ISSN No. 2221-6103

SANAM DRUPDREY

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June 2022

INSIDE

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Ministry of Agriculture and Forests (MoAF)

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Produced by:

Policy and Planning Division (PPD)
Secretariat
Ministry of Agriculture and Forests (MoAF)
Thimphu

June 2022

FOREWORD

Dear colleagues,

The Ministry of Agriculture and Forests have come a long way in bringing a significant change in the livelihoods of farming communities, some of which are highlighted through our very own Sanam Drupdrey, the RNR Magazine.

Sanam Drupdrey is the annual publication that has been sharing fruitful stories from the field for the past eleven years indicating that our farmers are reaping the fruit of agriculture development and progressing the nation towards National Food Security. The hard work and dedication of our RNR colleagues have played a crucial role in making a difference in the lives of our people, protecting the interest of both producers and consumers.

Agriculture farming is picking up in the country moving a step closer to achieving self-sufficiency in the long run. Our colleagues, farmers and private sector are working tirelessly to enhance production and help import substitution of some of the food items.

The pandemic situation although challenging provided a viable opportunity for the Ministry to front load & accelerate the agriculture production in the country. With borders and business opportunities closed down, the only option that remained was farming for many of the individuals who were the sole bread earner in the family. Many individuals opted to go for farming during the pandemic which helped them survive their livelihoods while also being able to contribute to the nation's food production goals.

This edition of the magazine shares with you some of the inspiring farming stories amid the pandemic situation. With their regular source of income adversely affected, how farming proved to be a successful livelihood venture for a women group in Chhuzanggang and an individual in Samtenling is commendable.

Further, our technical experts have explored various innovative farming technologies to benefit our farmers. The locally proven successful technologies including hydroponics, solar dryer, portable electric fencing, areca nut curing and alternative substrate for oyster mushrooms will significantly make the farming activities easy, time-

saving and profitable. All these interesting stories can be read in this edition which I am sure will inspire many readers.

Despite some of the pandemic challenges particularly in terms of marketing and infrastructure, the Ministry has been able to achieve most of the set targets and results.

As per the National Accounts Statistics 2021, the agriculture sector contributes 19.23% of GDP which translates to Nu.32977.45 M in 2020. The crop sector contributed the highest with 10.88% followed by the livestock sector 5.76% and the forestry sector with 2.6%. The sector's contribution to GDP was increased from 15.78% in 2019 to 19.23% in 2020 i.e. an increase of around Nu. 28 billion to Nu. 32 billion.

I hope, the year 2022 will be more fruitful for the Ministry and for everyone with business and other economic activities resuming after the pandemic.

With this, I would like to congratulate PPD and all the authors for bringing out yet another exciting issue of Sanam Drupdrey. I would like to encourage my colleagues to come up with more stories, be they a success, challenges or experiences sharing to motivate our audience and offer them a better view of the farming community.

I wish you all a Happy Reading!

Yeshey Penjor
Minister
Ministry of Agriculture and Forests

EDITORIAL PPD

Dear readers,

We are pleased to bring out the 12th edition of our annual publication, Sanam Drupdrey or the RNR Magazine highlighting some of the motivating stories and innovations in the field of agriculture, livestock and forestry.

This edition of the magazine features several success stories, farming tips and new discoveries made in the RNR Sector which will contribute to enhancing agricultural production in the country and inspire our readers.

We have an inspiring story from a women's group in Chhuzanggang who opted to take up mushroom farming after the pandemic hit their source of income. Today, they are successful farmers overcoming livelihood challenges. The pandemic also proved to be a blessing in disguise for an individual in Samtenling who ventured into farming with no other option left.

This issue shares with you some of the innovative technologies proven successful in the agriculture field. Our agricultural experts have introduced the best alternative substrates for oyster mushrooms. People tend to believe that oyster mushrooms can be grown only on straw but that is not true. Experts say that oyster mushrooms can be grown easily using maize stover and willow logs as substrates with proper management practices.

The magazine also talks about a locally viable technology to cure areca nuts, hydroponics, solar dryer and portable electric fencing which will be useful for farmers to ease their workload. Hydroponic technology is getting popular because of its various benefits. A few include less labour requirements, gender-friendly technology and year-round production possible with high-value crops. Another technology that will benefit farmers is the portable electric fencing, an alternative to the fabricated version which is a gender-friendly technology, easy to install and lasts longer.

The stories about Haa Italian Cheese, the promising value-added dairy product for farmers and Yusi-Adzuki bean, a potential new legume for the warm temperate agro-ecological region are noteworthy for readers. We also bring you stories about the Wengkhar Lambenda I and the Yangtsepa Ema, the high-yielding variety for tomato and chilli.

The magazine also highlights how the Ministry is trying to reduce yak mortality caused due to starvation, exploring the year-round bulb onion cultivation across major agro-ecological zones and supporting the wetland terracing and organic agricultural production. All these and more you can read in-depth in this edition of Sanam Drupdrey which indicates that agricultural development is proving to be promising for farmers.

PPD hopes that these motivating stories from the field will help everyone understand that farming is a reliable profession with better livelihood opportunities. The magazine will continue to enhance general awareness and understanding of the Ministry's priorities and opportunities to help contribute to the national goal of achieving food self-sufficiency.

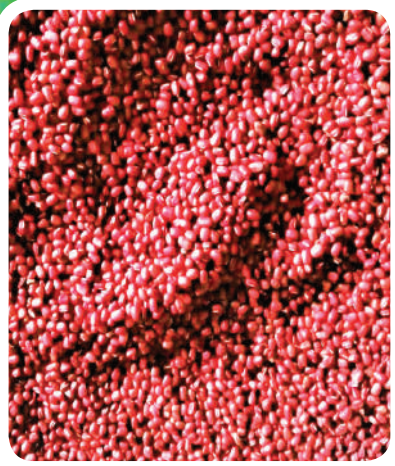
With this, PPD would like to extend our sincere acknowledgement to all the authors for their valuable contributions in bringing out this publication which will serve as an important source of RNR information to all readers.

CONTENTS

Yusi-Adzuki bean

A potential new legume for the warm temperate agro-ecological region

Laxmi Thapa and Kinley Om, NCOA-Yusipang



Grain legumes are an important component of the Bhutanese farming system. They are grown under diverse cropping systems such as dryland, wetland, kitchen garden and tseri. More than 75% of the legumes are grown in dryland. The popular leguminous crops cultivated in Bhutan are soybean (Glycine max), beans (Phaseolus vulgaris), peas (Pisum sativum) and other legumes.

Since legumes are a rich source of protein, it is important that farmers across the country have good access to them. In the past, farmers of the warm temperate agro-ecological zone (AEZ) used to have a limited choice of leguminous crops besides soybeans and peas. But this is not the case anymore. Farmers can now go for Adzuki bean (Vigna angularis), a potential leguminous cash crop option for them.

In 2021, the Adzuki bean variety Erimo was released as Yusi-Adzuki bean. It is a nutrient-dense crop and can be consumed as green tender young beans, bean sprouts and as dried seed. Like all legumes, it fixes biological nitrogen thereby improving soil health. Among other advantages, the adzuki bean can fit very well as a second crop after the harvest of vegetables in April/May, the winter wheat and barley in

May/ June and potato in June. Secondly, it's determinate growth habit makes it easier for commercial production.

Adzuki bean was first introduced to Bhutan from Japan in 2013 and was successfully evaluated at the National Centre for Organic Agriculture (NCOA) in Yusipang with an average yield of 296 kg/ acre. However, the production could not be scaled up due to low production in the farmers' fields. Following the renewed interest shown by a Japanese Company, the centre conducted a rapid evaluation of adzuki bean under organic management at 11 sites ranging from 2000-2900 masl in 2019 and 2020 to study its production potential.

Seeds were sown using the sequential method at an interval of 15 days starting from May to July 2020 following the Japanese organic production guidelines. A row-to-row distance of 65 cm and a plant-to-plant distance of 18 cm were maintained. Three to four seeds were sown per hill in lines with a seed rate of 20 kg/acre.

Adzuki bean can be successfully grown in the warm temperate region with an altitude range of 2000-2600 masl when sown from mid-May to the first week of July with a potential yield of 628 kg/acre. It is also found suitable for production under subtropical agro-ecological zone ranging from 640 masl to 2100 masl thus indicating a wide range of adaptability.

The most suitable rotations for Adzuki bean in the warm temperate region are adzuki bean-winter wheat, adzuki bean-barley, adzuki bean-vegetables (peas, carrot, radish, cole crops), potato-adzuki bean, vegetables (Cole crops)-adzuki bean and adzuki bean-mustard.

In the wet and dry subtropical region, adzuki bean can fit into several rotations but the most suitable ones are maize-adzuki bean, winter wheat/ barley-adzuki bean, potato-adzuki bean and vegetables-adzuki bean. In the lower elevations below 600 masl, adzuki bean can be grown as a winter crop after harvesting maize. The yield potential largely decreases above 2600 masl due to low temperature. It is relatively a short-duration crop taking an average of 104 to 126 days to mature.

Considering the positive results, the adzuki bean has been identified as a new legume crop for the organic production system

with a high nutritional and commercial value and an assured export market in Japan. There is an interest from a private entrepreneur to export adzuki bean to Japan and a farm gate price of Nu.250/kg has already been offered to the producers. The centre has already managed to export 200 kg of adzuki bean to Japan in 2022, their requirement is around 20 MT beans. However, the production of the required quantity for the export market with high-quality produce needs to be achieved.

The centre will upscale the cultivation of this important legume crop further after collecting information on the production plan from the region. They have now newly identified organic sites taking up the adzuki bean cultivation. With the assured export market, seed production and rapid promotion of this crop need to be taken up in the organic landscapes across the country.

Farmers were happy with the trial production. Karma Wangmo from Boeri village in Bongo gewog wants to continue the mass production for the 2022 season. Kinley, the organic producer from Chimakha village, Luni in Paro and growers from Chanachen in Geling gewog will also continue the cultivation in 2022. They expressed their interest to grow adzuki beans as it is one of the easy crops to grow and has an export market. They also shared that a buyback system and fixation of farm gate price for the adzuki bean would be helpful.

In the meantime, the Food and Nutrition Security Policy of 2014 emphasises the importance of supplementary protein for women and adolescent girls realizing that stunting and anaemia a public health problems in Bhutan. According to experts, the supplementary protein could be met by increased consumption of legumes.

In 2019, the production of legumes and oilseeds was 2,481.9 MT from a cultivated area of 7,236.63 acres (RSD, 2020).

Seed yield of adzuki bean under organic system under farmers' management in 2021

Sl. No.	Dzongkhag	Gewog	Village	Seed yield kg ac^{-1} at 14% MC
1	Chhukha	Bongo	Boeri	782.61
2	Chhukha	Geling	Chanachen	225.00
3	Paro	Luni	Chimakha	200.00
4	Thimphu	Chang	Yusipang	501.20
Mean yield kg ac^{-1}				**427.20**

Seed yield at three experimental organic sites in 2020

Sl. No.	Locations	Plant height (cm)	Length of pod (cm)	Number of pods/plants	Number of seeds/pods	Seed yield kg ac^{-1}
1	Yusipang	67.93	11.56	60	6	1215.00
2	Khatoe	37.47	9.90	34	6	540.00
3	Khariphu	67.89	10.57	61	7	967.50
Mean		**57.76**	**10.68**	**52**	**6**	**907.50**

Crop maturity days at three sites

Sl. No.	Test Location	Date of sowing	Date of harvest (Three times harvest)	Days to 50% flowering	Days to maturity
1	Khariphu, Thimphu	15.5.2020	11.9.2020	70	119
2	Khamead, Gasa	2.7.2020	13.10.2020	70	104
3	Yusipang, Thimphu	14.5.2020	17.9.2020	65	126

Chhuzanggang Women's Mushroom Farm

A success story amid the pandemic

Tashi Dawa, RNR-EC Chhuzanggang gewog, Sarpang

Since the mid of 2020, our lives and economy have been severely affected by the coronavirus pandemic. Dorji Yangki, a single mother who had been in the tourism business running an eco-lodge and a hotel is one among the many affected.

With no source of income from her business as an alternative option for livelihood, she bought a piece of land in Chhuzanggang to try her luck at farming.

She approached the gewog agriculture sector and shared her interest to go into commercial oyster mushroom cultivation. The sector advised her to form a group and particularly encouraged a women group with an interest in mushroom cultivation.

