrella plant etc.

The fruit is popular in countries like Thailand, Malaysia and Sir Lanka. Broadly, there are three types of dragon fruit such as red colour fruit skin with white colour flesh, red colour fruit skin with red colour flesh and yellow colour fruit skin with white colour flesh. It thrives

well in dry sub-tropical and tropical climatic condition with moderate rainfall. However, it is best for cultivation on tropical climate in marginal and sandy soil with optimum temperature range of 20 to 30°C. Alternate dry and wet climatic condition with average annual rainfall of 500 to 1500mm is best suited for its performance. Dragon fruit has substantial source of nutrition due to which there is huge demand in many countries. It is rich in protein, fat, fibre, carotene, calcium, phosphorous, iron, vitamin B, vitamin C, Thiamin, Riboflavin, Niacin and Ash.

It's young stem and flower buds are eaten as vegetable while it is consumed as homemade medicine after drying. In Taiwan, dry flowers are consumed as vegetable, in the form of juice, jam, salad and other product. The most valuable and commonly used edible part is the fruit, which constitute 70 to 80% of ripe fruit.

Due to its high content in vitamin C, regular consumption of fruit helps in fighting cough and asthma helps in healing wounds and cuts. It also plays a vital role in improving immunity. The fruits with red-fleshed varieties are rich in antioxidant. It helps in preventing colon cancer, diabetes and reducing cholesterol and high blood pressure.

The medicinal and nutritional value of the fruit could make the fruit popular in Bhutan where lifestyle diseases like cancer, diabetes, cholesterol and high blood pressure are straining the limited resources of the health ministry and the country.

Apple tree rootstocks propagation by CUTTINGS

This technique would be beneficial for apple nursery growers

Tshering Dorji, ARDC-Yusipang

Growing apples has been the main cash crop for the temperate regions of the country and the first plantings were planted in the 1970's. The aesthetic and physiological character of the fruit depends on the scion grafted but the rootstock (understock) are used to improve the flavour or skin thickness and they posses different characters like drought tolerant, tree height, disease tolerant etc. In Bhutan, the rootstocks have been only raised by stooling or mound-layering. In collaboration with Hirosaki University of Japan, a method for propagation of apple rootstocks by cuttings was studied on-station at the Agriculture Research and Development Centre-Yusipang in 2016-2017. The rootstock propagated was Maruba (*Malus prunifolia*) brought from Japan and it is the most common rootstock used for asexual vegetative propagation

of apples in Japan. It is easily grown preferring a moisture retentive well drained soil and highly resistant to frost, drought and grows very vigorously.

The main objective of the study was to evaluate the success rate in regard to our climatic condition raised by cutting and study its morphological characteristics. The study was set-up on 1.5m breadth by 20m of raised bed with soil finely tilled and was thoroughly irrigated before the beds were mulched with black plastic. Rootstock scions were collected from the mother block and cut into 25cm length. Two-third parts of the cuttings were inserted into the plastic mulch with plant-plant of 20cm and row-row of 30cm distance. Root hormones were not used and irrigations after the plantation were not required for once also.

It has been observed that the Maruba rootstock raised by the cutting methods had 90% success rate with very vigorous vegetative growth and well established root system. These rootstocks can be used for grafting in the next season shortening the gestation period unlike rootstocks raised by mound/ trench layering technique. This technique of raising rootstocks will be beneficial for apple nursery growers in the country.

Due to its advantages, after a detailed on-station research, it will be proposed for variety release in a year or two.

Green chillies in WINTER

A viable option for farmers of low lying areas and impact of technologies promoted

Nita Tamang and Kinley Tshering, Department of Agriculture

The winter chilli production program was implemented from August 2017 in sites with altitude ranging from 150-1200masl.

The program covered eight Dzongkhags and four Farm Machinery Corporation Limited farms with an objective to make fresh green chillies available in the domestic market during the winter season from December to May.

The program was funded by the government, FSAPP, RDCCRP, CARLEP and RRCDP. Despite several challenges faced from biotic and abiotic factors, farmers were able to produce 140.64MT of fresh green chillies till May 2018 from total area of 322.24 acres.

Cost benefit analysis

The winter green chillies produced from the production sites were mostly sold in the local market and some quantities were sold in centenary farmers' market (CFM) in Thimphu.

It was reported that farmers sold their produce in the local market at the rate of Nu.150-200/kg and at the farm gate at Nu.100/kg (but most of the farmers produce were sold at Nu.150/kg). As per the Department of Agricultural Marketing and Cooperatives report on prices for vegetables in CFM, the retail price of

green chillies (small local) from the month of December 2017-May 2018 ranged from Nu.250-400/kg (December Nu.250/kg, January Nu.250/kg, February Nu.400/kg and May Nu.200/kg).

At an average market price of Nu.200/kg of fresh local green chillies produced (140.64MT), the estimated return from the program was Nu.28.128M with a profit of Nu.5.579M over the overall total investment (Nu.22.549M) for the program.

The differences of returns against investment indicates that the investment made for the program was worth enough despite negative differences when sold at farm gate price. Farmers involved in the production program also expressed that it was worth growing winter chillies despite the challenges.

Technology dissemination and adoption

The best part of the program was that the technology dissemination and adoption was very effective as the program was being implemented in focused approach with promotion of improved technologies.

The production technologies promoted were staggered production system, using plug trays/plastic cups for seedling production, protected cultivation and efficient water use technologies.

With the adoption of staggered production system right from nursery to harvesting, extension officials as well as farmers were able to understand the correct timing of nursery raising, transplanting and harvesting in their respective production sites and have enabled them to have continuous supply of fresh produce to the market.

The farmers reported that the use of poly houses and plastic mulching have greatly benefited them and have observed vast production differences between open field conditions.

The use of plastic mulches have enabled them to use farm yard manure judiciously, saved labour required for weeding and irrigation and maintaining the soil temperature for growth and development of the chilli plants.

Drip irrigation was effective as during winter season there was shortage of water.

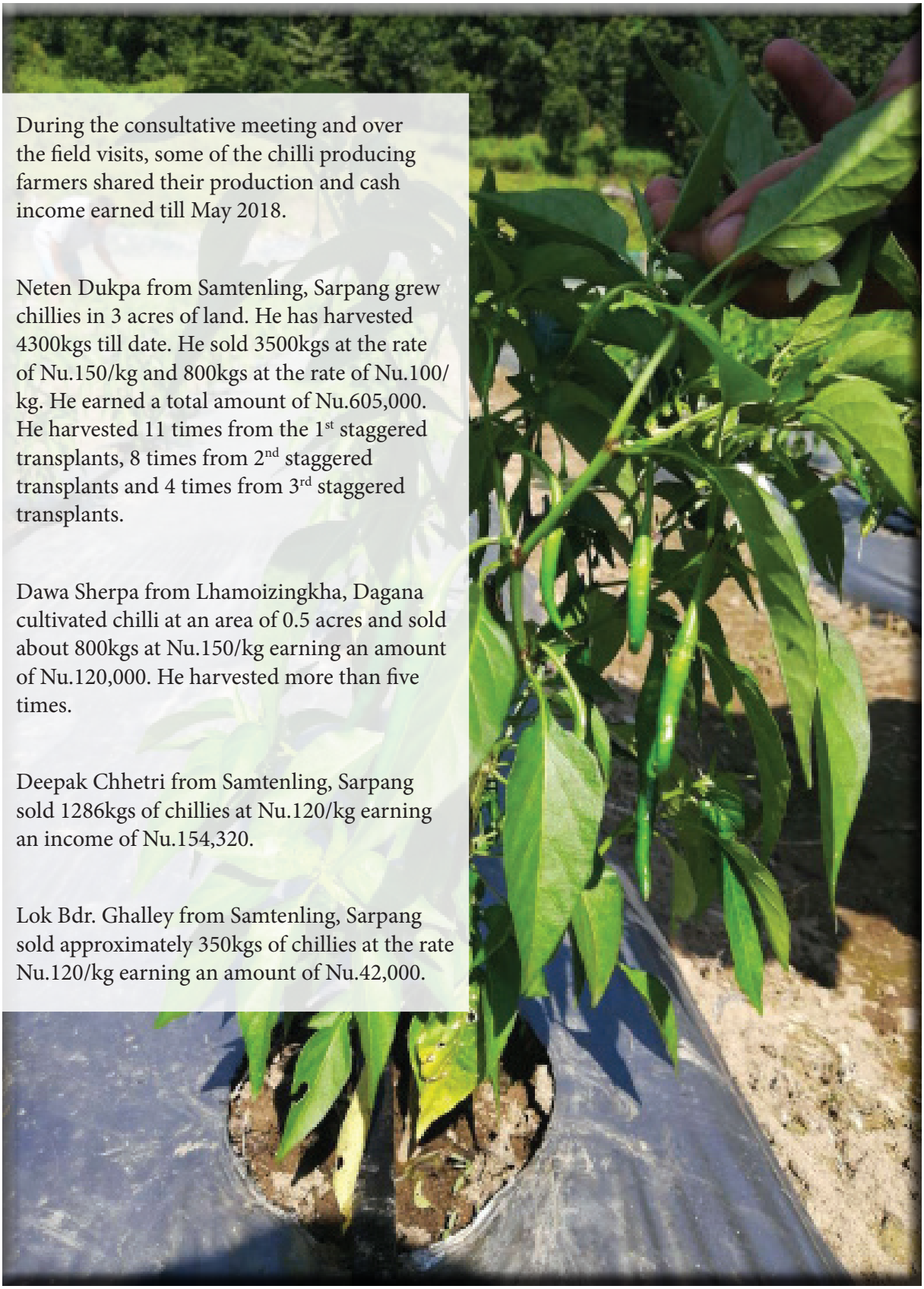
The impacts of the technologies promoted were positive in the sense that farmers are now aware and coming forward to upscale the technologies.

For the 2018-19 winter season production, a demonstration site on protected cultivation in an area from 0.5 to 1 acre have been established in five Dzongkhags.

Based on the request from the farmers, 42 pre-fabricated greenhouses (5 x 20m) have been supplied on a cost sharing basis (80:20).

The general issues/challenges faced by the growers and recommendations proposed are below:

Challenges/Issues	Recommendations/Suggestions
The uniform timing followed for staggered production for last season does not apply uniformly in all the production sites. It was observed the timing for staggered production depends on the location of the production sites.	Based on the experience gained by the growers and extension officials, it was suggested that the timing and interval for the staggered production will be implemented based on the locality of the respective production sites with reference to the plan produced by ARDC-Samtenling. But keeping in mind that green chillies are made available in the market starting from December month.
Damages by heavy and continuous rainfall for the first and second staggered nursery and transplants during seedling stages.	It was recommended to support the growers with pre-fabricated greenhouses on a cost sharing basis (80:20) especially for nursery production and up-scale use of plastic mulches in the main field in order to avoid splashes and damages from heavy rainfall.
Problem of pests and diseases-leaf curling of the chilli plants were observed in most of the production sites few weeks after transplanting in the main field. The common pests observed were thrips and mites. The main disease observed was chilli wilt.	The use of pesticides were discouraged, however, to overcome the pests and disease infestation issues it was recommended to apply effective bio-pesticides right after the seedlings are transplanted in the main field. If the infestation is severe or epidemic then to use pesticides as per the recommended dosage. Use of recommended fungicide (root dip in fungicide solution, preventive application of fungicide to the crop stand once established, drenching of nursery bed). The growers were informed that possibilities of supports for bio-pesticides and capacity development will be requested to National Organic Programme (NOP).
Hybrid varieties requires good soil fertility for its optimal production but it was observed that in most of the production sites especially in the southern belts there is issue of low soil fertility.	Farmers were encouraged to make composts in their individual farm and also bio-digesters in households where there are stall feeding cattle. The support for bio-digesters will be explored from Dzongkhags and NOP.
Shortage of irrigation water for the winter production.	Additional support for drip sets and plastic mulching will be provided. The construction of water harvesting structures using silpaulin sheets at household level was encouraged but especially in the southern belts, there was issue of restriction by health ministry if the structures are open because of mosquito breeding. It was agreed in areas where malaria is not a concern to support with water harvesting structures.
There is no uniform prescribed format for issuance of authentication letter; different gewogs uses different formats which is very much vulnerable to manipulation.	The gewog extension officers suggested having a uniform format across the country in the form of booklet or receipt with identification number in each page which will keep track of the manipulations if done by any as a copy of the letter issued with serial number will be with the concern extension and BAFRA officials. Department will discuss with BAFRA and come up with possible solutions for effective implementation.



During the consultative meeting and over the field visits, some of the chilli producing farmers shared their production and cash income earned till May 2018.

Neten Dukpa from Samtenling, Sarpang grew chillies in 3 acres of land. He has harvested 4300kgs till date. He sold 3500kgs at the rate of Nu.150/kg and 800kgs at the rate of Nu.100/kg. He earned a total amount of Nu.605,000. He harvested 11 times from the 1st staggered transplants, 8 times from 2nd staggered transplants and 4 times from 3rd staggered transplants.

Dawa Sherpa from Lhamoizingkha, Dagana cultivated chilli at an area of 0.5 acres and sold about 800kgs at Nu.150/kg earning an amount of Nu.120,000. He harvested more than five times.

Deepak Chhetri from Samtenling, Sarpang sold 1286kgs of chillies at Nu.120/kg earning an income of Nu.154,320.

Lok Bdr. Ghalley from Samtenling, Sarpang sold approximately 350kgs of chillies at the rate Nu.120/kg earning an amount of Nu.42,000.

Improving lives through ANIMAL HUSBANDRY in Tareythang

Sangay Tshewang, Tareythang

What happens when farmers raise cattle, have enough fodder and shed? It results in a better life.