Later, a nine-member women's mushroom group was formed and registered with the Regional Agricultural Marketing and Cooperatives Office (RAMCO) in Gelephu as Chhuzanggang Women's Mushroom Group in August 2020. The group was formed to develop women's professionalism, create employment and ensure rural income.

Following a discussion with the Dzongkhag Agriculture Sector, the plan was developed to implement the commercial oyster mushroom cultivation with Dorji Yangki as a group chairperson on her 0.9 acres of land which was

left fallow otherwise.

The essential inputs such as the irrigation facility, spawns and materials including plastic sheets, green nets and others were supported by Dzongkhag and the gewog agriculture sectors.

The team constructed 6 numbers of mushroom sheds with locally available bamboo (7 m x 16 m). It was calculated to harbour 500 blocks in each shed (6 sheds x 500 blocks =3000 blocks). A block of 1.5 feet was prepared with 5 layers of spawning. A packet of spawn was calculated enough for 2 blocks. With fund support from the Dzongkhag Agriculture Sector, 1500 pkt of spawn were bought for 3000 blocks which cost around Nu.90000 (Nu.60/ pkt).

With hard work, the group was able to produce 3300 kg of mushrooms but that was 45% less than the expected production of 6000 kg. They generated an income of Nu.594000 at an average price calculation of Nu.180/ kg. Out of which, a net profit generated in the first year of mushroom production was Nu.159,061, a profit of 26.77%.

Since the inputs (52.5%) costing around Nu.228339 were provided by the agriculture sectors, the group profit was calculated as Nu.387400 which is 65.21%. It was the best gain within half a year of farming.

However, mushroom cultivation was not a piece of cake. There were a few setbacks too. The greatest challenge was the pandemic situation with restrictions on movement and gathering which affected labour deployment hampering the cultivation time. The group experienced some pests such as pink moulds but was controlled by the lime application. The pink mould usually occurs in bamboo of which the sheds were made. So, it is important to be aware and vigilant of the moulds in the early stages. The sheds can be used for a minimum of three years with good sanitisation.

While the standard temperature to be maintained for mushrooms is below 20-30°C and 55%-70% moisture, it is not possible to maintain a good level at all times. Nonetheless, the area of establishment should be well studied. The north-east facing area seems ideal. Some shed trees would be necessary for the plains.

The second-year mushroom cultivation started early by October 2021. The group was reformed with 5 active members to ensure that the expenditure is less with all the necessary structures available. Again, the Dzongkhag Agriculture Sector supported 3000 pkt spawn worth Nu.180, 000. The group was already able to earn more than a hundred thousand from the first shed. The group met with RAMCO, BAFRA and the Gelephu vegetable vendors for a day to work out

linking the markets for better opportunities.

This time, the group aimed for 10 sheds and the cultivation is a continuous process to ensure the regular supply for the market. The group is expecting to earn a minimum gross income of Nu.1 M and a net profit of Nu.0.6 M. With the market linkages, the mushrooms are in good demand. The group has even managed to cultivate 2 acres of chilli on privately leased land nearby.

With experience in mushroom farming, the group provided hands-on training to 9 wives of armed forces from Pelrithang with facilitation by the gewog extension sector. Following the training, the participants established 6 small sheds to produce mushrooms particularly for the armed force colony.

The Chhuzanggang group is in the process of availing the GRF land on lease to establish a permanent structure for all-year-round mushroom production. They have applied to RAMCO for support. The farm could be one of the successful mushroom producing farms in the country.

The group is also looking forward to exploring an eco-camping program for the local and regional tourists in Chhuzanggang. A wild ride in the warm winter sands beside the vast Taklai and Mou Tsang Chhu rivers will be a treat for visitors.

The expenditure (RGOB)

Sl. No.	Particular	Amount in Million	Detailed expenditure
1	White oyster spawn	0.108000	1800 pkt x 60
2	Plastics for block	0.050000	5000 blocks
3	Mechanization for clearance	0.004000	4 hrs JCB x 1000/hr
4	Mulching plastic	0.015000	5 rolls x 3000
5	Green shed net	0.014400	6 rolls x 2400
7	Pipes 32mm	0.013539	3 rolls x 4513
8	Blue plastic 90 GSM 18 x 24ft	0.029000	Horticulture budget support
9	Druk HDPE pipes 32mm	0.013539	Horticulture budget support
10	Strip liner	0.004800	Horticulture budget support
11	Jute rope	0.022500	Horticulture budget support
12	Training budget	0.028350	30 farmers x 3 days x 315
	Expenditure A	**0.228339**	

The group expenditure

1	Bamboo	0.039900	70 x 570
2	Labour for construction of 6 sheds, water reserve and extracting bamboos	0.072150	400/labour
3	Power sprayer	0.006000	1 number
4	Jute rope	0.008800	For hanging the blocks
5	Nails	0.000750	For shed construction
6	Drums	0.009000	Metal drums for sterilization of straw
7	Paddy straw	0.020000	8 tractor loads of paddy straw
6	Water reserve tank	0.50000	Bricks and sand/cement
	Expenditure B	**0.206600**	
I	**Expenditure A + Expenditure B = Total Expenditure**	**434939.00**	228339+206600 =434939.00
II	**Gross Income**	**594000.00**	3300kg production x 180/kg
III	**Gross income-total expenditure = Net income**	**159061.00**	***Ngultrum One hundred fifty-nine thousand and sixty-one***

Community Forest Management Groups performing well in Tsirang

Gem Tshering, Territorial Division Office, Tsirang

In 1979, His Majesty the Fourth Druk Gyalpo announced, "The participation of the local community is the key to successful conservation and utilization of forest resources." Since then, this has served as an inspiration to start developing the social forestry programs in Bhutan starting in 1985. One among many initiatives is the development of the Community Forest (CF) across the country. It is a purely state-owned forest land where the community forest management groups (CFMGs) have the user rights, responsibilities and benefits based on their management plans.

As per the Forest and Nature Conservation Rules and Regulations, any community of at least five resident households willing to establish and manage a CF may form a CFMG. The group will have to get a Community Forest Certificate from the Department of Forests and Park Services to function. They shall carry out the forestry activity focusing on improvement and sustainable management of the resources as per the Department's standards and approved CF management plan.

Over the past years, there has been a tremendous increase in the number of CFMGs throughout Bhutan. The development of community forestry and non-wood forest products (NWFP) has come a long way in improving rural livelihood, reducing poverty and ensuring sustainable management of forest resources.

One such example is the community forest in Tsirang which plays an important role in the livelihoods of people and conserving natural resources. There are around 50 CFMGs in Tsirang with a separate CF management plan valid for 10 years. The management plan is developed to ensure sustainable management and utilisation of CF resources, carry out plantations in degraded/open areas, protect water sources and provide income-generating opportunities. They are simple and realistic so that it is easy for the community members to implement.

The revision of the plan is crucial to ensure the proper functioning of the group activity. It is carried out in the last quarter of the 9th year of the plan period with technical assistance from the forest officials. The renewal and approval of the revised CF plan are subjected to the findings of the final evaluation of the CF implementation for the past 10 years. During the revision, it will also consider the experiences from the previous plan.

The revision process includes a close consultation meeting for by-laws adoption and CF resource assessment in a participatory approach. The key stakeholders involved are CFMGs, local government, land records and forest offices.

As a part of the management plan revision, five CFMPs were revised in the fiscal year 2019-2020. Usually, the budget incurred for the revising activity is funded by the government. But with CF proving beneficial for communities, out of five CFMPs, two groups namely Samdrup CF and Zomnya CF volunteered to revise their management plan with their group funds.

During the consultation meeting, besides revisiting the CFMG roles and responsibilities, the team incorporated amended Forest and Nature Conservation Rules and Regulations Of Bhutan, 2017 in the plan. Samdrup CF contributed Nu.49,545 while Zomnya CF contributed Nu.70,435.00

to conduct the meeting. The fund was used for food, logistics and stationeries for the participants for five days. Such initiative indicates that CFMGs are successful and their hard work in managing the CF is paying them well.

Further, the CF fund generated through the payment for the environment service program for two CFs has been planned to use for their CF plan revision next time.

Samdrup CF is one of the successful CMFGs in Sergithang gewog with 132 members. Formed in 2006, the group has the largest area of 562.88 ha with an income generation of Nu.787,514 to date. The group at times faces challenges in terms of pest and disease attacks in pine forests, risk of forest fire and loss of timber resources to developmental activities.

Another successful group is Zomnya CFMG in Tsirang formed in 2010 and has 115 members. It has a forest coverage area of 553.75 hectares and focuses on timber production with an income generation of Nu.368,1626.31.

In the wake of a major economic crisis hitting Bhutan and other countries due to pandemic, a few CF in Bhutan portrays the philosophy of self-reliance. It is important to encourage those who succeed in sustainable management and utilisation of CF resources so they would be a role model for others. The United Nation declared 17 sustainable development goals to be achieved by 2030.

Considering the emerging climate change issues and pandemics, the forest can serve as a safety net and help to uplift the livelihood of poor and vulnerable communities. It may take some decades for all CFMGs to follow suit. Gradually, all CFMGs are expected to become self-sustaining and not be dependent on the government for any financial support which is the ultimate goal of forming a CFMG. They should be able to financially contribute to carrying out any important activities for their benefit.

At present, forest occupies a total geographical area of 2,730,889 hectares, of which 3.85% of the total forest area corresponding to 105,099.27 hectares (ha) are under community forests. In December 2020, there were 822 numbers of CF with 34,124 households in the country.

Exploring Honeycomb production in the highlands

Vijay Raika, National Highland Research and Development Centre

Beekeeping in Bhutan is an age-old tradition practised mainly in the southern parts for household honey production with the local bee species. For commercial purposes, the European honeybee, Apis mellifera managed in the modern hives known as the Langstroth hives were introduced in the early 1980s.

Since then, beekeeping for honey production has gained popularity in the country rewarding many with income-generation opportunities.

As a focal agency for apiculture, the National Highland Research and Development Centre in Bumthang has trained more than 400 farmers and youths with input support such as beekeeping tools and equipment including live bee colonies. The honey production in Bumthang is a successful venture today. The centre is now planning to expand it to other highland Dzongkhags of Haa, Wangdue and Thimphu.

The highlands in Bhutan are covered by pristine forests rich in medicinal value with a diversity of wild plants and other useful unexploited shrubs. This pristine environment is unused and untouched for the nectar collection. With beekeeping enterprises coming up as a source of income for potential entrepreneurs, it is exceptionally important to explore the feasibility of beekeeping in highland areas.

The present honey available at the market is a product after it has been extracted from its original honeycomb through a rapidly spinning machine called a honey extractor. This honey depending on the manufacturer is heated

and processed extensively before packaging. During the processing, it removes or reduces the number of helpful nutritional elements including antioxidants. On the other hand, the honey still in the honeycomb form also known as "combed" honey has all of its nutrients intact. All of the pollen, nectar and trace nutrients found in the honey itself are also in the wax which is consumed as it is.

The centre under the Highland Development Program initiated honeycomb production in the highlands on a trial basis to study feasibility and offer a product diversification option to highlanders. Sakteng in Trashigang and Katsho in Haa was selected for the trial for a period of two months in May-June 2021. A total of 5 bee colonies were migrated to each site.

The trial was successful with the production of 200 packages containing 150-180 g honeycomb in each package box, a good amount of product for the initial trial stage. The findings will help to create awareness of the importance of beekeeping and its feasibility in highlands as well as provide information on the initiation of a honey-based enterprise.

Comb honey production is much easier than liquid honey production as it does not require sophisticated equipment and tools. It is usually preferred by consumers due to its raw and pure honey content. For the production of comb honey, the wax used for the comb foundation sheet should be raw and pure which is easily chewed along with the honey comb.

Honeycomb production has the potential to be promoted in the highland areas fulfilling the goal of high-value, low-volume niche products. The trial is just the beginning, the centre will plan to encourage more farmers to take up this venture in the coming years by providing them hands-on-training for the processing part.

In the meantime, the market value chain for the comb honey is yet to be explored since it is in initial stage of diversifying the product.

Farmers in both rural and urban areas have well-adopted beekeeping in modern moveable hives which are easy to manage and require less investment. The total honey production increased in the country from 27 MT in 2015 to 65 MT recently which indicates that the scientifically designed easy-to-use hives can increase honey production.

There are approximately 20,000 honey bee colonies in the country. Besides providing livelihood benefits, they play a vital role in pollination services and environmental management.