Ask farmers of Tareythang and they will vouch for this. The gewog with five chiwogs of Tashichoeling, Yeozergang, Pemachoeling, Dorjitse and Woonchelu are living the difference made by small investment made in cattle rearing. The gewog has about 400 cattle but with recent intervention from the Department of Livestock, farmers are enjoying the fruit of their hard work. With aid from the Rural Economic Advancement Program, farmers of Pemachoeling were supplied 10 numbers of jersey cows. To ensure proper feeding for better yield, the

cows were followed by fodder grasses like Napier grass, paspalum and fig tree (fodder tree) to combat the fodder shortage.

However, feeding the cattle in winter is a challenge. To tackle that challenge, the livestock extension office encouraged silo pit construction.

With a shoestring budget of Nu.20,000 from gewog and technical support from the Dzongkhag Livestock Sector, farmers have completed the construction of silo pits for two farmers in Pemachoeling and Yeozergang.

Silo pit is expected to address the fodder shortage for about 3-4 cattle per household during lean season. Demonstrations on how to construct silo pits were carried out in the gewog.

As a southern gewog bordering Assam in the south, Tareythang gewog receives a lot of rain during monsoon. This had hampered animal husbandry even as livestock activities in the gewog was picking up.

Recognising the importance of proper shed for cattle, Dzongkhag and livestock extension offices supplied materials for the construction of cattle sheds.

To encourage using alternative source of energy and take advantage of animal husbandry, preferences were given to farmers who were willing to construct biogas alongside the shed. Today, the gewog has around 21 cattle sheds.

Since the inception of Bhutan Biogas Project (BBP) in 2011, farmers across the country have immensely benefited. BBP has been providing a sustainable energy source for households with livestock and help them reduce dependency on firewood and expensive fossil fuel.

It costs between Nu.36,000 to Nu.45,000 for farmers to construct biogas. Farmers are given loan of Nu.20,000 to set up the plant in addition to subsidy of Nu.11,700 for every plant.

Encouraged by the various support services, farmers of Tareythang have lately taken up biogas as means of clean energy.

In addition, the Royal Manas National Park granted all the required materials for biogas construction to interested farmers as gewog fall under buffer zone. Today, the gewog have 18 biogas user with lone mason and haven't encountered any defunct hitherto.

Off lately, farmers have realised the importance of bio-slurry for agriculture purposes. Farmers who have biogas plants were given instruction and hands-on practices how to collect bio-slurry. With two pits dug for bio-slurry, farmers have started to unload slurry and dry under sun. Those dried slurry are then taken to their agriculture field as it proves to be organic manure.

Tareythang in recent times have seen a lot of developmental activities with adoption of new technology.

With such developmental progress, farmers are equipped to combat poverty. Socio-economic status at farmer's level is also picking up with the sale of dairy products.

"Life has become more comfortable with lots of interventions from the gewog livestock extension office. "For people like us who depends on dairy cow, such intervention are timely," said Chojay Wangdi of Pemachoeling. "Firstly construction of cattle with supply of jersey cross cow followed by bio-gas then silo pit construction has benefited a lot of families," he adds.

Yeozergang tshogpa said, "The construction of cattle sheds has benefited farmers especially during summer when cattle are unable to sleep on muddy ground. Hoof rot disease has also decreased."

With a national vision of self-reliance, the role and support of the sector and gewog is instrumental in improving the livelihood of the rural people.

Locally made LAMINAR to reduce cost

ARDSC-Khangma developed the alternative to meet demand for spawn

Tshering Dorji and Thinley Gyeltshen, ARDSC-Khangma

With increasing demand for mushroom spawn from mushroom growers, the Mushroom Spawn Production Unit (MSPU) in Khangma is overwhelmed.

To ease the pressure and enable mushroom growers avail spawn, the Agriculture Research and Development Centre (ARDC)-Wengkhar initiated the youth engagement in spawn production as Youth Entrepreneurship Program in the region. Production of spawn is expensive. To reduce cost and expand the spawn production, the program required laminar flow, an essential equipment in spawn production.

Laminar airflow is defined as airflow in which the entire body of air within a designated space is uniform in both velocity and direction to prevent contamination of semi-conductor wafers, biological samples or any particle sensitive materials. The ARDSC-Khangma replicated a prototype from Maejo University, Chiangmai, Thailand and developed five low cost laminar airflow at the ARDSC-Khangma.

It was part of a post-training program by the mushroom team who attended mushroom production technique training in Maejo University supported through EU-TCP.

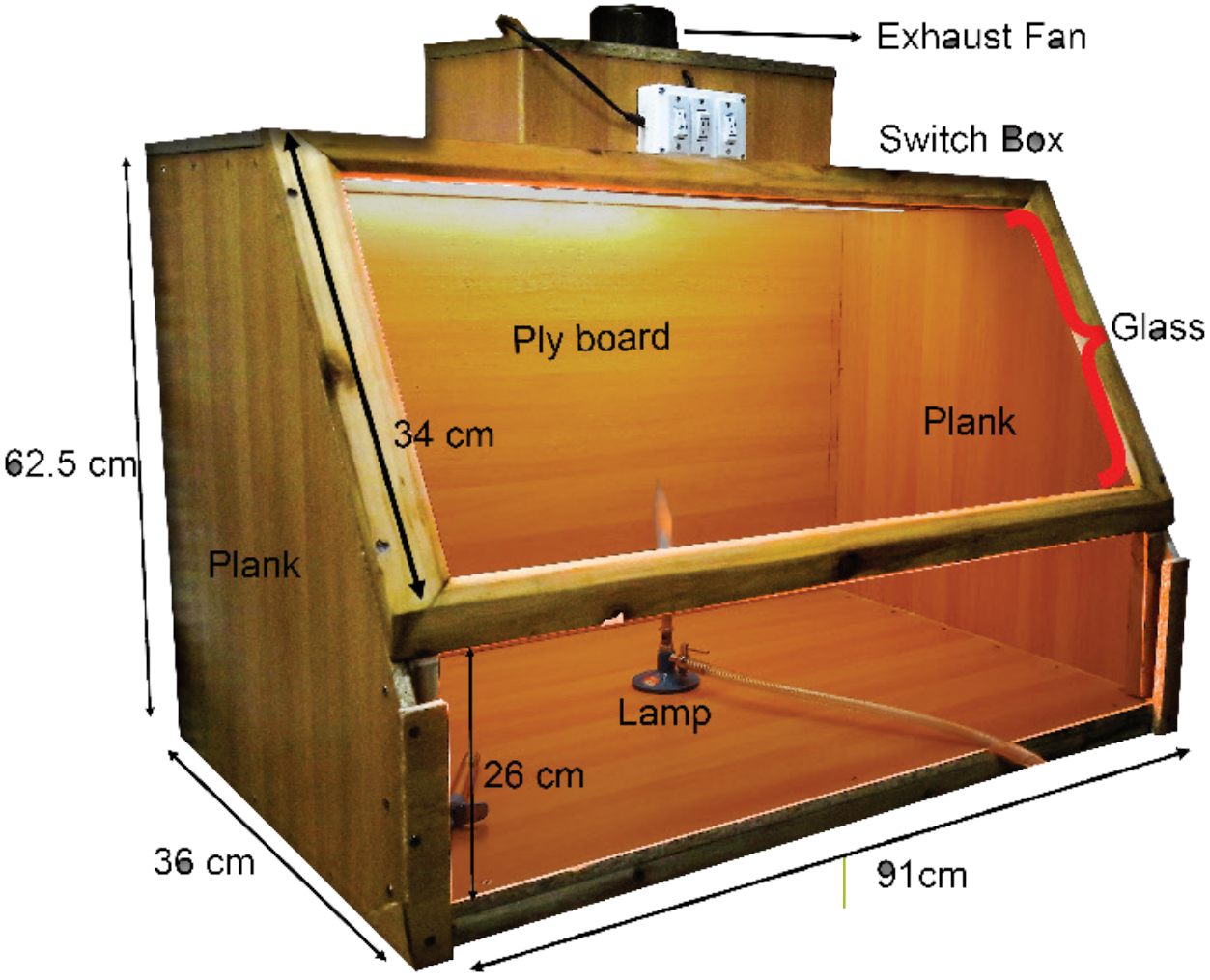
The locally designed laminar airflow is replicated in ARDSC-Khangma with fund from the Commercial Agriculture and Resilient Livelihoods Enhancement Program support to ARDC-Wengkhar.

The team used locally available materials such as ply board, planks and accessories from local hardware shops such as exhaust fans, U/V tube with frame, LED tube with frame, switch box, switch, screw, rice cooker cable, panel pin and glass to develop the laminar flow.

The current design is developed for dimension of 91cm x 36cm x 62.5cm.

The prototype developed at MSPU cost about Nu.7000 a set. This is comparatively cheaper than the manufactured type that usually comes with a minimum price of Nu.50,000 to Nu.150,000 per set depending on brand and option. Considering the possibility of reducing cost for major equipment, the fabrication of laminar flow could help to reduce cost of technology and enable use.

The five laminar developed by the centre will be handed over to targeted young entrepreneurs taking up spawn production and mushroom cultivation in the region.



Rikhey farmers intensifies SRI practices

An experience of Samdrup Jongkhar Initiative

Karma Dema, Ngawang Chojey and Pema Chophel, SJI

The Samdrup Jongkhar Initiative (SJI), a community-based organisation that operates under the auspices of the Lhomon Society, a registered civil society organisation in Bhutan is committed to contribute towards the national vision of going fully organic.

As rice is the most important and preferred cereals of the Bhutanese, SJI community decided to focus on organic rice production.

The community's vision was indeed highly relevant as the country is only 50% self-sufficient in rice. However, it is easier said than done. The visioning was easy but putting the vision into action was a formidable challenge. When the SJI community was in quest of technologies on organic rice production, a visiting consultant, Dr. Julian Gonsalves, an Indian environmentalist well known for his work on sustainable agriculture and rural development visited Samdrupjongkhar for project evaluation and suggested the System Rice Intensification (SRI) as a potential alternative. Thus from 2014, SJI



farmers started adapting the SRI method for organic rice production.

The International Rice Research Institute defines SRI as an evolving set of practices, principles and philosophies aimed at increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. While SRI is proven elsewhere as one of the crop management practices to increase rice production, Bhutanese farmers are yet to adopt it.

Despite the foreseen challenges of high requirement of farm labour for SRI, the SJI initiated promotion of SRI with a few farmers in Phuntshothang, Pemathang and Langchenphu with support from the Bhutan Foundation. The results from these gewogs were very encouraging. As SRI was a new practice for the farmers, they needed regular monitoring and advice. For this reason, the SJI decided to work at Rikhey village under Dewathang gewog. Rikhey is close to the SJI office at Dewathang.

Rikhey village has 64 households and farmers depend on agriculture and livestock for their food security and livelihood. The community has both rain fed dry land and irrigated wetland for crop cultivation.

The total rice area in Rikhey is about 76 acres but only 31 acres of it is being utilised for rice cultivation due to insufficient irrigation water and labour shortage.

The SRI initiative at Rikhey started with 13 farmers in 2016. Farmers were advised to use 15 days old seedlings and transplant only one seedling as compared to their existing practice of transplanting 2-3 seedlings which are 45 days old. Farmers transplanted the seedling at a spacing of 25cm between two seedlings.

After transplanting, farmers were asked to manage water through alternate wetting and drying of the fields. Weeds, a major challenge in rice production were managed by using simple hand tools like rotary weeder. Despite apprehensions and challenges, the outcome of SRI was encouraging. When participatory yield assessment was done at harvest, farmers were excited to record 60% yield increase under SRI system as compared to the farmer's conventional system.

SRI did not use any chemical fertilisers and pesticides. The most notable advantages of SRI according to Rikhey



farmers are saving of rice seed as less seed is required for SRI nursery since only one seedling is used with wider spacing between plants; less water is required for rice crop as alternate wetting and drying is followed as against the normal practice of continuously pounding water in rice terraces.

Sangay Dorji, a SRI adopter of Rikhey says that he saved 88% seeds following the SRI method. "Initially when single seedlings were transplanted, I was really worried because we have always been transplanting 2-3 seedlings," he shared. He requires 24kgs of seed to raise nursery when he practiced his conventional rice cultivation method but for SRI, he only needed 4kgs.

Another farmer, Seldon who is the first adopter of SRI and now in the second year of practicing SRI in Rikhey says, "When I started SRI last year, I found it labour intensive but this year, I don't feel it. This could be perhaps due to the familiarisation of the SRI techniques." Currently, 13 farmers are practicing SRI at Rikhey with funding from Bhutan Foundation.

SJI plans to further up-scale SRI with more farmers for accomplishing its vision of organic rice production.

It also plans to adopt SRI and promote the most preferred traditional rice varieties like Khamti that is in huge demand, fetches better price and yields higher returns for the farmers.

SJI is also collaborating with the Jigme Namgyel Engineering College at Dewathang for developing small tools for rice weed management through a participatory dialogue with the users. Following the success, SJI has also sent SRI farmers of Rikhey as resource persons to train farmers of Toktokha village in Chukha and Phajogoenpa in Lauri, Samdrupjongkhar as part of projects under Austrian Coordination Office and Helvetas, Bhutan.

The long-term vision of SJI is to make Rikhey, the first SRI and organic rice producing village in Bhutan. Further, SJI also plans to adopt SRI for upland rice.

SJI is also incorporating SRI component in lead farmers training supported by Commercial Agriculture Resilient Livelihoods Enhancement Program through the Agriculture Research and Development Centre-Wengkhar.

Grain yield comparison between farmers traditional rice cultivation and SRI at SJI sites

Year	Location	Grain yield kg/acre		
		Traditional farmers practice	SRI	% Yield increase
2015	Pemathang	1219.50	1850.00	52
2015	Phuntshothang	1080.00	1282.50	19
2016	Rikhey/Dewathang	910.58	2023.58	122
2017	Rikhey/Dewathang	2023.5	3237.60	60

ONION: Umling farmers' income

Ram Chandra Katel, Umling gewog, Sarpang

An onion production trial was started in Chhuborthang, Umling in 2017 to keep imported vegetables at bay that usually contain dangerous level of pesticides. Following a feasibility study, the Agriculture Research and Development Centre (ARDC)-Samtenling helped establish the chain.