Farming: A good livelihood option amid the pandemic

Jambay Lhamo, Agriculture Extension Office, Samtenling

Chilli crisis emerged in the country in June 2016 with its ban on imports from India due to high pesticides content. It is well known that adding chilli to cuisine is a must in the Bhutanese diet and people cannot think of consuming a meal without it. Hence, insufficient supply and a hike in the price of chillies later became the main issues in the market.

Nonetheless, the whole world has witnessed an unprecedented time due to the pandemic situation. No one is spared. At such times, one thing in common throughout the globe was an investment in the agriculture industry if not by choice but as an option.

The case of Thakur Singh Gurung is no exception. He is an orange exporter who ventured into winter chilli cultivation in 2020 after his business came to halt due to the pandemic. He leased 10 acres of land in Samtenling and with utmost dedication, he cultivated around 3.5 acres of chillies along with other mixed vegetables to generate income.

In the beginning, vegetable cultivation wasn't a piece of cake for Thakur. Being inexperienced, he faced numerous challenges in gaining momentum in his new field. Lack of farm machinery, shortage of labour and high wage rate were the other challenges. For each labour, he had to pay Nu.500-600 per day with lunch. Moreover, with escalated production in whole chilli growing areas resulted in marketing issues. The rate of chillies went as low as Nu.50 per kg. Later on, it was hard hit by monsoon which led to chilli rotting in the field. "I lost about 1500 kg of chillies due to monsoon," said Thakur with disappointment.

To improve the situation, Thakur sought technical backstopping and support from the Gewog Agriculture Extension Office and the Agriculture Research & Development Centre-Samtenling. He also visited a commercial farm nearby for knowledge and tried adopting them to improve his field. He gathered his family members as well as employed some local people to work in the field. Three was a good production but the local

market couldn't absorb all his produce, he had to explore markets outside Dzongkhag such as in Thimphu, Paro, Wangdue, Bumthang and Tsirang.

"To make the matter worse, the market price for chilli went as low as Nu.50 per kg which was a loss," shared Thakur. But he could recover losses from the good price of Nu.500 per kg that he earned at the start.

Under the Economy Contingency Plan, he was provided with the essential agricultural inputs such as seed, mulching plastic, greenhouse, fencing net, drip set and green net. With such support and technical guidance, he could produce around 4000 kg of chillies last season under favourable climatic conditions. His income exceeded six hundred thousand through the sale of chilli.

With his learning experience in farming, he was convinced that bean is one of the profitable crops which requires less investment. He claims that he could pay his yearly leased rent of Nu.50000 from selling beans. "I am very satisfied with the earnings that I made from farming. My venture succeeded beyond my expectation," said Thakur. To have a better income, he has started integrated farming adding a dairy farm with 8 cattle which turned out to be a profitable one.

While sharing his journey, he says he realised late that agriculture farming can be profitable in many ways. With the pandemic situation not showing any sign of improvement and

decline in the orange industry, he wishes to continue farming for livelihood which he feels is a better option compared to his past profession. Coming from a farming family, farming is adventurous for him and beneficial considering the current situation.

"Food is what brings people together and especially the youths need to take up the opportunity as the government and project are supporting extensively," said Thakur with his grinning face.

Now that he has gained confidence in farming, he has his heart set on expanding his farm in the coming season and developing it as a model farm in the future.

The pandemic has been a catalyst in the development of the agricultural sector which helped improve the livelihoods and the economy as well as reduce unemployment as many of them have ventured into farming and doing well.

Agriculture farming which includes winter vegetable cultivation is the main activity for farmers in Samtenling. There are around 40 households growing chilli with an annual production of 30 MT.

Supplementary feed for yaks to reduce yak mortality

Feed block is one of the alternative feed resources

Vijay Raika, National Highland Research and Development Centre

The feed and fodder shortage in yaks mostly during the winter is reported to be a major issue next to wildlife depredation in the highland Dzongkhags. There is an increasing gap between feed availability from the natural pastures and with limited supplementary feed options, the situation is challenging. This has led to mortality of young animals, low calving and reduction in growth rates and productivity with poor nutritional conditions. The case has also affected horses and sheep.

The feed shortage is a major concern for highlanders as the yak is the dominant livestock species that support their livelihoods.

Recognising the urgency to have alternative feed resources during the four winter months of December to March, the National Highland Research and Development Centre (NHRDC) and the National Research and Development Centre for Animal Nutrition (NRDCAN) in Bumthang initiated feed block production comprising paddy straw, molasses, salt and mineral mixture.

With technical support from the centres, the feed blocks were produced by the farmer's group which was procured by NHRDC through the Highland Development Program for supplying to the highlanders. In March 2021,

the Department of Livestock handed over 3087 kgs of feed block to the chairperson of Haalung Lhanor Nyamlay Tshokdee, Haa to mitigate the feed shortages and ensure the nutritional supplementation of yaks.

The yak mortality cases were severe in February 2022 due to heavy snowfall measuring about 3-4 feet. Around 380 yak mortality cases were recorded from various parts of the highland Dzongkhags. The mortality was mainly due to starvation with no green pasture and feed resources around the grazing sites as the herders couldn't reach the place due to extreme weather conditions and lack of accessibility.

To cope with the situation, the Department of Livestock and the NHRDC jointly with the Dzongkhag Livestock Sector came up with a preparedness plan to reduce such incidences of yak mortality in the future.

In Haa, the livestock officials initiated to provide feed supplement of mixed ration comprising mustard oil cake and maize flour (0.25 g each) to be fed at least 0.5 kg of ration per day for a minimum period of one month to the vulnerable yaks. Haa has a total yak population of 4879 out of which 30% were considered a vulnerable population including young calves, pregnant yaks, old age and physically weak animals. The feed supplements were provided to a total of 1464 vulnerable yaks.

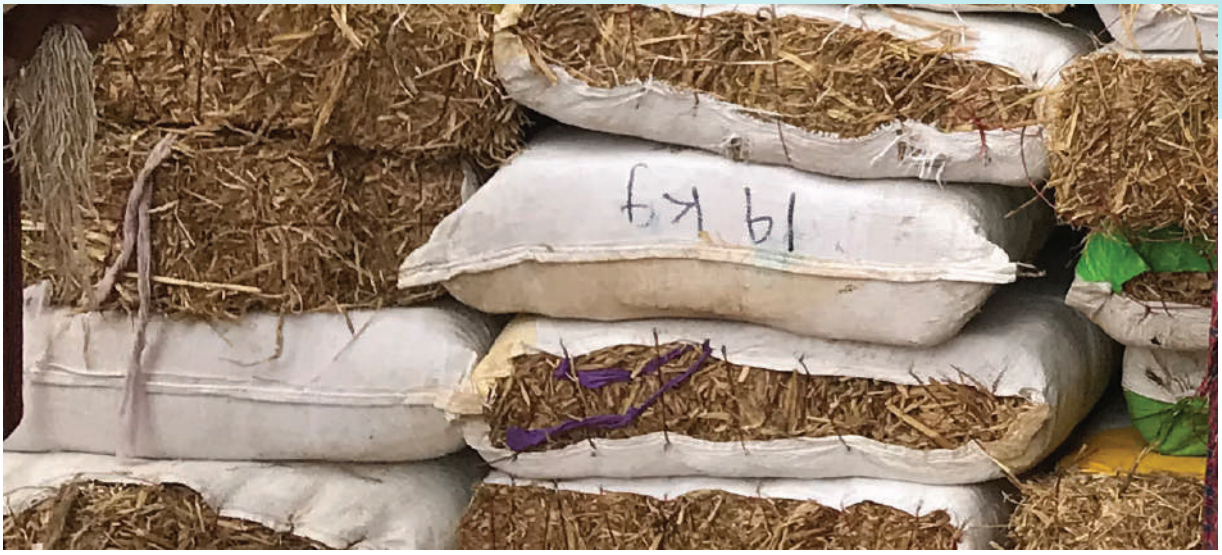
The two centres processed 4 MT of organic feed and distributed to yak herders in Bumthang and Gasa to ensure the nutritional feed for yaks.

Further, the Department of Livestock is implementing a long-term strategy to improve the degraded rangeland, expand the pasture lands and provide alternative feed sources such as highland oat seeds through the Highland Development Program. The department is also planning to establish feed blocks enterprises and formulate organic concentrate feeds to support highlanders.

With such an initiative in place, the yak herders are happy that the government has considered the livelihoods of highlanders important despite the pandemic situation in the country.

The feed block as an alternative feed resource is expected to reduce the yak mortality, maintain production and improve the overall health of yaks in the future. Nutritionally, it is being praised over the separate feeding of roughage and concentrate. Other benefits include the handiness as the straw and other roughages cannot easily be transported in highland areas due to bulkiness.

To date, 5316 kg of feed blocks have been produced and distributed to Haa, Wangdue and Gasa benefiting 80 farmers and the National Yak Breeding Farm in Haa. According to the National Statistics Bureau, there are 40,897 yaks in the country as of 2020.



Feed block making process

The common ingredients included in the feed block are Paddy straw (87%), molasses (10%), salt (1%) and mineral mixture (2%).

To make 100 kg of a mixture, it requires 88 kg of paddy straw, 10 kg of molasses, 1 kg of salt and a mineral mixture of 2 kg.

The paddy straws are chopped by a chaff cutter machine and molasses slurry is made by adding lukewarm water. The chopping is done for easy compaction of feed block and to save some energy required for chewing since soaking could increase the palatability of the feed.

All four ingredients are spread on the tarpaulin sheet and manually mixed them. The mixtures are then put into a hydraulic pressure feed block-making machine for the production of a brick shape feed block.

Hydroponics: An advanced technique for crop production at ARDC-Wengkhar

Dorji Wangmo, Tshering Penjor, Karma Yangzom, Loday Phuntsho, Lhap Dorji and Tshering Pem, ARDC-Wengkhar

Hydroponics is a soilless method of growing plants using nutrient solutions required by the particular plant. The word "Hydroponics" is derived from the Greek, hydro which means water and ponos means labour, literally meaning water labour. Water (nutrient solution) does the main work here.

Less arable land due to rugged terrain, land fragmentation of already limited arable land, rise in human and wildlife conflict, the incidence of pests and diseases and climate change issues pose a challenge to the conventional farming systems. Thus, hydroponics is one of the crop production methods that provide a buffer against these and can enhance production.

Compared to the conventional crop cultivation techniques, hydroponics is a clean crop cultivation method and is an Internet of Things (IoT) based technique whereby the youths of today will be more attracted to the field of agriculture that involves less or no drudgery. The labour requirement for crop cultivation is minimal and labour shortage particularly due to rural-urban migration is a serious issue in the conventional agriculture farming system.

Hydroponics has many advantages. It is quite effective in making required nutrients available to the crop, the

crops are protected from pests, diseases and harsh weather conditions; higher quality of produce is ensured, crops can be harvested in a shorter duration and the system is amenable to automation. However, due to its initial cost, crop selection is important and must be

selected based on market demands. The cost-benefit analysis of crop cultivation must be considered while selecting the crop. Further, the availability of nutrient mix for a particular crop is a prerequisite since the correct

nutrient mix is the secret to successful crop cultivation using hydroponics techniques.

There are various hydroponics techniques. The choice of technique depends on the choice of a crop which is largely determined by market demand. In general, the components of the techniques are a nutrient solution reservoir to store or hold the nutrient, a growth chamber for growing crops, a growing medium to provide an anchor to the crops, a nutrient solution to ensure various nutrients requirements and a pump for pumping the nutrient solution to the growth chamber.

Research on hydroponic methods of crop production

The hydroponic research at the Agriculture Research and Development Centre (ARDC)-Wengkhar started as a post-training activity. Initially, it began with the nutrient film technique (NFT) and deep-water culture (DWC) systems of hydroponics. Now it has extended to sprinkler based vertical towers and medium based hydroponics techniques. The Commercial Agriculture and Resilient Livelihoods Enhancement Programme (CARLEP) funded by IFAD is the main source of funds for the construction of the hydroponic structures at the centre.

The hydroponics method of crop production is gaining popularity across the country. It is being studied and practised in all the ARDCs,

some private entrepreneurs and some institutions as well. However, research to develop its own nutrient mix and automation of the hydroponic systems stand out as unique features.

The nutrient mix prerequisite for the growth and development of crops under a hydroponics system needs to be imported and the companies that manufacture them would not share the formula of the nutrient mix. Thus, the centre researched to develop its own nutrient mix using the reagent graded chemicals and was successful in growing celery, lettuce and strawberry. The confirmatory trial of the nutrient mix to grow lettuce and strawberry is underway.