An area of 0.6 acre was brought under onion cultivation with the seed and technical support from ARDC-Samtenling to kick start production.

Four farmers headed by the chiwog tshogpa took part in the program. The nursery was raised in October followed by transplantation in November. The crop was ready for harvest by end of April.

The only thing about onion cultivation that they did not like was the long gestation period, the growers said. From a crop cut area of 1m^2, it yielded 1.915kgs of onion which on average is estimated

to yield 7,75kgs of onions per acre. In the first year, approximately 2307kgs of bulbs were produced which when converted to monetary value amounted to Nu.92,280.

To make onion cultivation a viable source of income for the growers, farmers training on onion production and post-harvest management was conducted which attracted more interested growers.

With series of advocacy programmes, now the farmers of Umling gewog are convinced to add onion to their food basket and are encouraged to take onion production in larger area in coming season.

PNP records TWO new plant species

Jangchuk Gyeltshen and Phuntsho Wangdi, PNP

During field expeditions, a two new plant species namely, *Eriocapitella vitifolia* (Buch.-Ham. ex DC.) and *Habenaria dentata* (Sw.) Schltr. *Eriocapitella vitifolia* was discovered in the Phrumsengla National Park (PNP).

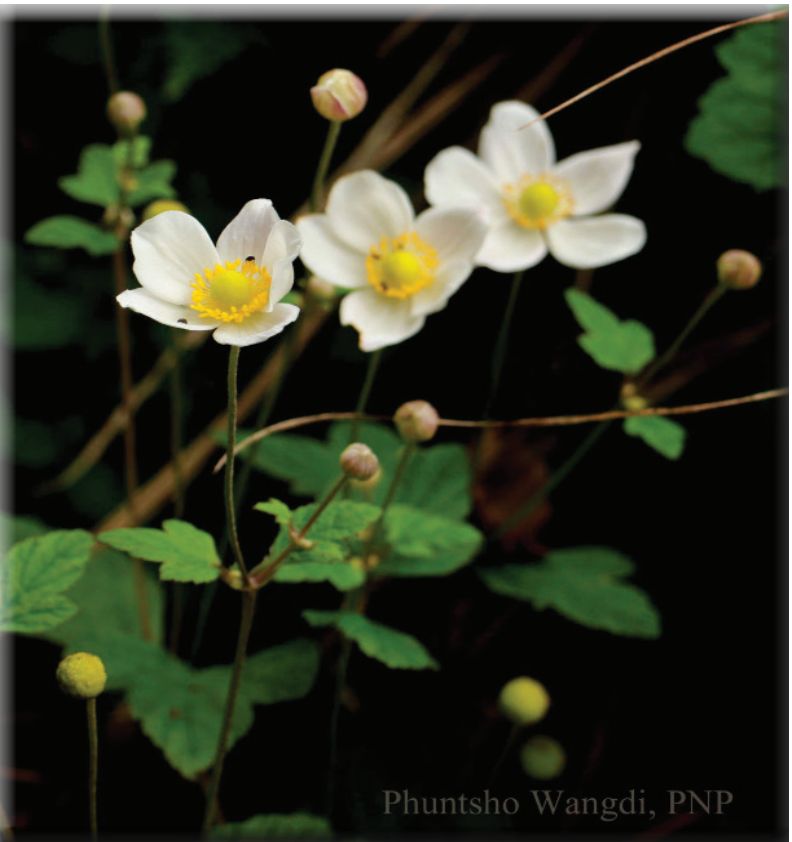
The park staff, Phuntsho Wangdi and Pema Thinley spotted *Eriocapitella vitifolia* below Namling in a cool broadleaved forest at an approximate altitude of 2300masl on October 1. It is not yet evaluated in IUCN Red list. *Eriocapitella vitifolia* is a newly accepted name as per the Catalogue of Life assessed on 24 September 2018. It was earlier known as *Anemone vitifolia* (Buch.-Ham. ex DC) under Ranunculaceae family.

The plant is said to be known from Nepal, Myanmar, China, Tibet, India, Pakistan, Philippines and Bhutan.

Both of them later on October 4, spotted *Habenaria dentata* which is listed as vulnerable in 2004 IUCN Red list under Orchidaceae at Yongkola. It was found growing at the edge of chirpine and oak forest. It flowers in September to October.

As per the record under the Orchids of Bhutan, the plant is also reported from Trongsa and Zhemgang at an altitude 610-1520masl.

With the addition of these two new species, the PNP is now home to 889 plant species.



Taming the Shemjong slide

Tshering Dorji, Divisional Forest Office, Sarpang

A couple of years ago, gazing towards Shemjong gewog from the Tsirang town, a glistening speck of area caught the attention. On clearer observation, one could see the 10-acre eroded land filled with exposed mica and silica rocks reflecting the sun.

Appearing like a huge pimple on a beautiful face, the eroded land is an eyesore for nature lovers. That is the massive remains of a landslide on Dangraygang, previously known as Daragaow in Shemjong gewog.

Linking the wrath of nature to human activities, residents of Dangraygang believe that the nature was disturbed. According to villagers, in the mid 1990s, there was a big tree in the area, the abode of a local deity (Devi Mata). The then village gup found it necessary to fell the tree for village development. After the tree was felled, torrential rain pounded the village. The heavy downpour continued for weeks subsequently bringing the birth of gully erosion, reel erosion and finally a massive land movement downwards.

The impact of the landslide was disastrous and powerful enough to chase away seven households living within the area. Precious and fertile arable land was washed away

including trees exposing jagged rocks and boulders.

Villagers believe that the deity was angered for destroying her home and was avenging the destroyers. Over the years, the landslide became unmanageable.

The Dzongkhag Forest Division, Tsirang carried out plantations and land management activities to rehabilitate the area but all in vain. Once all the people from 12 gewogs under Tsirang gathered at the site and carried out huge plantation and land management activities in 2007. As if the rehabilitation was not enough to appease the deity, two weeks of heavy rainfall followed immediately after the activities washing away all the seedlings and stonewalls. Seeing the failure and budget washed down the drains was a great loss to the nation.

In 2008, I was placed at Shemjong as the Forest RNR extension agent. The history of not being able to rehabilitate the area did not deter me to fight the battle.

Whenever villagers were involved to carry out plantation at the site, they would brush it off as a waste of time and money. Their anticipation for occurrence of landslide was so strong. True to their belief, sliding continued for three consecutive years. I was not ready to give in. In 2011, after a thorough study of the area, I found out that seepage of surface runoff above the landslide area was the main cause of the landslides. The important work to be carried out was just to divert the surface runoff away from the landslide area during the monsoon.

I wrote a proposal and in 2012, my proposal on land management was accepted by Small Grant Project. Singye Dorji, the then National Coordinator of UNDP have found my proposal genuine and immediately advised me to seek help from the National Soil Services Centre.

Calculated steps were taken to carry out the project. Sixty six determined warriors of Dangraygang village were involved in the project to fight the war against this annual landslide. We started with *Ruesangchey* (smoke rituals to appease gods) as requested by re-settlers and a ritual to appease the local deity as desired by Lhotshampas.

The very next day, armed with sickles, spades, crowbars and pic-axes, the warriors climbed uphill and started digging drains perpendicularly above the landslide areas to divert the surface runoff.

Commanding the warriors was hard as they were not paid wages and only option for me was to sweet-talk them always convincing that the work was for the benefit of their village. The tedious job was completed within three months. After constructing four long drains ranging from 800m to 1500m, construction of stone walls were initiated. The activities were followed by construction of checkdams and more small stonewalls. Blisters, back pains, cut and sprains didn't discourage them. They were convinced that the work they were undertaking was solely for their benefits.

The uniqueness of this land management project was that not a single seedling was planted on that eroded land. We waited for the monsoon.

The first monsoon after the land management activities, hit the land and to our dismay, it served us with another landslide.

It was disheartening. We didn't give up. Drains and walls were repaired as soon as possible. The following year, the monsoon was not kinder. Heavy rainfall hit Shemjong. But to our surprise and delight, there were no sign of landslide in 2013. The local deity had heard our prayers. In 2014, grasses began colonising the eroded rocky areas. Shrubs were seen intruding the barren land and as expected no erosion occurred in 2015 too.

Today, if you look towards Shemjong from the Tsirang taxi parking, you will find it difficult to point the landslide areal. Eighty percent of the barren land had been rehabilitated and lush green vegetation has dominated the rocky slopes. Today, alder trees with their roots deeps way in the breeze.

Whenever I pass Tsirang, I take time to look towards the hill, breathe a sigh of relief with pride. Heartiest gratitude to the public of Dangraygang village and to the project. A battle was fought and won-a battle that ended with winners and no losers.

Promoting entrepreneurship through post-harvest processing and value addition

Kinley Wangmo, IFFP; Lhap Dorji, ARDC-Wengkhar and Dechen Tshering, NPHC

Hydropower and tourism may be the drivers of the Bhutanese economy but agriculture is still the mainstay of our country. According to the population and housing census 2017, over 62.2% of the population living in rural area depend on agriculture for their livelihoods. Majority of the farmers practice integrated and subsistence farming by cultivating a variety of crops and rearing livestock. Major crops that the farmers grow includes vegetables such as cabbage, cauliflower, broccoli, radish, chilli, beans, mustard green; fruit crops such as peach, pear, persimmon, oranges, apples and cereals such as paddy, maize either for their consumption or for the sale in the domestic markets. With change in time, some of our farmers are now shifting

from subsistence to semi-commercial and commercial farming. Whatever is produced from their farm is brought to nearby local markets or in some distant markets. But quite often, not all the products are sold or fetch the best price as the increase in production and short shelf lives challenge farm products.

Opportunity

Our farmers cultivate diverse crops and more youth are now taking up farming. To help them adapt to farming practices, farming could transform and graduate from the subsistence to commercial level thereby promoting entrepreneurship and enhance local economy. This transformation and commercialisation of farming could provide opportunities for self-employment.

Institutionally, the Department of Agriculture (DoA) has aligned its programs towards commodity-based approach through which different agencies with different mandates are to converge for value chain intervention under which the Integrated Food Processing Plant (IFPP) at Lingmethang was established.

Financial investment in commercial farming, a bottleneck so far has now been cleared with the creation of the priority sector lending (PSL) scheme which can enhance the transformation of farming into a commercial enterprise.

Further since the 11th five year plan or even before, the concepts of one gewog one product (OGOP) was conceived and there is strong policy support towards developing specific products for a specific location.

The initiation of the Commercial Agriculture and Resilient Livelihoods Enhancement Program (CARELP) in six the eastern Dzongkhags has opened opportunities of supports and interventions in entrepreneurship development in farming.

Intervention

In order to mitigate constraints of short shelf life and encourage entrepreneurship promotion, a collaborative program on up-scaling alternative utilisation through value addition of farm products was started by the DoA through the Agriculture Research and Development Centre (ARDC)-Wengkhar and IFPP with financial supports from the National Post Harvest Centre (NPHC) and CARLEP.

Methodology

Products were first developed and designed on a trial basis at IFPP before expanding to farmers. Using the concepts of learning by doing, the existing post-harvest processing technologies were demonstrated to target groups who are potential adopter of agro-processing particularly youth and women.

Hands on practice trainings were organised in collaboration with the gewog agriculture extension office depending on the availability of raw materials within the locality, number of participants and appropriate equipment with the IFPP and ARDC-Wengkhar.

The CARLEP support to ARDC-Wengkhar and respective Dzongkhags support the promotion of post-harvest, youth engagement and enterprise development program through additional training materials, tools and other training costs.

Trainings on raw materials collection, selection, cleaning, processing-product development, packaging and labelling of the product were organised either at IFPP, ARDC-Wengkhar or in some of the farms.

In order to ensure application of training skills, the training encourages participants apply the skills as well as to come up with enterprise development for fund exploration particularly from the PSL and the CARLEP for which technical assistance in project development is arranged.

Progress

Between 2015 and 2018, product development by processing and value addition has worked on promoting about eight different products. About 400 farmers targeting youth, women, farmer groups, hoteliers and non-formal groups of unemployed

Eight products developed

Name of the product	Raw materials
Candy	Papaya, Pear, Peach, Indian Goose Berry, Mango, Quince
Fruit Roll-up	Mango, Papaya, Quince
Marmalade	Citrus
Chips	Banana, Potato
Pickle	Chilli (Urka and Dalley), Radish
Dried products	Pumpkin, Chilli
Cookies	Maize, Rice, Cassava, Millet, Quinoa, Pumpkin

housewives have been trained so far on the development and packaging of different farm products such as marmalade, candy, chips, cookies, pickles, maize and rice products. Seventy two percent of the beneficiaries were women.

Till date, four entrepreneurs: a youth group in Mongar composed of four young farmers, two women entrepreneurs and two farmers' group in Samdrupjongkhar and Yangtse have now started to carry out post training programs in developing farm products and marketing. These products are currently sold through retail shops in the local area and from their homes.

The Regional Agricultural Marketing and Cooperatives Office in Mongar is facilitating linkage of these entrepreneurs with bigger outlets such as retail shops and the OGOP outlet in Thimphu. There has been an increasing trend in the number of farmer attending agro-processing and value addition trainings. In the last three years, starting with some 20 farmers in the first year followed by 70 in the second year, the number increased to more than 300 in the third year.

However, its adoption resulting in initiation of enterprise has remained low, about 10% of the total trained taking up full-scale production and marketing. This is mainly due to the higher initial investment cost required to establish processing unit like equipment, utensils and packaging materials.

To encourage the adoption and practice of the post-training, the program will now tap the current PSL funding opportunity and support to post-harvest from CARLEP through enhancing the on-going collaborative programs with Dzongkhags.

Gangtey-Phobji Ramsar Site

The biggest in Bhutan

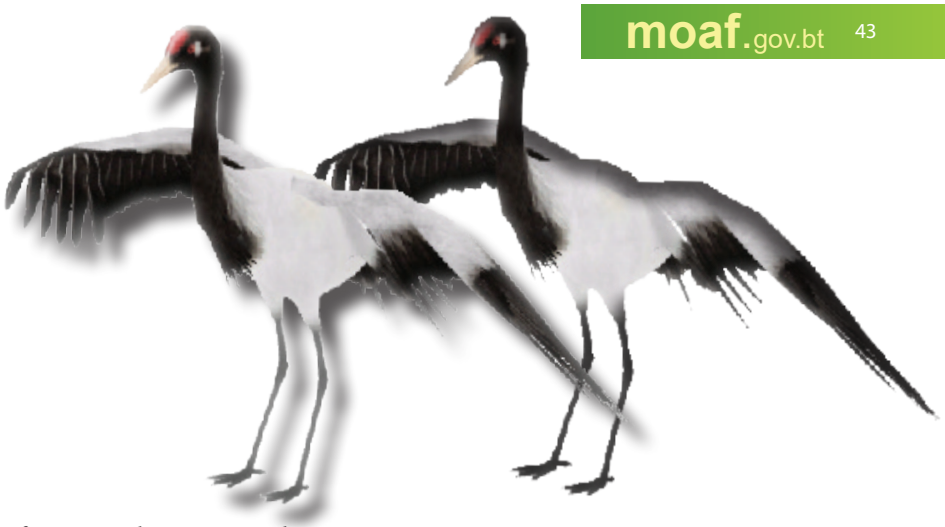
Water Mangameent Division

The Gangtey-Phobji Ramsar Site, the biggest in Bhutan support rich ecosystems and provide prime winter habitat for up to 300 globally vulnerable black-necked cranes and other threatened species such as the endangered red panda and tiger, and the vulnerable sambar deer.

The site with an area of 970 ha was designated as a ramsar site on 2 May 2014. It lies in a wide glacial valley that spreads across the central highlands of Bhutan. Most of the areas along the streams are marshy, covered by grass, bamboo and several species of shrub and herbs including thick sphagnum moss.

There are more than 24 species of mammals which visit the wetland area for food and water. The core wetland area is encircled by endemic rhododendrons with a total of 103 species belonging to 38 families being recorded. A few endemic herb species such as *Eriocaulon bhutanicum* and *Euphrasia bhutanica* are also recorded.

Gangtey-Phobji is a wide glacial valley with meandering streams through open grasslands and thickets of dwarf bamboo. It is one of the



sources for the tributaries of the Punatsangchhu. It serves as a water source for domestic use and irrigation for the people living in the valley and also downstream.

The water drains through the open grasslands to the Nakeychhu, Khewangchhu and other small perennial streams. Those are important ecosystem harbouring various life forms.

The black-necked cranes heighten the breathtaking scenery of Gangtey-Phobji in the winter months starting from October to March. They feed in the agriculture fields on grain residues and on shoots of dwarf bamboo, tubers and worms. Their arrival indicates the end of the harvesting season. This unpremeditated timing provides an excellent environment to the peace loving black-necked cranes.

Hydrological Values

The water table depth varies across the wetland and there are micro-topographical changes. Water is at the surface in some places while deeper than a metre at other places. In areas where there is surface water, there are puddles made by cattle hooves which provide microhabitat for several insects such as dragon fly nymphs, mosquito larvae and gnats. Cattle appear to influence the micro-drainage in these areas. Wet areas with grass have balls of small reddish earthworms in the root zone. This has strong relevance to the availability of different soil types that sustain the kind of natural biomass and agricultural produce in the valley.

Gangtey-Phobji is a u-shaped glacial valley. About 10-15m thick lower layer of the kame terrace is sandy silt (48% silt, 52% sand) saturated with water that seeps out at the contact zone with the underlying clayey glacial ground moraine.

The glacier carved valley is left with an impervious layer of clay rich ground moraine causing the valley bottom to be marshy. It was formed by glacial movement in the Pleistocene era. The Gangtey-Phobji wetland is one of the biggest wetlands dominated by marshes in Bhutan.

Social and Cultural Values

There are 44 villages scattered throughout the valley with a population of 4,740 people in 645 households dependent on the wetlands for water. Gangtey-Phobji population used to practice vertical transhumance. Some farmers have settled permanently in the valley.

The area is a popular tourism destination with the number of tourists increasing each year. A traditional festival is organised to welcome the arrival of the black-necked cranes in October which also promotes nature-based tourism.

The projects to promote community-based tourism have been implemented aiming at building local people's capacity and developing tourism products and activities such as home-stays, local guides, cultural programs and campsites.

Conservation Measures

There are forest management plans in the surrounding area. One of the biggest challenges in Gangtey-Phobji Ramsar Site is the increasing number of tourists.

A phenomenon called the Doxey's irridex which explains the effect of tourism development on the social relationship between visitors and host community has evolved over the years. The increasing number of hotels and tourists has resulted in the contamination of the water bodies and other associated problems. The benefits from the tourism industry do not trickle down to the community. These challenges are being dealt with through a watershed management plan.

The Royal Society for Protection of Nature (RSPN) has been involved in black-necked crane conservation work since its inception in 1987.

Since 1999, the RSPN initiated a series of integrated conservation and development programs mainly keeping in view local community's participation and support in conservation. Gangtey-Phobji landscape area management plan 2006-2010 was developed by RSPN and endorsed by the Ministry of Agriculture and Forests which has already been implemented.

Apart from the key conservation activities, a variety of community development programs including alternative energy, community-based sustainable tourism, community capacity development, women in environment, environment education, environment and health has been initiated in the valley. The Department of Forests and Park Services (DoFPS) and RSPN

established eight community forests in the catchment area. The Royal Government of Bhutan and the Austrian Government have jointly supported an initiative to provide underground grid electrification in the valley.

In order to encourage environmentally viable tourism and help people benefit from conservation, RSPN has been promoting community-based sustainable tourism (CBST) in Gangtey-Phobji.

RSPN has also been working with the communities to develop their capacity in catering to tourism needs, developing local tourism products and activities such as home-stays, local guides, cultural programs, campsite, local souvenir products, etc.

The black-necked crane festival that takes place since 1998 is an important part of the CBST program.

In February 1998, RSPN and the International Crane Foundation for the first time embarked on a project to study the migration route and locate the summer breeding areas of the black-necked cranes wintering in Bhutan by using a technique called satellite telemetry. Later, similar projects were conducted in 2005-06 by JICA and RSPN and in 2012 by Ugyen Wangchuck Institute for Conservation and Environmental Research.

What checks and balances have been established in the country?

The Forest and Nature Conservation Rules 2017 requires the conservation of wetlands. The forestry clearance will be rejected if there are significant wetlands in the area of concern.

The implementation can only be fully successful, if the implementers clearly know the stretch of wetlands in their area.

Therefore, the major task still lies ahead for comprehensive wetlands inventory in the country.

The Department is continuously working on various strategies to preserve the wetlands in the country.

Collaborations from all concerned stakeholders to provide a conducive environment for concerted efforts are being promoted.

How to conserve wetlands?

- Wetlands should not be altered at all.
- Rivers and streams should be left as natural as possible.
- Haphazard tapping of drinking water should be avoided.
- Lakes should not be fenced.
- Carrying out mass plantation of species not native to the locations should be avoided.
- Carry out effective management of the wetlands preserving the natural condition.
- Through advocacy programs, triggering the value of wetlands among citizens is effective and essential.

Functions of wetlands

- Clean water for all purposes.
- Food for all living beings.
- Habitat for a rich biodiversity.
- Disaster risk reduction.
- Economic growth.

Challenges

Unsustainable activities associated with economic development have fragmented the wetlands in the growing towns and cities. The fragmented wetlands are one of the causes of wetland loss as it fastens the process of degradation. The loss of wetlands is irreversible and most often requires enormous financial support for restoration.

Market-Oriented Farming

A success story in Vegetable Production in the East

Sangay Jamtsho and Choni Dendup, DAMC

Any old marketing text book or a google search will reveal that the 'Marketing concept is the philosophy that firms should analyse the needs of their customers and then make decisions to satisfy those needs better than their competitors.' Today, most firms including all farming households as they are all an economic entity have adopted the marketing concept. But this has not always been the case. Non-adoption of the concept could have been due to various reasons arguably but let us accept for this paper that perhaps it was more conducive to follow the other concepts of marketing namely production-producing and selling concepts based on the stage of economic development then. Likewise, in agricultural development and marketing in Bhutan, all these concepts are followed and all concepts have been relevant at one time or another in its developmental process. The production concept, product concept and selling concept have been followed for reasons like seasonal

advantages and ready markets along its southern borders. The production concept is that 'Consumers will favour products that are available and highly affordable.' The product concept holds that the consumers will favour products that offer the most in quality, performance and innovative features.

The selling concept holds the idea that 'Consumers will not buy enough of the firm's products unless it undertakes a large-scale selling and promotion effort.' The ideal societal concept of marketing is being pursued given the country's national environmental policies in general and not compromising its environment for economic gains in particular.

Farmers may produce for many reasons like research, trials and demonstration, self-consumption, nutrition, food security etc.

But if farmers want to sell their products, then we propagate that market-oriented concept be pursued i.e. produce what the market wants. That is deciding on what product to produce where to sell, how to sell and at what prices (the four Ps or marketing mix as known in marketing). These decisions must be taken prior to production of the product. In Bhutan, we can see in many places the market-oriented farming being adopted by our farming community, especially after various area development projects.

During the implementation of Market Access and Growth Intensification Project and Commercial Agriculture Resilient and Livelihoods Enhancement Program at the present time, the market-oriented farming especially commercialisation of vegetable production and marketing has been a success story in eastern Bhutan.

The vegetable marketing in the east started in 2011 with identification of six vegetables viz. cabbage, cauliflower, radish, carrot, beans and peas mainly to be marketed in nearby border towns of Assam.

It was observed that the Bhutanese vegetables comprised of only about 10% of vegetables available in nearby border towns of Assam.

The reports from Indian traders indicated that Bhutanese vegetables could increase its share in Indian markets by about 30-40%.

Seeing the scope of vegetable marketing and considering the favourable climatic conditions, the vegetable value chain program was initiated in the east with close collaboration among stakeholders.

The vegetable value chain program saw rise in number of farmer groups undertaking vegetable production and marketing. Over the years, the quantity of vegetable sales saw steady rise with increase in income generation of farmers.

While there was a huge demand for vegetables outside Bhutan, the problem of farmers groups not being able to produce vegetables consistently and non-availability of varieties of assorted vegetables gave a blow to marketing of vegetables outside Bhutan.

The marketing concept though pursued for export market was not able to materialise and thus an approach to compliment export marketing by supporting domestic marketing was explored. This resulted in linking of schools and institutions to the producers.

The demand assessment of vegetables in schools and institutions revealed 1400MT

of vegetables consumption in schools and institutions in a year. This demand had a value of Nu.23.6M. It was observed that local potential market for vegetables existed in local schools and institutions.

Today, farmers groups supply vegetables to schools and institutions with an agreement drawn before the start of academic session and fixes prices and schedule of supply from farmers groups. This has helped both the parties. Farmers have assured market for their vegetables and schools/institutions on other hand get fresh vegetables.

In order to further strengthen the linkage, dairy products and other cereal crops are also being included in the contract to propagate adoption of a market-oriented approach to the production system. A coordinated effort with clear concept of marketing will result in better linkage. The vegetable value chain program in the east has provided sufficient evidences that pursuing market-oriented farming system will help both producers and buyers fulfill their expectation.

The marketing approach is meeting the desire in an efficient manner with maximum benefits to both the parties.

SCHOOLS, a focus for Change

B. B. Rai, Department of Agriculture

School is a place of learning. It is an institution where young minds are shaped to take up responsibilities in the future. Newer concepts, keeping in mind the demands from reality would help mold a younger generation ready to face realities and the need of the country.

Science has proven that the cognitive reflections of individuals are significantly higher if individuals are exposed to the real situations as early as in their elementary school days. There is a lot of importance given to agriculture to fulfill the national vision of food self-sufficiency and food security. The School Agriculture Programme (SAP) is one such programme that could make a difference in the lives of students and contribute to the national vision.

In today's world, schools are targeted by many agencies and organisations as the place for change and developing proactive mindset. Among many programmes, school gardening through various approaches is one common agenda in many south-east Asian countries like Bhutan, Nepal, India, Thailand, Philippines and Indonesia (VeGoTs 2016).

Bhutan has been one of the pioneer countries for adopting such strategy as early as 1980s as OXFAM programme implemented by Ministry of Education (MoE) where gardening concepts among school children were provided as co-curricular activities.

The then programme did not pick up with popularity as farming was never envisaged as an attractive pathway. However, the same programme regained its popularity with the revamping of SAP in 2000 as joint activities between MoE and Ministry of Agriculture and Forests. Although the programme was tested in a few schools at the beginning but with popular integrated activities such as vegetable gardening, mushroom and livestock activities, the programme has picked its popularity among many schools and now covered in 60% of total schools ranging from primary till higher secondary schools.

Farming in Bhutan is distinctly categorised as integrated approach where agriculture farming cannot sustain alone without the link with livestock such as poultry, cows and pigs as most of the time these are interdependent for sustainability. For example, vegetable gardening requires compost and manures that is derived from cattle and chickens. Plowing fields in many small-scale farming needs oxen. The by-products from the agriculture field are used as feed for the cattle during off-season.

Bhutan has a dynamic approach of maintaining school enrollment through attraction of school feeding programme supported by the government and WFP. That has got its own merits of having gardens and livestock programme both

for introduction of balance diets for food diversification while paving ways for achieving the 100% school enrollment. Although with many difficulties, schools manage to provide a decent balance diet with the prevailing government stipend of Nu.1000/-child per month in full boarding schools. But challenges are always there if it cannot be supplemented from the school gardens.