In addition, the nutrient formulation trials for sweet basil, watercress and lettuce under DWC and chilli, strawberry and tomato in medium-based drip hydroponics technique are being carried out in collaboration with National Soil Services Centre.

In the hydroponics system, there are several parametres such as temperature, humidity, lights, water temperature, electrical conductivity and pH of the nutrient which are difficult to be controlled or maintained precisely by human intervention. These parametres are important for the healthy and faster growth of crops in the hydroponics system. Thus, hydroponics at the centre is automated. An open-source hydroponics application software called Mycodo acts as the main computing hub for automation.

The automation features include the schedule for switching on/off of different pumps, conditional switching of ventilation fans based on temperature and humidity, alarm and notifications through email when certain parametres exceed the normal value and data acquisition and remote access to the system. This prototype is installed in the hydroponic structures for NFT, DWC and sprinkler based vertical tower techniques. The prototype is found to be efficient, affordable and expandable.

For the medium-based hydroponics technique, Chatbot prototype has been developed and installed which provides basic data such as temperature, humidity and soil moisture and carries out pre-set functions like irrigation, heating and cooling of the greenhouse remotely. The nutrient application in medium-based hydroponics is also scheduled using an open-source application known as an open sprinkler.

Automation of hydroponics systems can reduce the labour required for crop production. Besides, the automation also improves the efficiency in usage of other inputs such as plant nutrients, water and electricity which further reduces the recurring cost of the operation of hydroponics systems.

Different types of hydroponic systems

Four types of hydroponic systems are being studied at the centre. The crops like celery, lettuce and strawberry

were successfully grown while others are being evaluated. In addition, a cost-benefit analysis of crop production under hydroponic systems is also being studied.

1. Nutrient Film Technique

NFT is a hydroponic method of crop production wherein a shallow stream of water containing nutrients required for the growth and development of the given crop is recirculated over the bare roots of the crops in an enclosed channel. Lettuce and strawberry were successfully grown under the NFT system. It covers an area of 26 m2 and can accommodate a total of 594 plants.

2. Deep Water Culture

DWC is a hydroponic method of crop cultivation where plants roots are suspended in a chamber which has required nutrients for the growth and development of the crop dissolved in water. Various nutrient composition trials on crops like lettuce, celery, watercress, Bok choy and arugula were conducted. Celery and lettuce were successfully grown under this system.

The technique covers an area of 135 m2 and can accommodate a total of 1200 plants (Lettuce and other leafy crops). The NFT and DWC techniques are placed in one greenhouse with an area of 15 x 5 m with an establishment cost of Nu.0.705 M.

3. Sprinkler based vertical hydroponics tower system

It is a modified aeroponic technique where the plants are grown vertically. The nutrient solutions are provided through a micro-sprinkler fixed above the tower. The structure is constructed inside the area of 9 x 5 m that covers 45 m2 area and can accommodate 2352 plants (Strawberry and lettuce). Lettuce has been successfully grown in this system and currently strawberries production is being studied. The cost of establishment for a sprinkler based vertical hydroponics tower system is Nu.0.445 M.

4. Medium based drip hydroponics technique

The medium based hydroponic technique uses mediums other than soil such as moss, biochar and cocopeat and their combinations to grow plants and nutrients are fed through the drip irrigation system. The study mainly focused on non-water-loving but high-value crops like chilli, tomato and strawberry. The technique is further divided into the pot method where the pots are filled with different types of media that can accommodate 150 plants (Strawberry).

The other one is the trough method where the trough is filled with different suitable media to grow larger plants like cucurbits, bulbs and solanaceous crops. This particular method can accommodate 96 plants (Tomato). The cost of establishment for medium based hydroponics is Nu.0.317 M.

Haa Italian Cheese: The promising valued-added dairy product for farmers

Tshering Doma, ICTD

Dairy farming plays a crucial role in the livelihoods of the Haa people providing them with a good source of cash income. Varieties of their dairy products including butter, cheese, chugo and yogurt are already popular in the market. A new addition to the list is the Italian cheese or the Caciocavallo cheese that youths have started producing as one of the value-added products.

The Italian cheese is a type of stretched-curd cheese made out of cow or sheep milk with a unique teardrop shape and a hard edible rind. It is a good source of protein and

the cheese in Haa in 2018 to improve the livelihood of farmers. He trained a group of farmers and the livestock staff for two days.

Today, the cheese is processed at the Tshelungkha milk processing unit located under Eusu gewog with technical assistance from the livestock officials. The unit established in 2016 is run by a group of youths who are trained by livestock officials.

According to Kipchu, the Dzongkhag Livestock Production Officer, the Italian cheese is produced as per the market demand. He added that around 10 litres of milk are required to produce a kilogram of cheese. "The unit produces around 12 kg of cheese at one go. They are preserved in the refrigerator and the new batch is processed before the stock gets over," he shared.

The unit collects milk from Eusu Meri Puensum Gonor Nyamlay Tshogdey which has 62 members from Eusu and Katsho gewogs. They supply around 1200-1500 litres of milk every day in summer and 700-900 litres in winter. They are paid on a monthly basis. The unit has greatly benefited both cooperatives and the youths by creating job and income-generating opportunities for them.

A kilogram of the Italian cheese costs around Nu.1200. The unit has produced approximately around 650

> Cheese is cut into a long slab of curd of 1 cm. Placed in hot water of 60-65° C and pressed and shaped with a freehand.

rich in vitamins and minerals with relatively high saturated fat and no fibre content. It is popular in Italy and Caciocavallo means "Horse cheese."

Considering that the Dzongkhag has a huge potential for dairy production, upon the Royal Command, Mr. Yoshida Solo from Japan introduced

kg of cheese to date. It takes around 10-14 days for the Italian cheese to be ready with less curing period as compared to Gouda cheese. One of the regular clients shared that it is tastier than other similar cheese.

The Livestock Production Officer said that around five training on processing the Italian cheese have been conducted reaching around 100 participants including the 40 livestock officials. He added that some individuals who have shown their keen interest in processing the cheese are yet to be trained.

Talking about the challenges, the Livestock Production Officer further shared that prior to the pandemic situation, the Italian cheese had a good market opportunity particularly from the high-end hotels in Paro and Thimphu. "Amankora was a regular client with an annual purchase of approx. 100 kg," he said.

Today, they are mainly sold at the one gewog one product outlets and a few other market outlets in Thimphu and Haa. It is noticed that some hotels and pizza huts are still importing similar cheese from abroad at relatively higher prices, the locally processed Italian cheese can be a good substitute for them. The cheese goes well with a variety of dishes, both Bhutanese and international including our favourite 'Ema Datshi.'

To reach out to more farmers and offer them a diversified product option, the Dzongkhag has plans to advertise the cheese through social media and mainstream media. The Italian cheese can be a better source of income for many individuals across the country.

With the opening of the tourism sector, it is expected that there will be potential demand for Italian cheese in the future. It has been already identified as one of the 'One gewog one product' in Haa. Through the fund support from the Queens Project Office, the cheese comes in proper packaging which helps in marketing.

To achieve self-sufficiency, the government is encouraging the general people to support the local products which in the long run will help reduce the import as well as

motivate our farmers and entrepreneurs to explore more value-added products for better market opportunities. To support our local farmers, we can contribute by trying this unique Italian cheese and several other locally produced items available in the market.

The Italian cheese-making procedures

Select high-quality whole milk.

Milk is heated up to 40-42° C.

Add lactic acid thermophillic culture @1 teaspoon per 100 litres of milk.

Rennet is added @10 gm (1 tablespoon) per 100 litres of milk by making a solution in cold water and sprinkling in the milk. Milk is then stirred well and kept aside for 10-15 minutes.

Coagulation, liquid milk slowly changes to semi-solid curd within 10-15 minutes.

Remove whey from the curd. After curd cubes attain a desirable consistency (elastic feel when squeezed), cubes are 'pitched' (curd cubes are being dropped to the bottom and piling them together) and whey is removed from the vat. Around 80% of the whey is drained out after cutting and turning.

Heating of curd cubes begins within 15 minutes of cutting. Re-cooking of curd is done at a temperature of 40-43° C for about two hours.

Cheese is cut into a long slab of curd of 1 cm. Place in hot water of 60-65° C and press and shape it with a freehand.

Hang cheese in cold water until finished making all the cheese into the final shape.

Cheese is then soaked in 90% salt solution overnight.

Soaked cheese is then taken out and hung on a rope.

The cheese curing period is about 10-12 days when hung at room temperature of less than 14° C.

Lull village ventures into Integrated Landscape based Organic Agriculture Production

First of it's kind in the country

Pema Zangmo, National Centre for Organic Agriculture

The Lull community, a hamlet located at Kazhi gewog in Wangdue is known for producing certified organic products in the country. Recent support from the GEF-LDCF project has enabled this community to embark on its organic journey. Being the first of its kind in the country, it has set an example for the rest of the farming communities across the country, motivating more to venture into organic farming with high hopes and aspirations.

The village is located at 2310 masl with a pristine environment isolated from other communities and commercial production areas making it highly suitable for landscape-based organic farming. Five households have brought 10.9 acres of the total land holding under organic production. Wheat, barley, maize, potato, garlic, chilli, cole crops and temperate fruits are some of the major crops grown with some livestock farming also visible.

The village was nearly abandoned with only one household up until 2013. However, when electricity and road facilities were introduced, four households returned to the village following the Tshogpa's initiative to bring about this remarkable development. With their personal contribution, six households managed to bring the 8.8 km road to Lull from Sill village which opened new opportunities for them. The old and antique houses, traditional tools and implements, traditional ways of farming and reliance on indigenous knowledge are still vividly visible in this village, making it unique to other settlements.

A small, cooperative and vibrant community surrounded by a pristine

environment has proven that organic production is possible, sustainable and reliable for income and livelihood.

In 2014, the Dzongkhag Agriculture Sector advocated for organic farming and supported the community with seeds and seedlings to initiate production. Gradually, the community started to take up organic farming. The National Organic Programme (NOP) in collaboration with ARDC- Bajo assisted the community in converting their village into an organic village. While embarking on complete organic production, farmers have discontinued using fertilisers and pesticides making their fields organic.

Through NAPA-III/GEF-LDCF project, NOP identified Lull village to be established as an Integrated Landscape Model Organic Village as it was much easier to build on their existing capacity and experiences. Since 2018, the project supported the community in capacity building including in-country and ex-country training/exposure on the management of soil fertility, plant protection, crop diversification, post-harvest technologies and the organic certification process. The marketing of their products was promoted through the launching of their organic products, linking with the market, certification of produces and value addition.

Initially, farmers were apprehensive and concerned with regard to crop diversification and its adaptability as they were used to the traditional system of crop cultivation. However, the farmers expressed satisfaction with their outcome as the implementation of the project progressed.

The main challenge faced by farmers was an inadequate substitute for organic inputs which makes the farmers worry about the sustainability of their village as a model organic village after the

project period. In addition, the farmers' expectation of premium prices for their organic produces remains unfulfilled due to a lack of awareness of organic food and limited market outlet for organic commodities.

With the intervention, the livelihood of the village has improved in terms of living standards and income generation with easy access to healthy and diverse food. The fallow lands were also brought under cultivation. A total of 10.9 acres are now under organic cultivation in Lull. While the premium price still remains an issue, the project enhanced the annual household income of the village by 17% within the three-project execution period through crop diversification and the sale of vegetables.

The village has now 11 organic certified commodities including buckwheat flour, wheat, garlic, potato, chilli, radish, coriander, bunching onion, cauliflower, cabbage and broccoli. They were certified organic on 21 May 2020 under the local organic assurance system, an organic certification system for the domestic market based on the Bhutan Organic Guarantee System. With the certification, they can now use the Bhutan Organic Mark on their products to market them as certified organic products for better marketing opportunities.

To further strengthen organic production, the Lull villagers will explore coming up with value-added products and promote market linkages both within and outside the country. They will also try to expand and replicate this approach in other communities for better organic production, initiate homestay and exhibition centre to promote organic products and increase income as well as integrate climate-smart farming practices.

Maize Stover as an alternative substrate for oyster mushroom production

Cheten Wangchuk, Mushroom Spawn Production Unit, Khangma, Tshering Pem, Loday Phuntsho and Tshering Dorji, ARDC Wengkhar

In Bhutan, the commercial production of mushrooms is gaining fair popularity. In general, mushrooms are considered complete food since they are nutritious and contain fewer carbohydrates.