Therefore, schools with their own vegetable gardens and poultry farms can supplement and meet better diet. In recent years, the government endorsed a policy called three eggs per child per week which is a popular and successful intervention in the schools where they have their own poultry establishment supported by various agencies such as SAP, Dzongkhag Livestock Sector and central organisations such as WFP, Rotary clubs and local government. Notwithstanding reservations based on religious and cultural grounds from the communities and parents, many schools are able to establish piggery and poultry farms in the schools for educational and supplementing nutritional requirements.

As per the nutrition experts, pork is one of the richest sources of protein and thiamine (B1) that was lacking among the diets of school feeding programme and cause the neuropathy disease (MoH 2013). Pig farming either in schools or in the neighbourhood is always economical business as they can be easily fed with food waste from the kitchen and hostel. Housing for pigs can be met with local materials and low cost resources. However, challenge always remains with the sentiments among the Bhutanese population.

Given the beliefs and sentiments surrounding raising pig to be slaughtered, one interesting trend in most of the SAP schools with piggery farming is that they do not consume the meat of their own pigs. They buy pork from the revenue generated from the sale of the school's pigs.

In recent years, MoE has accepted the incorporation of the formal agriculture curriculum in the middle and higher secondary schools as the progression of SAP activity to formal academic learning with practical skills while still in schools. For those brilliant students this

subjects, called 'Agriculture and Food Security' is seen as scoring subject for academic progression while for other ordinary students, it is a pathways to take up vocational carrier towards farming.

Anybody can opt a vocational training in either College of Natural Resources or Rural Development Training Centre for obtaining certificate course and venture for priority sector lending schemes in farming sector.

There is opportunity in the RNR entrepreneur development either as producer, product development or even for export with the Bhutan brand. Organic farming and natural farming products from Bhutan has the advantages in finding markets. The geographical location and organic policy of the country are some of the advantages for the new upcoming farming world among others. The Japanese technology, effective micro-organisms introduced in the country has vast scope to substitute the chemical farming practices in Bhutan.

Food production by school children is an important contribution in the food and nutrition security of the country although the quantity at school level may be small but while compiled together, the produce is remarkable. For instance, a total of 197MT of assorted vegetables, 77MT of pork and 15,00000 nos. of eggs has been produced in 2017. This was consumed by the students themselves through the school feeding programme, at the same time generating substantial SAP fund for the school.

The approach of introducing farming concept through SAP over the last 18 years in Bhutan has resulted in shaping the mind set of many educated youth taking up farming as an alternative livelihood.

The youth have broader prospectus of eating habits and importance of food diversity. In the nooks and corners of the country, there is a trend of educated farmers depending their livelihood on poultry farming, mushroom farming and vegetables among others.

First Honey Group at Mandrene

Dil Maya Pradhan, Samtse gewog, Samtse

The word buzzing around these days in Mandrene village in Samtse is honey.

The Mandrene Sebjam Tshogpa (beekeepers association for Mandrene) has found a new way of harvesting honey and they are into enjoying the honey dew of slumber with their new found wealth. The village had been keeping bees since time immemorial. The honey was produced and used only for local consumption. This is because with the traditional method, there is not much to spare, except in few quantities when they needed some extra cash income.

Realising the potential of honey business, an association was formed with the help of the gewog livestock extension office along with the Dzongkhag Livestock Sector in 2017. The objective was to improve traditional beekeeping practices and turn it into a beekeeping enterprise in the future by making it economically viable for the poor and the unemployed youth.

Local bees (*Apis cerana*) were usually kept in log hives where they build their combs in a natural way. Honey is harvested by opening up the log at one side and breaking out the combs filled with honey. Often, combs

containing broods were also taken out which would make the colony vulnerable. The honey was collected by pressing the combs through a strainer or clothes. The product obtained contained a large amount of impurities.

Realising the wastage of honey and impurities collected when harvesting honey, a modern method of beekeeping was started, called as the WBC method named after its designer W. Broughton Carry.

The system of movable frames allows extracting honey without spoiling the combs, thus exempting the bees from a lot of additional works. The new method had increased production and is wlecomed by the farmers.

Farmers say that they used to collect a maximum of around 1kg honey per log when following the traditional method. Moreover, due to presence of impurities, it did not fetch good price in the market. But with the modern technology, they collect between 1.5 and 3kgs of honey per hive. The quality of honey also improved.

Today, there are 25 modern hives owned by the 15 members of the tshogpa and they are going to add more hives. The first time they harvested was in 2018 and the production was 50 litres of pure honey after formation of the group in 2017.

The honey is collected in a hygienic manner and impurities are separated by filtering and bottled carefully. With improved production quality, farmers are now into better packaging for better market. They collect honey first from each member in jars. Then the honey is brought to the centre where they are bottled in 275 and 500 grams. The bottled honey is labelled with the date of collection, net weight and priced.

Greenhouse Solar Dryer

A new technology to dry agricultural products

Pema Lhaden and Lhap Dorji, ARDC-Wengkhar and Kinley Wangmo, IFFP

A new technology called Greenhouse Solar Dryer is in place to provide farmers an alternative option to dry their agriculture products. The technology is developed by the Agriculture Research and Development Centre (ARDC)-Wengkhar to replace the age old practice of open sun drying.

Drying in the open space is still widely practiced in Bhutan which is believed to be unhygienic and time consuming. The solar dryer is found to be a better option for farmers which will also enhance shelf-life and add value to the farm products.

With increasing production of fruits and vegetables through commercial farming initiatives, the centre felt the need to enhance promoting agro-processing. The centre realised that drying farm products for a commercial purpose would require a large area and an economically suitable technology.

Considering this, the ARDC-Wengkhar with support from Commercial Agriculture and Resilient Livelihoods Enhancement Program (CARLEP) initiated a research on developing an alternative drier using conventional greenhouse with a concept adopted from Silpakorn University in Thailand.

The base of the greenhouse is lined with black plastic or concrete surface painted with black to increase absorption of solar radiation. A solar powered exhaust fan is attached to greenhouse to ventilate the dryer. Proper shelves are used to dry the produce.

A preliminary testing of the solar dryer was done on banana and its performance was assessed based on its effectiveness.

The electric dryer developed in 2004 is also an effective technology for drying but it is found to be suitable for small scale purpose incurring a high energy cost.

The greenhouse solar dryer operates on a free solar energy and helps to reduce energy cost as it operate the exhaust fans especially at night. Dual connection to power line for power backup could further enhance its effectiveness.

According to records, the greenhouse solar dryer takes five days to dry agricultural products while open sun drying would take 21 days. Although the new technology has lots of benefits, it would be expensive at its initial development.

In order to further ensure the technology, trials are underway at Wengkhar and on-farm outreach sites in Yangtse and Thrimshing for drying chilli.

GEALS in Sarpang and Samtse

A survey to identify GEALS and its presence

Chinta Mani Dhimal and Ratu Kinley
ARDC-Samtenling

Snail is commonly called for land snails, terrestrial pulmonate gastropod molluscs and molluscan class Gastropoda that have large coiled shell enough to retract itself into. It is a general name applied for all snails found on the land as well as in sea and fresh water.

Accounting all the gastropods both in sea as well as on land, there are approximately 80,000 species of snails. However, the sole land snails are estimated to 35,000 species around the globe except Antarctica.

Among the land snails, Giant East African Land Snail (GEALS) is one of the largest terrestrial gastropods. GEALS (*Achatina fulica*) is one of the largest land snails and most invasive species in the world which damages a wide range of agricultural crops. It

feeds on at least 500 different species of plants. Among 100 most harmful invasive species around the world, this species is more dangerous to human as it is a vector of disease. Given its large size, it has the ability to adapt itself in adverse conditions even outside its natural habitat.

It can withstand diverse environmental conditions. Commonly it has the life span of five to seven years and is hermaphrodite. However, with the availability of enough food and suitable habitat, it can live much longer. Some of them even live up to 10 years.

In Bhutan, it has been observed that this species is slowly getting familiar due to its occurrence in few pocket areas. In 2010, there was an outbreak of Giant African Land Snails (GALS) in Gyelposhing, Mongar. It was mechanically collected and the population had been controlled through community campaign approach. A similar type of snail was spotted in backyard kitchen gardens in Sarpang-Gelephu area. However, there is no formal issue raised by anybody since it is negligible. There is risk of increasing its population and damaging crops.

More importantly, the Agriculture Research and Development Centre (ARDC)-Samtenling region being in the sub-tropical region has potential risk of its outbreak in future. Therefore, timely survey and documentation was felt necessary for which a survey was conducted in different gewogs of Sarpang and Samtse Dzongkhags to study on its occurrence and identify the species.

Since snail prefer to live in humid and warm areas, more gewogs located in lowland areas with sub-tropical climatic conditions were selected and only a few gewogs located at higher altitude were selected. Physical observation was done by visiting the areas where snails were spotted. Samples were collected, measured and their morphology was observed. Discussion with farmers and gewog extension staff was also done along with the physical observation.

Characters of GEALS observed through survey

From the information collected from farmers and gewog extension staff, it is known that they are aware of the incidence of GEALS in Samtse and Sarpang. All the respondents expressed that they have encountered this snail five years ago in their respective locality. It was confirmed that GEALS feed on all types of vegetables including cucurbitaceous vegetables, papaya, beans, green leafy vegetables, mustard green, tomato, coriander, brinjal, maize, rice, millet, other cereals and grasses.

They are also found feeding on cemented concrete walls. The leafy vegetables especially mustard green, radish and other soft vegetables get infected and rot when they snails over plant parts. They are found in low altitude with warm and moist condition with less sunshine under presence of shade. It was confirmed that GEALS are found in low altitude areas only. As per the information received from respondents, the exposure and occurrence of

this snail starts with the onset of monsoon in May-June till September with July and August being the peak season.

Although they are sexually hermaphrodite, they were found mating during the survey time. They were found in a wide range of environment such as grassland, trees, ground, stones and rocks, houses wall, inside water storage tanks and other moist environment. They used to move towards shade, humid and less sun shine areas when they were kept in dry and sunny areas.

From the specimen collected, the colour of shell was brown with reddish to brown and light yellow or cream strips running along its length. The shell colour was observed mildly different in some location since the snail's shell colour changes with diet and environment.

The colour changed when the environment became dry and less humid. All the specimens were found conical in shape with light yellow shell lip colour. The shell body whorls are enlarged while spire is conical narrowing towards apex. It was observed that all the whorls are convex with deeply daunted sutures. Similar to the study conducted by U.S. Fish and Wildlife Service, the shell lip was found to be sharp, thin and curved to uniform semi-ellipse which run till the body whorl and inserted into it. The columella was found to be partially concaved in smaller specimen and broader in larger specimen.

The parietal callus and columella are white to bluish white in colour. Both qualitative and quantitative characters were observed. The eggs are white to creamy white in colour, oval in shape and are hatched in clusters. The average length of eggs is 0.5 milimetres and 0.4 milimetres in diametre.

GEALS not common in the country until recently, could become a potential agriculture pest in the sub-tropical region of the country. Although farmers have not reported its presence as a nuisance, the presence in Sarpang and Samtse should be noted by researchers and extension officials as it could be a potential pest in near future.

From the observation done on morphology of targeted snails, it was confirmed as GEALS. Further it is confirmed that this species is found in sub-tropical areas of Sarpang and Samtse but are not found in higher areas above 1000masl.

2018 HIGHLIGHTS

Seventy seven new graduates join RNR Sector

Seventy seven new graduates joined the RNR Sector in 2018. Out of 77, two has been placed under the Directorate Services, one in RDTC, 28 in DoA, 20 in DoFPS, 24 in DoL and two in BAFRA.

Prior to the joining, the graduates attended an orientation program from January 10-12. They were briefed on the Ministry's overall vision, mission, mandates, plans, policies and issues under the various departments and agencies among others. Addressing the graduates, Lyonpo Yeshey Dorji encouraged them to work hard towards achieving the common goals and objectives.

National Veterinary Hospital

Her Majesty The Gyaltsuen graced the inauguration ceremony of the National Veterinary Hospital on February 5. The hospital located in Motithang, Thimphu will provide better facilities and services to the animal and meet the increasing demand for modern animal care and treatment. It will render animal health services from diagnostic to the therapeutic.

The hospital was constructed at a cost of Nu.57M with fund from the Government of India. The construction works begun in July 2015 with the ground breaking ceremony which was graced by Her Majesty The Gyaltsuen.

Integrated Yak Breeding Farm

The Department of Livestock conducted the salang tendrel ceremony for the construction of Integrated Yak Breeding Farm in Chonaphu, Haa on February 9. The farm will contribute to yak breeding and conservation, promote yak based cottage enterprise, support restoration and sustainable utilisation of rangeland and build capacity of extension staff and communities for sustainable rangeland resources.

The farm is supported with a fund of Nu.3.6M from the Bhutan Trust Fund. It will be implemented jointly by the Haa Dzongkhag, Integrated Yak Service Centre and National Highland Research and Development Centre, Jakar.

National Workshop to celebrate Himalica project

Fifty two change agents participated in the knowledge sharing national workshop on building resilient livelihoods on February 26 in Paro. The workshop shared experiences from the EU funded support to Rural Livelihoods and Climate Change Adaptation in the Himalaya (Himalica) program implemented by ICIMOD, the Ministry and Tsirang Dzongkhag in Bhutan. The program was implemented in five chiwogs of Barshong gewog, Tsirang to support the development of rural livelihoods in the context of socio-economic and climate change. The Himalica has empowered over 200 rural households in the project areas.

National Highland Flagship Program

A consultative meeting on National Highland Flagship Program was held on February 27 to seek endorsement of its concept note and agreement on forming a technical working group. The program is the first among flagship programs to reach the final stage of implementation.