Oyster mushroom (Pleurotus ostreatus) is the most widely grown. Pleurotus spp. is rich in medicinal and nutritional properties. It is believed to have anti-cancerous, anti-inflammatory, anti-viral, anti-biotic, anti-diabetic and anti-modulator properties. Moreover, the mushroom residues can be used for cattle feed and composting. The oyster mushroom is a saprophytic fungus. It can be grown on all types of agricultural wastes throughout the year in any agro-climatic zone if given proper cropping shed. It generates food by decomposing complex organic matter into simple compounds.

The oyster mushroom is commonly grown on rice straw as a substrate. Oyster mushroom cultivation on rice straw has limited scope for expansion since farmers use rice straw as fodder for cattle and there are limited rice-growing areas particularly in the east because of which it is difficult to get in the first place and then expensive to procure it.

On the contrary, maize is an important cereal crop

in eastern Bhutan with six eastern Dzongkhags contributing more than half of the national maize production in the country. The crop residue is often discarded and left to rot in the fields or burnt after the harvest. Thus, there is a potential to use the unused maize stovers for mushroom cultivation in the east.

Therefore, the Mushroom Spawn Production Unit based at Khangma under the Agriculture Research and Development Centre in Wengkhar conducted a study on oyster mushroom production using maize stover as an alternative mushroom substrate.

Even though maize stovers are readily available in the east, they were never tried as the substrate for mushroom cultivation in the past.

The study to compare the growth and yield of oyster mushrooms on maize stover against the conventionally used rice straws was conducted at Khangma using a complete randomised design with 15 replications. The maize residues (leaves and stalks) were obtained from nearby villages. The substrates were chopped at 6-7 cm length and filled in jute bags. It was soaked for 30 minutes and sterilised by steaming for 2 hours in a steel barrel. Each sample weighed 3 kg and was inoculated with 25 g of spawn per bag. It was incubated at a relative humidity of 60% and a temperature of 20-25°C. The same treatments were applied to the rice straws.

Though mycelium colonisation rate was observed to be slower in maize stover than in rice straw, there was no significant difference statistically. On

an average, it took around 45 days in maize stover and 35 days in rice straw under the optimum conditions. Pinheads (small mushrooms) started to form within seven days of complete colonisation in maize stover and five days in rice straws.

In terms of yield, maize stovers produced a comparable yield to rice straws. On an average, a 3 kg bag of maize stover substrate yielded 2.8 kgs of the oyster mushroom while 3 kgs of mushrooms were produced from a 3 kg bag of rice straw. Hence, the use of maize stovers as the substrate for oyster mushroom production is quite promising.

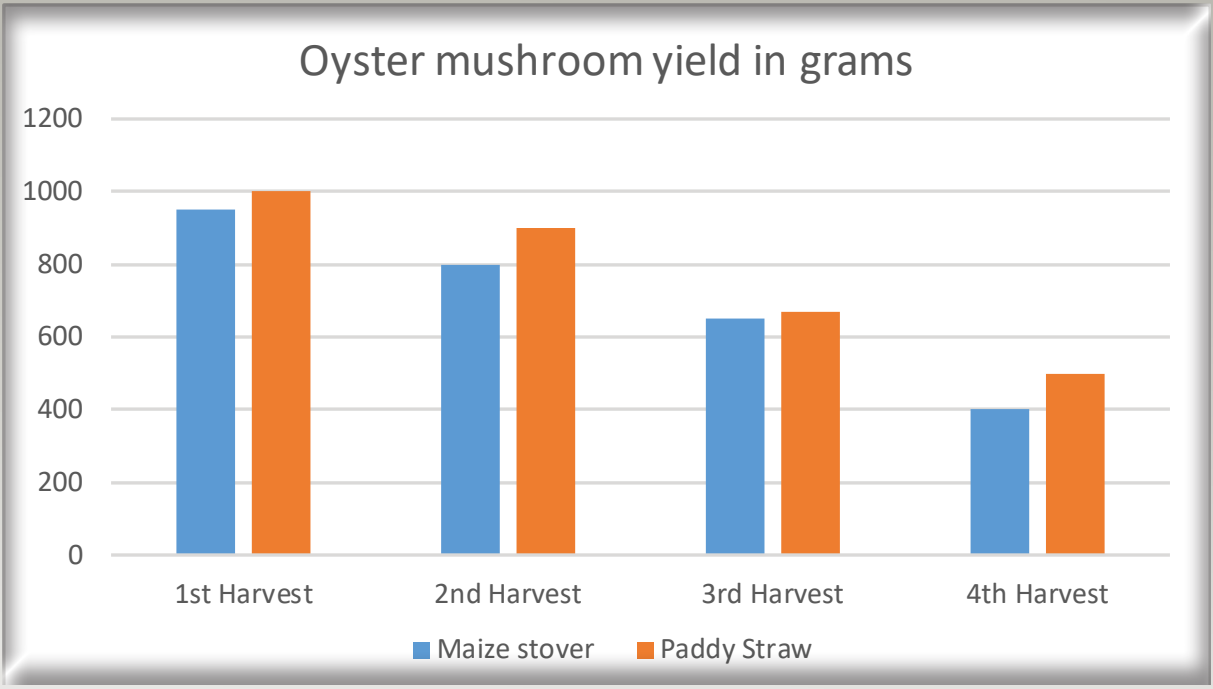
Compared to rice straw, maize stover is found abundantly in the east. Though rice straw is commonly used as the substrate for oyster mushroom cultivation, the study found that the yield of mushrooms from maize stover is comparable with that of rice straw. Given the abundance of maize stover, oyster mushroom production can be enhanced. Therefore, maize stover provides a viable alternative to rice straw for the cultivation of oyster mushrooms.

The study will enhance the year-round oyster mushroom production at low cost of production and add economic value to maize drivel as almost all the eastern part of Bhutan is dominated by maize and most of the plant parts remain underutilised after the crops are harvested.

The centre replicated the production of oyster mushrooms in maize stover through the Mushroom Intensification Program. It was promoted in Resa under Saling gewog and Khangma and Lumang in Trashigang.

The research on oyster mushroom production on maize stover was initiated in 2018 when assessing the comparative yield of oyster mushrooms on different substrates. The on-farm trial was conducted at Kalapang in Mongar.

As per the record, on average, a household earns about Nu.29,300 from the sale of oyster and 13,800 from shiitake mushrooms.



Lhuentse adopts the hydroponics technology for fodder production

Neten Dorji, Phurpa Tshering and Menda Lhamo

Dzongkhag Livestock Sector, Lhuenste

Livestock plays a dynamic role in the life of rural people providing them with income and employment opportunities and one among them is dairy farming. The government has given the highest development priority to the dairy sector since the first five-year plan by ensuring the policy support and allocating substantial resources.

Today, a shortage of green fodder during the lean season and the increase in the cost of feed is the greatest drawback for subsistence farmers in the country. Any improvement in livestock production depends on improving the quantity and quality of fodder resources. The nutritional limitations of the available livestock feed and fodder are the most important constraint that needs to be addressed for enhancing livestock production.

Although the government has introduced many alternative feed technologies, the feed shortage is still a critical challenge for dairy farmers. Bhutan being a Himalayan country, less arable land, small landholding size, water scarcity, attacks by wild animals and natural calamities are great challenges for farmers.

Considering the fodder issue, the Lhuentse Dzongkhag Livestock Sector initiated the development of an on-farm low-cost hydroponics fodder production unit in October 2020.

Hydroponics is basically growing plants without soil which help to grow plant 40-50% faster than plant growing in soil. The hydroponics technique has the potential to overcome feed shortages in the winter season. Further, the effect of fresh forage

harvested from hydroponics has a great impact on milk yield, composition and body weight gain of dairy cattle.

The unit was developed to sensitise farmers on hydroponics technology and its benefits for fodder production as well as promote hydroponics fodder as an alternative to solve the fodder shortages in lean seasons.

A total of six hydroponics greenhouses were installed at Meanbi and Minjey gewogs. The airtight shed measuring 10 x 10 ft was developed with no holes to maintain the temperature inside the shed and protect the plants from winter frostbite. To meet the minimum requirement of water and enhance the seed germination, the temperature of the germination chamber was maintained. Seeds were sown under controlled temperature in the shed. It is necessary to control the temperature and humidity and light inside the greenhouse. The fodder easily grows in controlled environmental conditions with temperatures ranging from 15-32° C and relative humidity of 80-85%. An adequate amount of gaps in the shed is required for air circulation.

The amount of seed used was 1 kilogram per tray. The seeds were all cleaned, washed and re-soaked in tap water overnight before sowing. The planting trays and the growing cabinet were also cleaned and disinfected for safety measures. The deeds were sown in the trays with holes at the bottom to allow drainage of excess water during irrigation. The tray with seeds was then covered with a piece of wet cloth (gunny bag) until germination. Only good-quality seeds were used for hydroponic fodder production.

In twelve days, the green fodders (Maize) get ready to harvest. Immediately after

harvesting the fodder, the fresh yield recorded was 8 kg from 1 kg of seed. The green fodder was then cut into small pieces to feed the cattle and minimise the wastage. It is not advisable to keep the fodder for more than nine days in the trays as after twelve days, the nutrient content and tenderness of fodder gradually start decreasing and the development of fibers starts thereafter.

Feeding green fodder to the livestock with other basalt diets is very much compatible with dairy cattle. A feed with good nutrient content and tender hydroponic fodder increase milk yield by 13% in dairy cattle. In order to operate the hydroponics easily, it is advisable to construct the hydroponics shed nearby the dairy farm.

These hydroponic sprouts can easily meet the daily dietary requirement of dairy animals. The study has confirmed that the hydroponic method for fodder production can be adopted by the Bhutanese farmers during winter without much investment and hard work and still produce good quality fodder for their cattle. Farmers can build their own hydroponic greenhouse using the available raw materials or can use unused rooms such as store, garage or cowshed and modify it into a hydroponic shed at low cost and in less time.

With positive results, the sector has introduced this technology to farmers. As of now, 7 households have adopted this technology in Lhuentse. According to Thinley Jamtso from Thinelypang village in Meanbi, hydroponic technology is a boon for dairy farmers as it helps increase milk production. Another farmer, Tashi Wangchuck from Jalang in Minjey is happy to find this technology as the best alternative for costly feed. This technology has been also introduced in Samdrupjongkhar and Mongar.

Other than maize, soybean and oat seeds can be also used for hydroponic fodder production.

The technology has potential opportunities for dairy farmers particularly those who want to start fodder production enterprises in the country. This year, the sector is installing a high technique poly house-hydroponics for winter fodder production with fund support from CARLEP.

Hydroponics fodder production process

Add 5-7 litres of warm water in a plastic bucket and unwanted seeds are seen floating because they will not sprout and other impurities are also removed.

Add 50-100 gm of salt to the water to minimise the chances of fungal growth on the sprouted seed.

Allow this seed to soak in water for around 12 hours.

After 12 hours, drain the water and then wash the seeds with clean water.

Transfer this washed seed to a gunny bag and allow them to sprout. In a cold climate, they will take more than 24 hours to germinate while in a

hot climate, the seed will take about 24 hours.

Before using the tray, wash them properly and check all holes if they are blocked or not.

Transfer sprouted seeds from the gunny bags to trays and evenly spread them and place these trays on the rack.

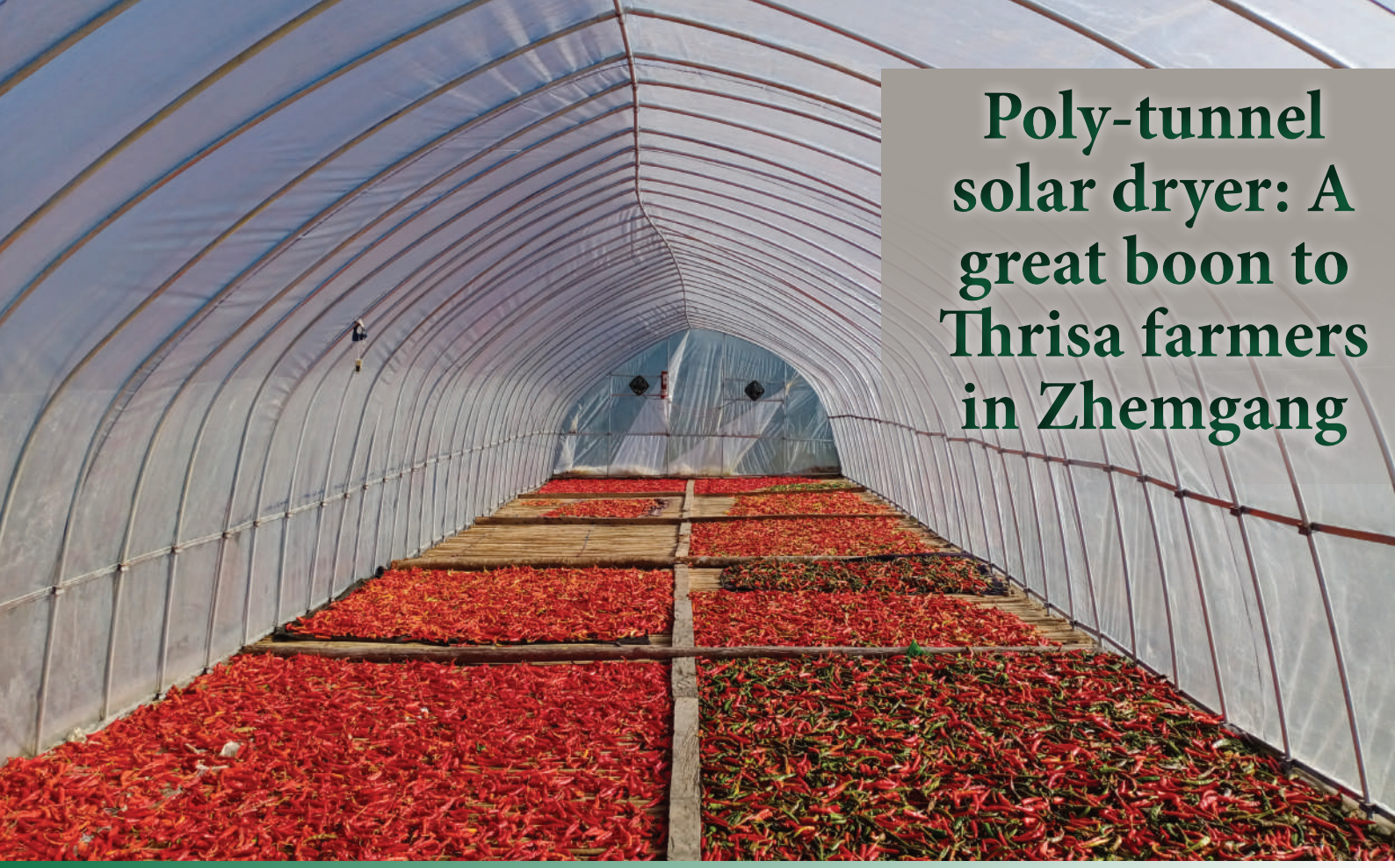
Sprinkle water daily to sprouted seeds using watering cans or a sprinkler system.

In hot weather conditions, add water every two hours and in cold weather conditions, add water every after 4 hours to maintain moisture among the seeds.

In twelve days, the green fodders get ready to harvest.

The table shows the cost-benefit analysis for fodder production in hydroponics for 5 milking cows with calves. The cost is calculated for one completed cycle (12 days).

Sl. No.	Particulars	Number	Cost (Nu.)	Amount (Nu.)
A	Fixed cost			
	1. Plastic (Low-cost greenhouse of 15 m sq)	1	6735	6735
	2. Plastic tray (size 0.61 m by 0.41 m)	50	300	15,000
	3. Palm water spray	1	100	100
	4. Labour cost (Shed construction)	5 men for a day	215	1075
	Total			**22910**
B	Variables cost			
	1. Maize seed	20 kg	30	600
	2. Labour & no. of days	1	215*12	2580
	Total			**3180**



Poly-tunnel solar dryer: A great boon to Thrisa farmers in Zhemgang

Jeewan Rai, National Post Harvest Sub-Centre, Zhemgang

Thrisa is one of the pioneering hamlets in Shringkhar gewog, Zhemgang to go commercial organic chilli production until recently. The place is approximately located at an altitude of 1887 masl. The village has 54 households with around 888 people who are primarily indulged in integrated agri-business.

Chilli is the main cash crop for farmers, popularly known as Thrisa Ema. It is one of the renowned spicy hot chilli natives to the place with an average length of 14 cm and diametre of 5 cm. The plant grows up to 40-50 cm in height. The seeds are usually sown in August and harvested probably from September to November.

Thrisapa (locals) recall the chilli being their main source of livelihood today. The history of chilli production dates back to time immemorial. Some say it was there since their great grandparents' times but came into the limelight after Dasho Keiji Nishioka visited the place who made a selfless agricultural revolutionary effort in the village. Those days, when the village was not connected by the modern facilities viz. roads and big markets, the farmers while carrying at their back marketed to the nearby markets such as Bardo, Tali, Shringkhar, Dakphel, Zhemgang and Bumthang to some extent.

Not so long ago, the village received many philanthropic supports like greenhouse, electrical dryers, poly-tunnel solar dryer, biogas, poultry and dairy farm and milk processing unit from various

stakeholders which cumulatively transformed this beautiful place into a hub of agri-business and a model village. Unlike in past years, farmers need not have to depend on mules, fuel woods or barter their produces. But they are often cut off from nearby markets and the outside world due to rugged trails and distant transportation during some parts of the season. The farmers here still wear a big smile on their faces as they feel secure and self-sufficient.

Owing to its huge popularity and market demand in the region, every household used all their available land space for commercial chilli production and partially for other cole crops. There was a time, a kilogram of fresh chilli fetched Nu.300-500 and Nu.600-900 per kilogram for dried chilli all around the seasons.

Chimi, a mother of one was an employed woman once with a luxurious life. As she had a huge fraction of land in the village, she decided to return home, do farming and help her elderly parents. After that, there was no looking back. Today, she is an inspiration to many early school leavers and youths. She earns a good sum selling vegetables and livestock products. She is also the chairman of the milk processing unit. The village also comprises a couple of enthusiastic farmer groups producing vegetables, chillies, cole crops and rearing livestock. The amazing fact is that women here are as strong as men.

However, the farmers here were equally challenged with a lack of proper post-harvesting, handling and management technologies particularly in drying. Although the improved household-level electrical dryers were adopted to serve the purpose before, this however, wasn't feasible for drying up their abundant produce at once.

Likewise, the traditional drying method on the rooftop was Hobson's choice, the product obtained was of inferior quality perhaps infected with pests

and diseases and contaminated. The procedure was further tiresome and lengthy.

To mitigate the post-harvest losses, promote a sustainable commercial chilli production chain, uplift the economic stability of farmers and achieve the national aspiration of attaining food security and sufficiency, a poly-tunnel solar dryer was promoted in Thrisa for better results in September 2021.

Drying in the poly-tunnel solar dryer reduced drying periods, incidents of pests, diseases, moulds, spoilage and

cross-contamination. It took just two weeks to dry the chillies which otherwise takes one month or two in an ambient environment. However, the drying duration is mainly determined by external factors including a weather pattern, temperature and relative humidity of the concerned environment. At the end of the day, the product looked promising with appealing colour, taste and texture.

In comparison to the ambient drying, the farmers are optimistic about the technology and had goodwill to increase production and extend the marketability of the chilli to markets near and far. They say, the technology was a great boon and convenient to utilise unlike the traditional methods.

Today, almost all the households in the village are benefitted from this technology. Around 13 farmers have adopted this cost-effective and time-saving technology, they were provided user training on operating the same. They were a bit reluctant at first in adopting this technology because of the village location. A farmer will have to invest around Nu.100,000 to establish one poly-tunnel solar dryer which can be used to dry all vegetables, fruits and spices.

The technology was promoted by the Dzongkhag Agriculture Sector, Zhemgang and the National Post Harvest Centre with fund support from Green Climate Fund and technical assistance from UNDP Bhutan.

Since the present dryer could not accommodate all the chillies that farmer produces in one season, they want to opt for a bigger sized dryer in the future to curb their losses, wastages and have fair utilisation practices for all.

The village produces around 10-15 MT of chillies annually. Lately, Thrisa Ema has been identified as an organic product and the place as an organic village by Dzongkhag. The Dzongkhag is in the process of availing the organic certification which will offer them a better price and market opportunities both within and outside the country. Once the Thrisa Ema is certified organic, the village has a plan to explore exporting their chilli as a branded organic spicy Bhutanese product, identify it as a one gewog one product and preserve the germplasm for the future.

In terms of challenges, the blight disease is the main issue for farmers along with the human-wildlife conflict and the possibility of natural cross-breeding of Thrisa Ema with other chilli varieties. Therefore, efforts must be made to preserve this indigenous chilli variety.

Besides chilli, the villagers are also dependent on paddy, dairy, poultry and cardamom farming for income. Recently, the farmers received a milk processing unit, poultry farm and all agricultural inputs including the greenhouses, water sprinklers, mulching plastic etc. for vegetable farming benefitting all the village youths and farmers. Thrisa people are believed to be hardworking, sincere and supportive of each other.

Portable Electric Fencing, an alternative to the fabricated version

The gender and user-friendly technology for saving crops

Lhendup Dorji, National Plant Protection Centre

Since 2013, the Department of Agriculture has been promoting fabricated electric fencing (FEF) to protect crops from wild animals. The technology is a psychological barrier that produces electrical shock in pulse mode when the animal comes in contact with the fence wire. FEF was initially promoted among subsistence farmers and most of the materials including the wooden post, HDPE pipe insulator, nails and galvanised iron (GI) wire required for FEF are locally available.

Over the years, the human-wildlife conflict has increased mainly due to conservation efforts. Therefore, the FEF has become a must-have barrier for both subsistence and commercial farmers to prevent wildlife from raiding the agriculture fields.

By 2021, a total of 6400 km of FEF has been established in the country protecting 38,000 and 23,000 acres of dryland and wetland respectively (National Plant Protection Centre, 2021). The national impact assessment on FEF conducted

by the centre observed a few major constraints in the sustainability of the technology. The use of wooden posts, rusting of GI wire, non-reusability of the materials and technology not being gender-friendly

were some of the constraints reported in the assessment.

On average, 88 trees were felled to fetch 350 numbers of posts to establish a kilometre of FEF which totals up to 563,200 trees to establish 6400 km of FEF. Further, wooden posts were replaced by farmers after every 2 and 3 years in temperate and subtropical regions respectively which indicates the higher number of trees cut for establishing FEF. Additionally, GI wires rusted within two to three years due to exposure to different climatic conditions.

The FEF establishment is labourious and takes an average of seven days for five men to establish a kilometre of FEF. Fetching a wooden post, clearing fence corridor, erecting posts, fixing insulators and stretching wires for the establishment of FEF is not gender-friendly and requires mostly men.

To address the limitations of FEF, the centre piloted portable electric fencing (PEF) at Tsakhorthang, Choekhor gewog in Bumthang on 17 April 2021 covering an area of 1.5 acres.

PEF is established with a mild steel flat post instead of a wooden post. The flat post lasts for more than 25 years and reduces the requirement for trees by 99%. The fixing of the flat post does not require the digging of the ground; it weighs only 2 kg per pole and can be easily pushed into the ground. Thus, it is more gender-friendly. Unlike GI wire, the poly wire used in PEF can be easily stretched consuming less time. Further, the poly wire is UV-protected and lasts longer than five years. Finally, the ring insulator can be easily fixed on the post with a screw that doesn't require additional time for preparation like the HDPE pipe insulator used in FEF.

The main advantage of PEF is portability and its reusability which helps to establish a fence within a short period. It can be also

used by highlanders to protect livestock from wild predators during migration as the fence can be installed around the grazing land as and when required.

The average cost to establish one kilometre of PEF is Nu.193,000 (One hundred ninety-three thousands). The details of the materials are available at www.nppc.gov.bt.

The trial PEF at Tsakhorthang benefited five households. The village has more than 100 acres of agricultural lands mainly growing vegetables, potatoes, buckwheat and chilli as cash crops. For farmers, the crop damage by wild pigs has been the main issue which was reduced after establishing the PEF.

According to farmers, the PEF is easier, faster and more convenient to establish compared to fabricated wooden pole EF. They added that they do not have to visit forest offices for pole permits and PEF is gender and user friendly enabling them to establish it anywhere and anytime. Some also shared that the PEF is more effective as there is less wire resistance and fence voltage drop. "The coloured poly wire makes it more visible during the night time adding to its effectiveness," says a user.

The other objective for developing the PEF is to go beyond agriculture. There are many instances of domestic animals being predated by flagship animals such as Tigers, leopards, bears etc. The PEF can also be effective to protect domestic animals from these predators.