Flagship programs involve multi-sectoral interventions to address key national issues; therefore the Government places a high priority to these programs. As a strategic approach to address issues and challenges, the broad interventions shall take place under thematic areas of policy, education, health, energy, communication, livelihood, and tradition and culture.

Fifth World Wildlife Day

Bhutan celebrated the fifth World Wildlife Day with a theme 'Big cats: predators under threat' at Dodheyna, Thimphu on March 3. It was attended by 55 students from Thimphu along with other participants.

Participants were briefed on importance of wildlife focusing on big cats conservation and their role in the ecosystem. A short nature walk inside the park was also organised for students. The day was organised by the Nature Conservation Division and Jigme Dorji National Park with fund from RGoB, International Fund for Animal Welfare and Wildlife Trust of India.

Sarpang gets yogurt plant

A yogurt plant with a capacity to absorb 500 litres of milk for yogurt production was established at Dekiling, Sarpang on March 30. It is operated by the Lothuen Om Detshen that was established in 2008.

The group with a total of 172 members market their products in Sarpang and Gelephu. The market will be explored to nearby regions in the future. It was established with support from the Rural Livestock Project and the Department of Livestock to address constraints faced by the group in marketing their milk and milk products.

Nine nature-based products launched

The Hon'ble Lyonchhoen, Tshering Tobgay launched the nine nature-based products consisting of anti-wrinkle cream, balm, liniment, massage oil, perfume, soaps and hand sanitiser on April 5 in Thimphu.

The launch as a part of the framework of Access and Benefit Sharing (ABS) was jointly initiated by the National Biodiversity Centre, Menjong Sorig Pharmaceuticals Corporation Limited, Bio-Bhutan and UNDP. The ABS project is supporting collaborations among the government agencies and a private entity by engaging the local communities to support their livelihoods and promote conservation of biological diversity.

Critically Endangered Chinese Pangolin rescued

The forestry staff of Tsirang Forest Division rescued a critically endangered female Chinese Pangolin. The injured Pangolin was found in its defensive (rolled) position. She was treated for her minor head injury at Damphu Veterinary Hospital. After recovery, she was released to the natural habitat.

Of the eight species of Pangolin occurring globally, four species are seen in Asia whereby Bhutan harbours a good habitat for Chinese and Indian Pangolins. As per the International Union for Conservation of Nature, its population is in drastic decline due to poaching and illegal trade.

4th RBFE at Thangzona

The 4th Royal Bhutan Flower Exhibition (RBFE) was held at Thangzona, Punakha from April 25-30 attracting over 34 thousands of visitors. The exhibition included both Bhutanese and international participants. Sixteen themed gardens were developed by various agencies featuring a number of beautiful floral and plant displays.

Various stalls for souvenirs, medical checkup booth, traditional medicines and plants were also available. Few more activities including displays of village life, food stalls, horse riding and children's play area were added this year. The exhibition contributed to the area by developing some permanent features.

49th ICIMOD Board of Governors Meeting

Bhutan hosted the 49th Board of Governors (BoG) meeting of ICIMOD from May 14-18 in Thimphu. The meeting reviewed the centre's progress, policies and strategies among others.

ICIMOD works for the advancement of mountain people in the Hindu Kush Himalayan region. It is governed by its BoG which consists of one representative each from its regional member countries-Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. Bhutan is a founding member of ICIMOD and the Secretary of the Ministry of Agriculture and Forests, Dasho Rinzin Dorji serves as its Chairman.

International Biodiversity Day

International Biodiversity Day was observed on May 22 with a theme 'Celebrating 25 years of Action for Biodiversity' in Thimphu. More than 150 students from Thimphu, 50 researchers and official guests from conservation and funding sector attended the day. The event focused on creating awareness to students on the importance of biodiversity.

Four publications namely, Alpine Plants of Bhutan, a Pictorial Guide to Major Invasive Plants of Bhutan, Access and Benefit Sharing Toolkit for Management of Genetic Resources and Associated Traditional Knowledge and National Biodiversity Centre Vision 2030 was launched on the day.

Social Forestry Day

The Social Forestry Day on June 2 coinciding with the coronation anniversary of our beloved Fourth Druk Gyalpo is an important annual event for the Department of Forests and Park Services. The day was widely celebrated across the country by planting tree saplings.

In Tsirang, His Majesty The King joined the nation in celebrating the day by planting a *Jangchub Shing* (Ficus Religiosa) at Damphu Central School.

At Kuenselphodrang, Thimphu, some 300 people lead by the Agriculture Secretary with officials from the Ministry, Desuups and volunteers planted about 1,500 saplings.

Historically Significant Trees of Bhutan launched

The Ugyen Wangchuck Institute for Conservation and Environmental Research launched the Historically Significant Trees of Bhutan at the 10th World Dendro Conference on June 10 in Thimphu.

The report serves as a baseline information to document important trees that are present in Bhutan. It briefly covers the stories of 35 historically significant trees including the cypress tree of Kuje Lhakhang in Bumthang and Pangrizampa in Thimphu. The report states that since almost all the historically significant trees have hollow and rotten trunk, the study couldn't exactly determine the age for trees.

Regional workshop on Sustainable Intensification of Rice

The Department of Agriculture organised a regional workshop on Sustainable Intensification of Rice based cropping system in Bangladesh, Bhutan and Nepal from June 12-14 in Thimphu. Participants discussed the project proposals focused on sustainable intensification of rice based cropping systems in line to the 12th five year plan of the RNR Sector which aspires to "Achieve food self-sufficiency for a prosperous and self-reliant society living in harmony with nature."

The project is a three-country initiative initiated by Lyonpo Yeshey Dorji to help unite to a common ground and generate a doable collaborative project.

Bhutan joins Seed Sharing Protocol

Bhutan joined the Siem Reap Protocol of Discussions (PoD) on June 13 with the Agriculture Secretary signing the agreement. The PoD is the regional cooperation among Bhutan, Bangladesh, Cambodia, India, Myanmar, Nepal and Sri Lanka in seed sector.

The agreement covers rice based crops such as maize, vegetables and pulses among others with the possibility to include many more in the future. It was initiated by IRRI in 2013 between Bangladesh and Indian with rice seeds. With the signing, Bhutan can now exchange and import high yielding varieties with its partners.

Lhuentse celebrates June 17

Lhuentse joined the global society to mark the World Day to Combat Desertification and Land Degradation on June 17 with a theme 'Land has true value. Invest in it.' It was celebrated in Lekpa village under Gangzur gewog which was identified to create a sustainable land management (SLM) model village. The day promoted public awareness and shared national and global actions to combat desertification, land degradation and drought. Participants also planted hedgerows.

The day focuses on SLM as a way to regenerate economies and revitalise communities. It was funded by LDCF-GEF.

LOAS certified products launched

The local organic assurance system (LOAS) certified products including Turmeric powder from Takabi Women's Group and Dakpel Women's Group in Zhemgang, Bhutan Herbal Tea from Bumthang, Bhutan Green Tea from Samdrupcholing Zangja Nymaley Tshogdey in Trongsa and potato, garlic and carrot from Rangzhin Sonam Detshen in Gasa was launched on June 26. The groups trained on organic concepts are registered with the National Organic Programme (NOP) since 2016. LOAS managed by NOP is based on trust which aims to ease the marketing of organic operators and help consumers to identity the organic products.

AFACI workshop on Horticulture

Experts from 14 member countries attended a workshop on 'Transferring technology on Horticulture' from July 4-6 in Thimphu to share the information on post-harvest and good agriculture practices in horticulture. The workshop result helped to strengthen support from Asian Food and Agriculture Cooperation Initiative (AFACI) in the safe production of horticulture crops and post-harvest technologies applicable in Asia. The workshop was organised by AFACI, Rural Development Administration (RDA), Korea and Ministry of Agriculture and Forests, Bhutan. Bhutan has been implementing nine projects through the grant from RDA, Korea with a budget of Nu.22M.

International Day of Cooperatives

The Department of Agricultural Marketing and Cooperatives celebrated the International Day of Cooperatives (IDC) on July 7 in Gelephu with members from the six different cooperatives of Sarpang engaged in agriculture production, livestock farming and savings and credit. The theme for this year was, 'Sustainable Consumption and Production of Goods and Services.' The highlight of the day was a competition amongst the cooperatives to see who has the most forward looking and progressive vision for their cooperative. IDC is an annual opportunity to highlight the status, challenges and opportunities of the cooperatives.

Agriculture curriculum to be strengthened in Schools

A memorandum of understanding (MoU) signed in 2013 was renewed on July 9 in Thimphu to strengthen the Agriculture for Food Security (AgFS) curriculum in middle and higher secondary schools. It was renewed between the Ministry of Agriculture and Forests, Ministry of Education (MoE) and Royal Education Council.

As per the MoU, the three parties will share information, facilities, monitor, evaluate and report to improve AgFs subject among others. With the MoU in place, the MoE proposed to regularise the subject in all middle and higher secondary schools as optional subject starting 2019.

SAP promotes urban school gardening

To promote the school agriculture programme (SAP), 23 school teachers from 19 schools of Thimphu Thromde were trained on urban agriculture gardening concept and skill development from July 12-14.

The training equipped the focal teachers with basic skills to develop a vegetable, herbal and flower gardens along with container gardening, flower arrangements, compost making and use effective micro-organisms in organic farming. They were also educated on how to administer SAP at school level. They were awarded certificates by the Department of Agriculture to function as a Focal Agriculture Teacher in their respective schools.

Native Poultry and Heifer Breeding Centre

The Native Poultry and Heifer Breeding Centre at Sertsam, Lhuentse was inaugurated by Lyonpo Yeshey Dorji on July 17. It has a total area of 95.5 acres with 126 cattle including milking cows, heifers and young bulls. There are also 272 native poultry birds including the Black Seim and Belochems.

The centre was established with a fund of Nu.30M from the EU/GoI Project, Bhutan Trust Fund and RGoB. It will conserve the pure line native poultry and dairy breed (Nublang) and produce high quality indigenous products and sex-sorted heifer for breed improvement.

New Flow Analyser at NSSC

The new Flow Analyser, SAN++ System set up was inaugurated at the Soil and Plant Analytical Laboratory of the National Soil Services Centre (NSSC).

The much needed new analyser was procured from EU funded Rural Development and Climate Change Response Programme. The analytical equipment which costs Euro 73,715.00 was procured from Netherlands to replace the old unit procured in 1992 with EU budget. The old instrument will still continue to function and analyse plant samples while the new unit will take on the much harder responsibility of analysing soil samples.

RNR Statistical Framework 2018

The Ministry of Agriculture and Forests released the RNR Statistical Framework 2018 (RSF 2018) which shall be the guiding document for all statistical activities within the domain of the RNR Sector. The framework will help to generate reliable, quality and timely RNR statistics for evidence-based decision-making by streamlining statistical mandates, strengthening coordination mechanisms and promoting use of appropriate methodologies.

The RSF 2018 was published by the RNR Statistics Division (RSD) of the Ministry after being reviewed by the RNR Statistics technical working group. It is endorsed for implementation by the RNR-GNHC committee.

International Tiger Day

The International Tiger Day was celebrated at Norbugang Primary School, Nganglam in Pemagatshel on July 29 with a theme, 'Monks and Farmers for Tiger Conservation.' More than 500 people including farmers from all chiwogs of Norbugang, forestry officials and others attended it.

One of the attractions on July 29 was that more than 20 poachers have taken a vow from the Khempo of Dhongag Tenpailing Monastery to give up poaching activities. The celebration of the tiger day started from July 26 with an awareness programs to the communities in four chiwogs of Norbugang.

Secretariat Office for Bhutan For Life

The Hon'ble Lyonchhoen, Tshering Tobgay and Lyonpo Yeshey Dorji launched the secretariat office for Bhutan For Life (BFL) at the WWF Bhutan office on July 31. The office will manage the BFL project with a fund of US$ 43M to protect the Bhutan's network of protected areas which constitute 51% of the country, the highest percentage of land designated as protected in Asia.

Lyonchhoen awarded certificates of recognition to the Ministries of Agriculture and Forests, Finance and Foreign Affairs; GNHC, Bhutan Trust Fund, Prime Minister's Office and WWF Bhutan for their contributions to the project.

First World Ranger Day

Bhutan celebrated the first World Ranger Day on July 31 at Samarzingkha, Thimphu to acknowledge the work of forest rangers. The day also commemorated the forest rangers killed or injured in the line of duty and the critical ranger's work to protect our natural treasures. The day further recognised the women rangers from around the country.

During the celebration, the Ministry launched publications such as Druk Rangers Magazine, National Forest Inventory Report Vol. II, Tiger Action Plan 2018-2023, Six Technical & Policy Briefs and 50 years of Environmental Journey in Bhutan among others.

Bhutan's 2nd Dog Population Survey

Humane Society International and the Department of Livestock conducted its second dog population survey in Bhutan since 2009 when the country's National Dog Population Management and Rabies Control Project was launched. Approximately 85,000 dogs in Bhutan have been sterilised and vaccinated till date.

The survey results will help to determine the pet population per 100 humans. The findings will be crucial for designing responsible pet ownership and community engagement programs. Key categories of data collected includes a total number of sterilised and unsterilised dogs and lactating females among others.

Awareness on consequences of feeding wild animals

An awareness campaign on feeding wild animals along the highways was organised at Gangkha, Thimphu-Paro highway and Rinchending check post on August 9.

The campaign educated the road users on feeding of wild animal especially monkey and its consequences. Monkey feeding is a growing problem in many areas of Bhutan mainly along the highways and it is leading into a human-wildlife conflict. During the campaign organised by the Department of Forests and Park Services, Royal Bhutan Police and Road Safety Transport Authority, the team covered 1899 people and 501 vehicles.