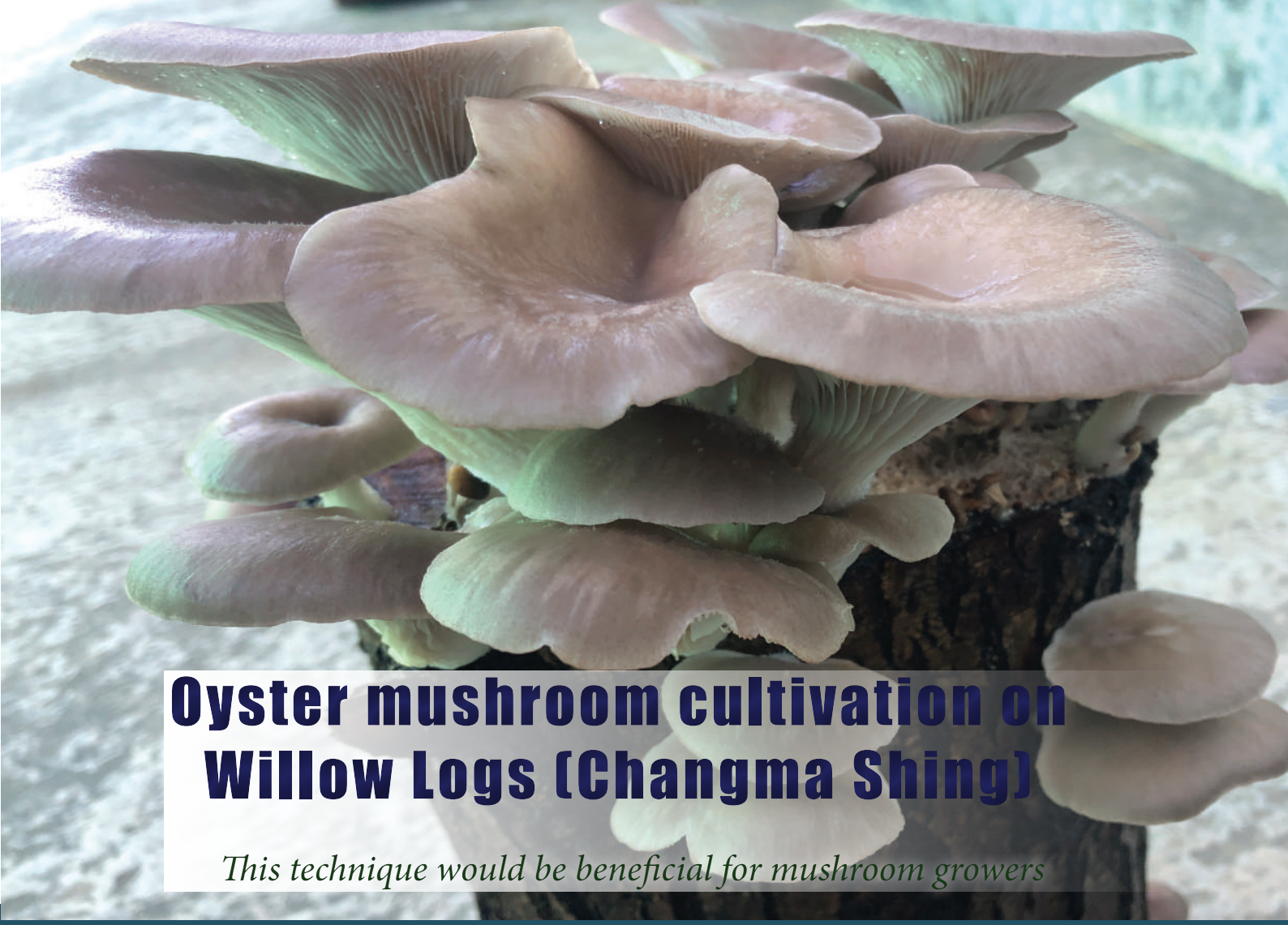
Besides Tsakhorthang, a smaller demonstration version of PEF has been established at ARDC-Wengkhar and another 1 km has been established at Khariphu, Mewang gewog in Thimphu. The centre will

establish a scale of 8 km covering 100 acres at Damji, Khamoed gewog in Gasa in 2022.

Although it has not been a year of piloting, a few farmers who have seen the PEF have already started to inquire about it. The centre aims to develop and demonstrate new ideas and technologies to provide better opportunities for farmers. By publishing this article in Sanam Drupdrey, the centre hopes to reach more people by creating awareness of this effective technology.

Cost comparison of different EF materials

Types of pole	Rate	Cost for 1 KM (same no. pole used) 350 poles	Total cost for 1km powered by electricity (basic materials)	Total cost for 1km powered by solar (basic materials)	Remarks
Wooden pole	205/pole (1.59 cft)	71750	**27897**	**5375**	**105022**
HDPE pipe pole	348.8/pole	122080	**27897**	**5375**	**155352**
Plastic pole	250/pole	83,500	**26517**	**5375**	**115392**
MS Flats, ring insulator with holes	290/pole	96860	**51017**	**5375**	**153252**
Cement pole	750/pole		**266560**	**5375**	**271935**
Portable EF (MS flat, poly wire, ring insulator)	290/pole	96860	**90265**	**5375**	**192500**



Oyster mushroom cultivation on Willow Logs (Changma Shing)

This technique would be beneficial for mushroom growers

Karma Thinley and Chencho Dukpa, National Mushroom Centre

Over the years, oyster mushroom cultivation has picked up in the country as it is a good source of income. In Bhutan, most people often think that oyster mushroom is grown on paddy straw only. When we ask some people if they are interested to grow oyster mushrooms, they often say, "Oh we don't grow paddy" or "It is very difficult for me to find paddy straw so I never tried oyster mushroom cultivation." However in fact, oyster mushrooms are very versatile and can be grown on almost any kind of substrate ranging from any crop residue to papers to wood.

In fact coming to the wood part, here is where it gets interesting for oyster mushroom as it loves growing on wood. No wonder the wild oyster mushroom in Bhutan is sometimes known as Changma shamung as it is not uncommon to see it thriving on willow tree stumps. The good news is that willow trees unlike oaks are fairly abundant throughout Bhutan.

To drive home this point, the National Mushroom Centre collected some freshly cut willow tree stumps and branches that were found lying at Semtokha and brought them to our office at Wangchutaba (2300 masl) and inoculated oyster mushroom spawn into them on 15 May 2021. The logs were then left in a dark corner of a barn near our office for the spawn to colonise the wood. From

summer months to keep the logs moist.

On 15 November 2021, the logs were soaked in a barrel drum for 24 hours to induce fruiting. Ten days after soaking the logs started to give fruiting. How does it taste? We cooked the mushroom and invited all staff to taste it and many said it tasted great like it had some natural flavour as though picked from the wild.

The only downside here is that it took about six months between inoculation and fruiting-pretty long, right? That is because the wood substrate is much tougher to colonise than soft straw. But even if it takes that long to fruit, it will be worth it as the willow logs will give many more flushes of tasty mushroom for a couple of years compared to straw which typically gives only about two to three flushes from the same amount of spawn. Now if the cost of spawn is substantial that is something to think about.

The production as per the entire life cycle is higher in willow logs since the logs last for 3-4 years with a minimum of 4 harvests in a year whereas the straw will last only for 3-4 months. However, the production per harvest will be higher in straw as compared to willow logs.

The centre is planning to create awareness of this technique through farmers' training and social media and websites. The technique has not been replicated for now but interested mushroom growers are encouraged to try out this beneficial technique.

Towards becoming a clean and beautiful Dzongkhag

A waste management program initiated

Gem Tshering, Territorial Division Office, Tsirang

Waste management is a collective responsibility of all. With an increase in human settlement, waste management has become challenging. The proper education and awareness of waste issues are crucial to creating a waste and pollution-free society.

With a similar aim to keep the Dzongkhag clean and beautiful, the Territorial Division Office, Tsirang initiated the waste management awareness and cleaning program in Tsirang Teod, Puentenchhu, Patshaling and Sergithang gewogs. It was conducted in 13 primary schools, 1 central school for 3541 students, 214 teachers and 557 households from communities and Dratshang under Tsirang Dzongkhag in May-June 2021.

The project distributed 8 numbers of large waste bins and 35 numbers of small bins for the communities, Dratshang and schools. The majority of waste materials consist of plastic which has greatly affected the business community and the environment. At present, the market is flooded with furniture and utensils made from plastic. Further, the wooden furniture and utensils are being substituted by plastic as they are light and affordable. On the contrary, all these have highly polluted mother earth. It is noticed that water birds and fishes eat these plastics and in turn, we use them and drink water with microplastic present and that ultimately affects our health.

The waste problem in the gewog is also increasing with the waste storage site always full and thrown outside making the surrounding dirty. "Shop keepers buy goods from town and take it to the village and plastic waste is a big problem since the gewogs don't have a proper

disposal site. Further, the waste collection vehicle doesn't come on time making the scenario worst," said Kinley of Tsirang Teod.

As a part of the program, the Buri-chhu and Lare-chhu area was adopted. At present, some people from Puentenchu, Tsirang Teod and Sergithang bring the dead body to the site for a funeral. Due to poor waste management and the increasing pollution in the river, the Division jointly with local communities and the local government of the three gewogs initiated a cleaning program at the site. Under this initiative, the local communities were made responsible for proper cleaning of all the waste after the funeral. The communities adopted both Lari-chhu and Buri-chhu and agreed to keep the rivers clean. This will help them to coordinate and participate in the cleaning of river banks and get sensitised to waste management enhancing a better living space for aquatic lives, animals and people.

The program funded by BTFEC not only created awareness to the mass but also immensely facilitated communities to ensure the waste management in their surroundings and the state reserved forest lands as well as take part actively in cleaning campaigns. With

the waste bins provided, the communities have learned to dispose of waste properly. The funding support to schools has been very fundamental in ensuring continuous waste management practices in and around the school compounds for clean, beautiful and healthy living. Besides, it had helped to instill values on waste management in our youths, the future of Bhutan.

The program recommends that sensitisation on waste management should be continued at all levels including the monthly waste cleaning program. It also recommends that proper waste storage sheds at strategic locations in all gewogs be placed and ensure the timely deployment of the waste collection vehicle. The Division would like to acknowledge all the stakeholders involved and BTFEC for making this program a success.

Today, the people in Tsirang carry out monthly cleaning on the 9th of every month. With waste management initiatives in place, Tsirang plans to achieve zero waste by 2030.

Bhutan has already taken steps towards reducing solid waste with the bans on the import of second-hand cars, scraps and the use and sale of plastic carry bags in the country. In addition, a sound policy framework for solid waste management in Bhutan is already in place with the Waste Prevention and Management Act of Bhutan, 2009.

Despite the active efforts by many agencies, waste management remains a big challenge. This is probably due to the lack of institutional coordination, limited resources and civic responsibilities for waste management. As a result, the state of the country's environment is severely affected.

To overcome these constraints, the Department of Forests and Park Service strives to continue its commitment to reducing and mitigating waste issues. This can be further enhanced through continued waste advocacy, cleaning campaigns and legal enforcement of the Waste Prevention and Management Regulation, 2012 to achieve Zero Waste by 2030. But with the age of technologies and changing lifestyles, there is a need to invest in new strategies to educate the new generations and benefit all the living beings on this planet.

Wengkhar Lambenda I:

New Tomato variety

Karma Yangzom, Thinley Wangdi, Yeshi Lhadon and Kinga Wangchuk, ARDC-Wengkhar

Tomato (Lycopersicon esculentum) is an annual crop that usually prefers the warm season. It is a rich source of lycopene, an antioxidant that has many health benefits including some protection against certain cancers. Tomato has become an integral part of Bhutanese cuisine and the demand surpasses the supply leading to import in large quantities.

As per the Bhutan Trade Statistics 2020, more than 3000 MT of tomatoes were imported. The shortage of locally produced tomatoes during the COVID19 lockdowns reinforces the need to enhance its production both in terms of quality and quantity. Thus, the tomato is also identified as one of the mandatory crops by the Department of Agriculture to be promoted for large-scale cultivation.

Four tomato varieties were released to date and two-hybrid varieties have been notified so far for cultivation. However, the scourge of blight disease has been one of the biggest challenges for the large-scale production of tomatoes. Hence, there is increasing demand for variety that is not only high yielding but also tolerant to pests and diseases and provides the option to growers.