Strengthening Farm Mechanisation Project

The four years project on Strengthening Farm Mechanisation Project Phase II, JICA completed on August 10. The project was aimed to support the research and development of farming technology, standards and testing of farm machines and the better hiring models for the execution of hiring services in the country.

The Agriculture Secretary during the last joint coordination committee meeting expressed his gratitude and appreciation to the project officials and JICA for continued support in enhancement of farm mechanisation in the country.

National Organic Flagship Program

Experts including the agriculture, livestock, marketing, forests, BAFRA and planning officials met to discuss the proposed National Organic Flagship Program on August 15 in Thimphu. The program will be implemented in 20 Dzongkhags focusing on rice, maize, buckwheat, quinoa, ginger, turmeric, honey, egg, trout, chugo, matsutake, amla, chirata, pipla, traditional fruits, vegetables and herbs among others. The program will enhance the organic production, its marketing and bio-inputs as well as serve as an import substitution for agro-chemicals, strengthen organic regulatory system and sustainable livelihood and establish diversified organic enterprises.

Fourth Mushroom Festival at Geney

The fourth Mushroom Festival was held at Pehizhi Goenpa, Geney in Thimphu showcasing the tradition and culture of Geney gewog, promoting conservation and sustainable mushroom harvesting and marketing on August 15-16. The festival organised by the Geney community and National Mushroom Centre celebrated the importance of mushroom particularly Matsutake which plays a huge role in the gewog's socio-economic development. The festival is a major source of cash income for Geney farmers and their income from the Matsutake sale varies from Nu.8500-10,000/-. The festival also attracted many foreign visitors promoting off season tourism among others.

Product Certification License for Food Industries

The product certification license was awarded to Zimdra Foods Private Limited, Phuentsholing and VEEN Waters Bhutan Private Limited, Samtse on September 12 in Thimphu.

BAFRA awarded the license to Zimdra for the manufacture of fruit juices while the VEEN Waters received the license for the packaged natural mineral water.

The product certification is an established conformity assessment activity that provides confidence to consumers, regulators, industries and other interested parties that the products conform to specified requirements such as product performance, safety, interoperability and sustainability.

First sighting of White-bellied Heron in PNP

On October 9 at 4pm, an adult White-bellied Heron (*Ardea insignis*) was found feeding at one of the shallow river sites towards the right river bank of Kurichhu near Lingmethang, Mongar. The area falls within the jurisdiction of the Phrumsengla National Park (PNP).

White-bellied Heron is listed as a critically endangered species by IUCN. With the addition of this bird, the park has a total bird species of 365. This makes the park as one of the top bird watching spots in Bhutan. According to a record, Bhutan has 24 White-bellied Herons.

World Food Day in Thimphu

World Food Day (WFD) is observed every year on October 16 to mark the foundation day of FAO. This year, the global theme was "Our Actions are Our Future: Zero Hunger World by 2030 is possible."

Bhutan celebrated WFD with School Agriculture Programme (SAP) award winners, students, teachers, government officials and members of UN organisation. The annual best school farm awards for SAP was one of the highlights of the day.

The day promotes worldwide awareness and action for those who suffer from hunger and the need to ensure food security and nutritious diets.

New Minister joins MoAF

The Hon'ble Lyonpo Yeshey Penjor joined the Ministry of Agriculture and Forests (MoAF) as a new Minister on November 7. His Majesty The King conferred Dakyen to him along with other cabinet ministers of the government.

Lyonpo hails from Nubi-Tangsibji constituency in Trongsa. He was formerly the Project Director of the Green Public Procurement Project and has a Masters degree from Thailand.

The RNR family offers our warm welcome and heartfelt congratulations to Lyonpo on his new appointment.

DoL hosted SAARC Policy Meeting

The National Research and Development Centre for Aquaculture hosted a SAARC meeting on "Framing Policies for Transboundary Aquatic Disease Management in South Asia" from November 7-9 in Paro. Participants included delegates from Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. The meeting discussed current status of aquatic animal diseases, their quarantine measures, surveillance, monitoring, diagnosis, research and development and prioritised the areas of collaboration in SAARC member countries. It also strengthened policies for aquaculture and fisheries development needs in managing aquatic diseases in South Asia.

World Antibiotic Week

The World Antibiotic Week from November 12-18 November raised awareness on the health risks posed by antibiotic resistance and promoted related good practices to limit the emergence and spread of resistant bacteria. Antimicrobial are medicines used to treat infections particularly those of bacterial origin. They are essential to protect human and animal health welfare. Inappropriate use can lead to the emergence of resistant bacteria that do not respond to antibiotic treatment. This phenomenon, called antimicrobial resistance which poses a threat to disease control globally is a primary concern for human and animal health.

Living Planet Report 2018

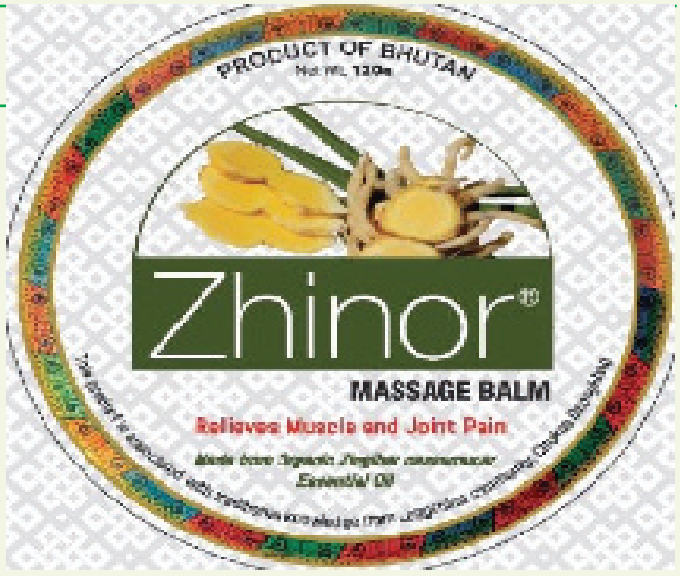
The Living Planet Report 2018, first published twenty years ago is a science-based assessment of the health of our planet tracking the state of global biodiversity. It provides its readers with the latest science and figures on the state of our planet and is a critical advocacy and communications tool to galvanise actors across the board, governments, businesses, institutions and individuals to act for the planet.

Lyonpo Yeshey Penjor and Mr. Michael Philipp from the Fisheries Conservation Foundation, USA launched the report published by WWF, Bhutan on December 3.

Zhinor trademark registered

The National Biodiversity Centre (NBC) registered the trademark *Zhinor* with the Department of Intellectual Property, Ministry of Economic Affairs for its nature based products. The term *Zhinor* was coined from the Dzongkha word "zhidey-gi-norbu" which means a precious jewel for peacefulness.

The trademark will be used for marketing the launched massage balm and liniment oil made from organic Zingiber Cassumunar and essential oil. It was developed by NBC in partnership with Loggchina community under the Access and Benefit Sharing framework.



First International Mahseer Conference

Mahseer is a critically endangered species of fish in the Himalayan region often referred as the 'tiger' of the water. With its species under increasing pressure across southern Asia, the experts gathered to discuss their growing threats and the most effective strategies for their long-term survival at the first International Mahseer Conference from December 3-7 in Paro. The conference hosted by Bhutan shared the latest research findings, management concerns, potential solutions and conservation strategies on Mahseer including their migration patterns, reproductive behaviour, juvenile survival, critical habitats and the impact of human activities.

Civil Service Award Day

The Ministry of Agriculture and Forests celebrated the 'Civil Service Award Day' on December 11 in Thimphu. A total of 325 RNR staff was privileged to receive the awards in Lifetime and Dedicated Service categories.

Forty-four staff received the Lifetime Service Award for superannuating and serving the Tsa-Wa-Sum with clean service records.

Out of 281, 57 received the gold medals for 30 years and above, 128 received silver for 20 years and above and 96 received bronze medals for services of 10 years and above.

The National Biodiversity Centre has a content-enriched web presence (www.biodiversity.bt) focusing on biodiversity information from Bhutan. The website uses a crowd-sourced method, harnessing collective intelligence from anyone with an interest in biodiversity to maintain the content in the portal or by providing taxonomic services to other users who have uploaded content into the website.

NBC receives ICT for MDA 2018

The National Biodiversity Centre (NBC), Bhutan and Kathmandu Living Labs, Nepal ICIMOD received the Information and Communication Technology (ICT) for Mountain Development Award (MDA) 2018 at the International Mountain Day on December 11. The award presented by ICIMOD honours the achievements in ICT-enabled innovations and good practices that promotes environmental sustainability in the Hindu Kush Himalaya.

NBC was awarded for the initiatives carried out in the consortium-based Bhutan Biodiversity Portal (www.biodiversity.bt).

FAO tablets for pilot RNR Census

The Food and Agriculture Organisation of the United Nations handed over 50 numbers of tablets to the RNR Statistics Division (RSD) of the Ministry on December 20 in Thimphu. The tablets were handed over by the Assistant FAO Representative in Bhutan to the Director of the Ministry's Directorate Services in presence of officials from RSD.

The tablets will be used for RNR census questionnaire pre-test and the pilot census in January 2019. RSD as the RNR census secretariat will conduct the 3rd RNR Census of Bhutan in March 2019.

RNR TIPS

Beneficial Insects

What are beneficial insects?

There are many insects found on agriculture land those are not threat to the crop production but beneficial to the farmers in different aspects such as natural enemies, pollinators, productive insects, scavengers, weed killer and soil builders.

Use of chemicals can be a important crop production tool to maximise yield but heavy and indiscriminate use of chemicals also exposes farmers to serious health risks resulting in negative consequences for the insect those are beneficial to the farmers.

Requirements for enhancing beneficial insects

The generalised intensification of agriculture and the use of broad-spectrum pesticides decrease the diversity of natural enemy populations and increase the likelihood of pest outbreaks. Indeed, pesticide use has been shown to be associated with a large decrease in natural pest control services. Thus, enhancement of agro-ecosystem appears to be one of the best ways in which we can decrease the use of chemical pesticides for pest and disease control.

Role of beneficial insects in agriculture

As pollinators

Insect-mediated pollination is an essential step in reproduction for the majority of the world's flowering plants including numerous cultivated plant species i.e. sunflower, cucurbitaceous vegetables, alfalfa, coriander, cardamom, apple etc.

As natural enemies

Insect predators and parasitoids that attack and feed on other insects particularly on insect pests of plants are considered natural enemies. Through this type of feeding, natural enemies contribute to a type of pest regulation referred to as natural biological control.

As weed killers

Many insects feed upon unwanted weeds just the same manner they do with the cultivated crops. In many cases, the occurrence of these insects has contributed much towards eradication of the weeds.

As soil builders

Insects which live in soil make tunnels creating channels for smaller organisms, water, air and roots to travel through. Insects improves soil aeration and earthworm activity can enhance the soil nutrient cycle and soil physical properties such as soil structure and tilth and activity of other beneficial soil organisms.

As scavengers

Insects which feed on dead and decaying matter of plants and animals are called as scavengers. Insects (scavengers and decomposers) help in the bio-chemical cycling of the nutrients.

Examples: Bark beetle, water scavenger beetle, termites, ants etc.

Source: National Plant Protection Centre

Anthracnose on Beans

Anthracnose is caused by the fungus *Colletotrichum lindemuthianum*. The fungus can survive on contaminated seed and on crop debris for at least two years. Rain splash and wind will spread the spores of the fungus within the crop.

Disease symptoms

Leaves, stems and pods are mostly infected parts of bean plants. Small reddish-brown, slightly-sunken spots form on the pods and rapidly develop into large and dark-sunken lesions. In moist weather, masses of pink spores develop on these lesions. Black-sunken spots similar to those on the pods are produced on the stems and the leaf stalks. Red to black spots occur on the leaves particularly along the veins, on the under surface.

Disease epidemiology

Anthracnose fungi are invariably associated with wet weather. Moderate rainfall and wind and temperatures of 18-25°C favour the diseases they cause but the infection is delayed or prevented by temperatures beyond the range of 7-33°C. Bean anthracnose is seed borne disease.

Control strategies

Cultural control

• The use of disease-free seed is the most important control measure.

• Do not plant beans for at least two years in land that has carried an infected crop.

• Intercropping with maize is reported to reduce the incidence of the disease.

• Planting in widely spaced rows that run parallel to the prevailing wind enables the leaves and pods to dry as quickly as possible reducing risk of infection.

• During the growth of the crop, apply mulch to prevent soil from splashing on to the plants during heavy rains. Do not carry out field operations when the plants are wet to minimise the spread of the disease by water splash.

• Avoid cultivating and harvesting an affected crop when wet to prevent the spread of spores.

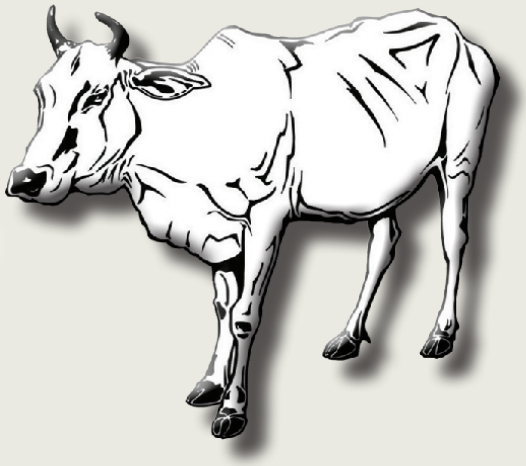
• Do not pack lightly diseased pods as anthracnose can develop during transport.

• After harvest, collect and burn debris or plough the remains into the soil.

Chemical control

Fungicide sprays of fixed copper are the only recommended chemical. The appropriate times to apply fungicides are at flower set, late flowering and at pod fill stages.

Source: National Plant Protection Centre



Yogurt Manufacture

Yogurt is a dairy product produced by the fermentation of milk using selective bacterial cultures. The bacteria used for the production of yogurt is known as yogurt cultures that ferments lactose into lactic acid and acts upon the milk proteins to produce the characteristic yogurt flavour and texture.

Raw materials required

- Milk of very good quality (low acidity and low microbial count).
- Yogurt cultures (*Streptococcus thermophillus* and *Lactobacillus delbrueckii subsp. bulgaricus*).
- Skim milk powder or Whey protein powder.

Equipment required

- Yogurt vat (heating up to 90-95°C).
- Cream separator.
- Incubation chamber.
- Cold storage.
- Yogurt cups and lids.

Constraints for production

- Poor quality raw milk (high numbers of microbes).
- Contamination with bacteriophage.
- Poor hygiene of production personnel.
- Lack of good manufacturing practices.
- Milk with antibiotic/antibiotic residues.
- Poor hygiene in plant.
- Post-production contamination of product.
- Poor HACCP control in plant.

Cream separator

Detailed manufacturing process

Selection of raw materials

The raw milk selected for the product must support good growth of the culture and should be fresh, have normal milk composition, be free from mastitis and other diseases, be free from antibiotics and other inhibitors, be free from off-flavours and have low bacterial count.

It is important to conduct all necessary platform tests on the milk supplied and reject milk that fails the platform tests.

Yogurt vat

Standardisation and pre-treatments

Standardisation of milk to meet requirements for fat and solids-not-fat (SNF) will have to be carried out by the manufacturer. Ideally, good quality set yogurt is obtained from milk having 13-15% total solids.

Milk fat contributes to flavour and richness of the product. About 3% fat is sufficient to have good quality product while SNF can be increased to 10-12% by supplementation with skim milk powder.

It is important to select ingredients of the highest quality to avoid contamination of milk and ensure a good end product.

Homogenisation

Homogenisation of the milk at 100k/cm^2 at 60-70°C can be carried out as an optional step and is useful to provide uniform mixing of all raw materials, reduce the problem of fat separation in curd and improve gel stability.

However, the homogeniser and the interconnecting pipes can be an additional source of contamination, if it is not properly cleaned, it may add to the total micro flora of the milk.

Heat treatment

The heat treatment destroys pathogenic microbes and makes the milk safe for human consumption and is considered as the critical control point in HACCP program for yogurt. It is therefore important to ensure that after heat treatment, the milk should not get contaminated by extraneous micro-organism. Milk for yogurt manufacture must be heated

Homogeniser

to and held at one of the following time temperature combinations: 80°C for 30 minutes or 85°C for 20 minutes or 90°C for 10 minutes or 95°C for 5 minutes.

This high heat treatment is also useful for supporting good growth of the culture as it destroys other competing micro flora giving free ground for the starters to proliferate.

It also inactivates natural inhibitory substances in milk, produces some growth stimulating agents for starters and denatures whey proteins to improve gel stability.

Inoculation

After heating, the milk is cooled to the incubation temperature of 42-45°C for addition of starter culture. Inoculation of starter culture should be carried out as fast as possible to prevent the growth of unwanted microbes.

The inoculated milk should be uniformly mixed prior to filling in containers. The milk is inoculated with active yogurt cultures comprised of *Streptococcus thermophilus* and *Lactobacilus delbrueckii subsp. bulgaricus* at the rate of 2% (v/v) of milk. Usually both the cultures are added in equal proportion (1% each).

Filling in retail packs

The inoculated milk is filled in retail containers before incubation. The packing material must efficiently be treated and sanitised to minimise contamination as risk of mould and bacterial spores decreases shelf-life.

Incubation

Incubation temperature should be kept 42-45°C. The period of incubation varies between 3-6 hours depending upon the rate of acid production by the culture in the milk. However, the best end point to stop fermentation is just after the milk sets. Setting takes place at about 0.6% acidity and the remaining acidity required in the product can develop while cooling.

During incubation, the milk is very sensitive to mechanical disturbances and other changes. Hence, it should not be disturbed.

Cooling

As soon as the curd sets or desired acidity in the product is achieved, it must be cooled. Cooling is done to reduce the rate of multiplication of starter cultures and stop their growth at the end of cooling. This is essential to avoid over acidification in the product.

The rate of cooling affects the quality characteristics of the product and should be decided according to the percent lactic acid expected in the final product. Rapid cooling may lead to more contraction of gel and separate more whey while too slow cooling may sour the product.

In yogurt, two stage cooling is preferred i.e. in first stage cooling from 42°C to 20°C and in the second stage from 20°C to 5°C in cold store.

Storage

The yogurt must be stored at less than 5°C to ensure growth inhibition of starters and non-starter micro-organism.

Temperature fluctuations or temperature increases during storage will promote the growth of culture as well other micro-organisms and will make the product sour or produce other defects.

Hence, maintenance of temperature during storage is very important. The distribution of the finished product should always be through cold-chain facilities.

A good quality yogurt has shelf-life of 2-3 weeks at 5°C.

Source: National Dairy Research and Development Centre

SUPER GRAIN BAGS

A solution to manage storage insect pests

In Bhutan, insect pests cause serious post-harvest losses during storage. Field trials, implemented by the National Plant Protection Centre in 2014 using super bags have shown excellent results in reducing storage losses due to storage insects and in maintaining the grain quality for extended periods.

Super bags work on the principle of "hermetic storage" where flow of oxygen and water from outer environment is completely checked. This prevents damage and proliferation by storage insect pests and helps reduce grain losses without using any insecticides.

Additionally, it greatly helps preserve the quality, germination and vigour of the seeds.It can be used to store a wide range of commodities (maize, paddy, milled rice, wheat, millet, beans, coffee, soybeans etc).

STEPS in using a SUPER BAG:

1. For maize: Make sure the grains are properly dried (<12% moisture content). Shell grains.

2. Place the super bag inside another bag such as a jute bag or polypropylene bag.

3. Fill the super bag with dried seed or grain.

4. Remove air from the bag completely. To remove air, press from the side of the bags to take out air from the bag. Then twist the free plastic to fold it into two.

5. Tie off the twist with a strong rubber band or an adhesive tape.

6. Close the outer bag by tying or sewing. Make sure not to puncture the super bag.

PRECAUTIONS when using a SUPER BAG, make sure that you:

- Do not over fill the super bag.
- Do not puncture or damage the bag.
- Never carry the grain by holding on to the super bag, always use the outer bag for carrying.
- Seal properly.
- Do not use hooks to hang the bags.
- Clean, dry and fold undamaged super bags as it can be REUSED.
- Check regularly for leaks and re-seal.

Super bags help in extending germination of seeds, maintaining stable seed weight and moisture content for extended periods. Most importantly, they control insect pest without any insecticides.

Live insects in the bags have been observed to be dead after 1-2 weeks of storage.

Super bags are inexpensive. Hence, this technique compared to traditional storage systems would be one of the most effective and economical tools in reducing storage losses at the household level.

Source: National Plant Protection Centre

What is Green Manuring?

Green manuring is the practice of growing lush plants on the site into which you want to incorporate organic matter then turning into the soil while it is still fresh. The plant materials used in this way is called a green manure.

Green manuring is an easy method of improving soil structure and fertility.

Since the crop is grown right where it is utilised, the costs are also minimal.

Generally the practice of green manuring is adopted in two ways:

a) In-situ green manuring.

b) Green leaf manuring.

a. In-situ green manuring

In this system, the short duration legume crops are grown either before or along with the main crop. Traditionally, green manure crops are sown and allowed to grow for 60-80 days after sowing or cut down just before they begin to flower and buried in to the soil and are left to decompose, releasing vital plant nutrients back into the soil which are then used by the next crop.

In-situ green manuring can be done in the following ways:

1. Cover Crop

A cover crop is any crop grown to provide soil cover regardless of whether it is later incorporated. Cover crops are grown primarily to prevent soil erosion by wind and water.

Cover crops and green manures can be annual, biennial or perennial herbaceous plants grown in a pure or mixed stand during all or part of the year. In addition to providing ground cover and in the case of a legume, fixing nitrogen, they also help suppress weeds and reduce insect pests and diseases.

2. Catch Crop

When cover crops are planted to reduce nutrient leaching following a main crop, they are often termed "catch crops."

A catch crop is normally established after harvesting the main crop and is used primarily to reduce nutrient leaching from the soil profile.

For example, planting cereal rye following corn harvest helps to scavenge residual nitrogen, thus reducing the possibility of groundwater contamination. In this instance, the rye catch crop also functions as a winter cover crop. Short-term cover crops that fill a niche within a crop rotation are also commonly known as catch crops.

3. Winter Cover Crop

A winter cover crop is planted in late summer or fall to provide soil cover during the winter. Often a legume is chosen for the added benefit of nitrogen fixation.

In temperate regions, the plant selected needs to possess enough cold tolerance to survive hard winters. Hairy vetch and rye are among the few selections that meet this need.

4. Summer Green Manure Crop

A summer green manure crop occupies the land for a portion of the summer growing season. These warm-season cover crops can be used to fill a niche in crop rotations, improve the conditions of poor soils and prepare land for a perennial crop. Legumes such as cowpeas, soybeans, annual sweetclover, sesbania, guar, crotalaria or velvet beans may be grown as summer green manure crops to add nitrogen along with organic matter.

Non-legumes such as sorghum-sudangrass, millet, forage sorghum or buckwheat are grown to provide biomass, smother weeds and improve soil tilth.

5. Living Mulch

A living mulch is a cover crop that is inter-planted with an annual or perennial cash crop.

Living mulches suppress weeds, reduce soil erosion, enhance soil fertility and improve water infiltration.

Examples of living mulches in annual cropping systems include over seeding hairy vetch into corn at the last cultivation, no-till planting of vegetables into subclover, sweetclover drilled into small grains and annual ryegrass broadcast into vegetables.

Living mulches in perennial cropping systems are simply the grasses or legumes planted in the alleyways between rows in orchards, vineyards, windbreaks and field nursery trees to control erosion and provide traction.

6. Forage Crop

Short-rotation forage crops function both as cover crops when they occupy land for pasturage or haying and as green manures when they are eventually incorporated or killed for a no-till mulch.

Examples include legume sods of alfalfa, sweet clover, trefoil, red clover and white clover as well as grass-legume sods like fescue-clover pastures.

For maximum soil-improving benefits, the forage should not be grazed or cut for hay during its last growth period to allow time for biomass to accumulate prior to killing.

How does it enrich the soil?

Green manures usually perform multiple functions that include soil improvement and soil protection:

•Leguminous green manures such as clover and vetch contain nitrogen-fixing symbiotic bacteria in root nodules that fix atmospheric nitrogen in a form that plants can use.

•Increases percentage of organic matter (biomass) in the soil thereby improving water retention, aeration, increasing biological activity and helps in pest control in crops.

•The root systems of some varieties of green manure grow deep in the soil and bring up nutrient resources unavailable to shallower-rooted crops.

•Suppresses weeds, prevents soil erosion and compaction.

•Some green manure crops when allowed to flower provide forage for pollinating insects.

•A rapid increase in soil micro-organisms occurs after a young relatively lush green manure crop is incorporated into the soil. The soil microbes multiply to attack the freshly incorporated plant material. During microbial breakdown, nutrients held within the plant tissues are released.

Source: National Soil Services Centre

Chilli Blight

Phytopthora capsici

Chilli blight is one of the major diseases of chilli. It was first described by Leonin in 1922 in New Mexico.

In Bhutan, the disease was first reported in 1995 from Lobeysa. Since then, the disease has been reported from areas where chilli is grown.

Chilli blight is caused by *Phytopthora capsici* and is known as Phytopthora blight. The fungus is soil borne. It has a wide range of hosts such as tomato, cucumber, watermelon, squash, eggplants, pumpkins and pepper.

Favourable conditions

•Prolonged rain or irrigation leading to excessive soil moisture.

•Repeated cultivation of chilli in the same field and stubbles in the field.

Symptoms

•The fungus infect all parts of chilli plant. It causes root and crown rot forming distinct dark brownish black lesions.

•Infection around the stem or roots result in wilting of the plants.

•Stem and branch infection are indicated by dark purplish or brownish lesions.

•The lesions appear as water soaked greyish brown spot on leaves and fruits starting from the tip of the pod and leaf margin.

•The fungus can cause damping off resulting in the death of seedlings in the nurseries.

•In the field, flood irrigation can spread the fungal structures to the other parts of the field.

Dispersal of inoculum

•Long range dispersal occurs when infected soil or plants are transported to uninfected areas.

•The disease is spread due to the practise of transplanting seedlings raised in another place and sharing of seeds and seedlings.

Disease management

•To reduce the inoculums in the soil, a long term crop rotation must be followed. Select areas that have not been planted chilli or other related hosts in the past years.

•Field used for both nursery and transplanting must not have any low lying areas that can accumulate water.

Bed preparation for nursery and transplanting

•Prepare beds of approximately 1.2m wide and 30cm high.

•Level the beds properly to avoid water accumulation.

•Keep at least 30cm spacing between beds for drainage.

Nursery operations

•Do not use high seedling rate.

•Do not select seeds from heavily infected fields.

Transplanting operations

•Use healthy seedlings.

•Transplant seedlings on raised beds.

•Do not leave any depression around plant base.

•Mulch with farm yard manure or any locally available materials after transplanting.

Irrigation

•Use furrow irrigation.

•Drain out any standing water from the field immediately after irrigation or rainfall.

Monitoring

•Monitor the fields for blight symptoms especially after rainfall.

•To reduce fungal spore production in the field, remove infected plants, collect them and burn.

Chemical control

Under low rainfall condition

•1st spray-Mancozeb @2g/litre within the first week after transplantation.

•2nd spray-Mancozeb @2g/litre 30 days after the first spray. Waiting period of atleast 7 weeks must be observed after the last spray before harvesting.

•3rd spray-Copper Oxychloride @2.5g/litre 14 days after the 2nd spray.

Note: Use Sandovit Sticker (2ml/litre)

Source: National Plant Protection Centre