Given the potential for higher yield and better tolerance to blight disease besides other desirable characteristics such as its open-pollinated nature, the Wengkhar Lambenda 1 was released for commercial cultivation by the 23rd Variety Release Committee which was endorsed by the 7th National Seed Board Meeting of the Ministry of Agriculture and Forests in 2021.

Wengkhar Lambenda 1 is a selection from the Srijana strain introduced from Nepal. For more than 10 years, the selection of new strains was carried out at Agriculture Research

and Development Centre (ARDC)-Wengkhar. Hence, it is an open-pollinated strain and can save its own seeds. It has greater adaptability and tolerance to bacterial wilt and blight compared to other released varieties. It is suitable for both open and protected cultivation. Since it is an indeterminate type, it gives a higher yield and comparatively performs better in the lower regions indicating tolerance to heat as well.

The fruit is high rounded in shape and turns bright red when matured. As per the International Plant Genetic Resources Institute, it falls under the small size category of tomato with an average fruit size of 4.3 cm. The locular cavity of the fruit is fully filled and the fruits have a longer shelf life which are desirable characteristics of tomato.

The new variety was evaluated on-station for two consecutive years at ARDC-Wengkhar and ARDSC-Lingmethang and one year trial was conducted at ARDC-Samtenling in Gelephu. The yield was found to be higher in Samtenling (370 masl) compared to Wengkhar (1600 masl) and Lingmethang (640 masl). On-farm production, the yield data also indicated great scope for its commercial cultivation.

On-farm production was carried out by female groups at Tongphugang (1200 masl) in Lhuentse and Kidheykhar (1600 masl) in Mongar. Overall, the new variety yields about 1.6 kilograms of fruits per plant compared to the check variety Ratan which produces about 1.4 kilograms per plant.

Important features of Wengkhar Lambenda 1

- Special characteristic: High yielding, tolerant to blight and open-pollinated
- Average yield: 10-14 tons/acre
- Description: Indeterminate, fruit bright red, high rounded, average fruit size of 4.3 cm, fruit weight 49.3 grams and fruit height 4.1 cm
- Days to maturity: 70 to 88 days

It has a longer shelf life and performs comparatively better in the lower elevations

Ideal growing season

Altitude Range (masl)	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Below 600												
600 -1400												
1400-1800												
1800-2700												

	Sowing
	Transplanting
	Harvest

Wetland terracing: A guiding path towards improving the agriculture productivity

GCF project plays a crucial role in easing the livelihoods

Jambay Lhamo, Agriculture Extension Office, Samtenling

Farm labour shortage coupled with access to farm mechanisation is primarily a notable shortcoming in agriculture development. Furthermore, the traditionally developed terraces that are of small size width-wise in Samtenling gewog, Sarpang makes it even more difficult to progress positively as deploying farm machinery to curb labour shortage is obstructed. This contributes to the high cost of production.

Samtenling has 465 households with a 3068 population mainly depending on agriculture and livestock farming for livelihoods. The village has 400 acres of agricultural land with major crops being paddy and vegetables. With well-connected road access and marketing opportunities, land development was the main challenge for farmers.

"I have a four-acre of the land but I cannot hire labour as the wage rate is Nu.500 for a day," said Kencho, a 66 years old man from Samtenling sharing the reason for leaving his land fallow in 2020 cropping season.

With a timely intervention from the Green Climate Fund project, Samtenthang villagers under Samtenling could consolidate their traditionally developed wetland terraces and deploy farm machinery.

project, 62.54 acres of wetland were consolidated benefitting 167 households in Samtenling and Khempagang gewogs of which 47% were women beneficiaries.

Dhendu is one of the project beneficiaries. Following the wetland terracing, he is planning to continue growing paddy followed by maize and winter vegetables in his four-acre of fallow land.

Many lands in the village were left fallow otherwise because of the labour shortage. The labour exchange system was also not possible as there are mostly old-age people residing in the village.

The project is aimed at reducing land degradation and improving land productivity through terrace consolidation. Through the

With the implementation of agricultural land development activity, the farmers could resolve labour shortage problems by hiring and deploying tractors, power-tillers and paddy reaper machines. The fields are cultivated now with paddy and are in the maturity stage. After harvesting, the fields will be fully utilised

for cultivating the winter vegetables.

Lachi Maya Monger, happily asserted "With terrace consolidation support, I can now complete rice transplantation in one day which otherwise takes a minimum of three days to complete with 20 labours. The terrace consolidations have helped us yield the benefits of farm mechanisation." She has 1 acre and 50 decimals of land for rice and vegetable production.

The project has been instrumental in easing and improving the livelihoods of villagers by turning unproductive land into productive lands. It is believed that investment in land is a key to successful development.

To further boost the agriculture activities in Samtenling, the Food Security and Agriculture Productivity Project is supplying the agriculture inputs to farmers and providing them with capacity building. The government is also procuring fertilisers for the newly developed paddy fields.

White Tara Farm: One of the mega chilli farms in Chhuzanggang

Tashi Dawa, RNR-EC Chhuzanggang gewog, Sarpang

In the mid-summer of 2020, Singye Tshering enquired the gewog administration office about the availability of mass GRF land to start chilli farming. To support the proposal, the gewog administration and the gewog agriculture offices helped him lease 30 acres of fallow lands for the long-term after negotiating with 9 absent landowners with land holdings ranging from 1 to 5 acres. This is how the White Tara Farm emerged, one of the mega chilli farms in Chhuzanggang.

The farm owner, Singye Tshering was working with the National Assembly Secretariat as an IT officer then. He resigned from his job at the early age of 38. "I will serve the nation through my farm," he said. His family has been into vegetable marketing for a long time. He remembers helping his mother at the centenary farmers market in Thimphu during his school vacations. His family agreed to support him financially to start the farm.

Amid the pandemic in August 2020, the land preparation for the chilli nursery started. There was no stopping after that. The agriculture sector supported the farm with some farm mechanisation, irrigation materials, mulching plastics, fabricated and low-cost plastic sheds and improved chilli seeds. The farm could transplant its first batch of chilli in mid of October 2020. Some issues related to chilli mites and soft rots that appeared during chilli nursery and transplanting were managed by replacing the plants and using Nembicidine which somewhat helped control mites.

Singye made his first harvest of 87 kg of chilli in mid-January 2021 and sold at Nu.500 per kg earning Nu.43500, the very first income from the farm. His production increased later and his product was marketed to Thimphu linking to the centenary farmers market with the help of his mother. Amid the movement restriction beyond Darachu of the Tsirang-Sarpang border, he made a weekly calendar schedule to drop and pick up chilli at Darachu and so they reached Thimphu market in time.

The farm has invested around Nu.3.3 M to produce 3.48 MT of chilli excluding the inputs support from the agriculture sector. The farm expenditure is higher because it is located at two sites of 15 acres each so all the amenities like fencing and irrigation had to be done separately.

The expenditure was mostly incurred in the initial establishment including the labour cost. The farm was expected to produce 45 MT out of 30 acres of chilli cultivation, one acre is expected to produce 1.5 MT. With an average market price of Nu.200 a kilo of chilli, the total cash income estimated was Nu.9 M.

On the other hand, calculating by 1 acre with 12 pkts of seeds and the number of seeds with standard production, it gives way to high production which seems "Building Castle in the Air". The actual investment was Nu.3.5 M and the overall income was Nu.6.5 M, a profit of Nu.3 M in a year (46% profit). The second-year may surely bring good returns. Our assumptions and theoretical calculation and high expectations sometimes make one lose hope in the real production and the progress made.

The farm carried out the second-year chilli production in the same field, they were well prepared to protect from the chilli rots, damping off and the mites. The farm will not have to invest much in the second year. With good progress, the farm also provides employment opportunities to locals and students during the peak season. It has employed two

caretakers to look after the farm. Further, his brother and wife who were contact teachers have also resigned from the job to join Singye in taking the farming to greater heights.

Singye did not avail any of the farming training to start his journey, he learned it watching videos and through guidance from the technical team. With a good profit, he has bought a new single cabin bolero which will help him minimise the transportation cost among many other benefits. Amid the pandemic, many people have ventured into chilli farming which has proven to be a profitable business for them.

This year, the chilli price is much lower than in the past and the production from Singye's farm is also not good as expected. Nevertheless, he is all set to continue his farming journey and make a difference in society. He has no regrets about leaving the white colour job behind.

Meantime, there are 3 mega chilli farms in Chhuzanggang, if the crop performs well, the chillies have good market opportunities. The village has 614 households with a total population of 2222.

The table shows the detail production data from the White Tara Farm and its income

Production month	Production in kg	Average price (Nu.)	Amount (Nu.)
January	583	462.80	269812.40
February	1286	493.75	635209.38
March	1725	395.45	682131.25
April	3388	250	847000
May	17232	200	3446400
June	5030	96.36	484690.80
July	1240	72	89280
Total production	**30484.5**	**Total Revenue**	**6464543.83**

Yangtsepa Ema

The high yielding variety with good market opportunities

Pema Yangzom, NCOA-Yusipang

Chilli scientifically known as Capsicum Annum is an integral part of Bhutanese cuisine. It is widely grown and used in almost all Bhutanese dishes. Chilli stars the popular 'Ema Datshi' that has become a go-to dish for most of the Bhutanese and has gained popularity around the world.

Among various chilli varieties grown in the country, Yangtsepa Ema (Urka Bangla) originated from Trashiyangtse is known to be one of the most popular varieties among Bhutanese. They are fleshy with a mild pungent. The fruit shape is bulky and resembles the shape of sweet bell pepper (capsicum). The chilli plants are short and spreading. This variety is also known as the pride of Trashiyangtse as it is known to fetch a good market price.

Despite its popularity, the decline in traditional varieties of chilli has been reported as a prominent issue. This could be attributed to minimal research and data availability in terms of traditional varieties. The inadequacy of basic information has further hindered the planning, production and promotion of suitable high yielding open-pollinated varieties.

To address the issue, the National Centre for Organic Agriculture (NCOA) in Yusipang collected five different traditional varieties of chilli which were evaluated for their characteristics and potential. The main objective of the trial was to test the growth and suitability of the traditional varieties of chilli in Yusipang at 2600 masl.

Five accessions of chilli including Yangstepa, Nubi Ema, Begup, Haa local and Tamchu with Sha Ema as local check were evaluated at Yusipang with four replications on a bed size of 5 x 1 m2. The beds were mulched with black plastic. The seeds were sown in February 2020 under polytunnels and transplanted on 22 April 2020 at a spacing of 45 x 60 cm. The data from

the total of two harvests of 8 and 18 September 2020 were collected.

The results showed that among the varieties, Yangtsepa Ema weighed the heaviest at 456.7 g per plant and Sha Ema the lightest at 293.3 g. In addition, the Yangtsepa variety had the highest yield of 8784 kg. The results of the evaluation indicated that one of the promising varieties under the traditional lines is the Yanstsepa Ema. Given the successful result, the varieties were also distributed to other Agriculture Research and Development Centres in Samtenling and Bajo for further trials and tests in mid and low altitude ranges.

Although the Yangtsepa variety was found to be promising, there are certain challenges in terms of its post-harvest management. Owing to its fleshy nature, the sun drying of the chilli gets a little difficult. To overcome such issues, using the improved drier and drying in greenhouses can be good alternatives.

The success story of the trials has proven Yangtsepa Ema an asset in the vegetable sector. It encouraged the Yusipang community to take up the variety and grow it in their gardens.

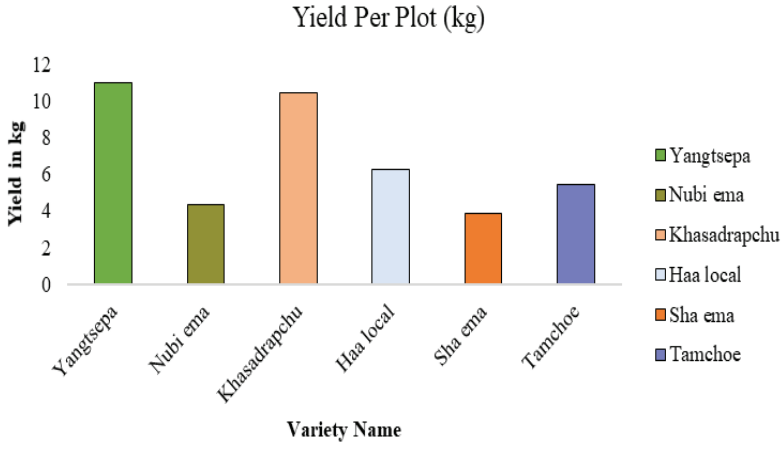
The trial result has not only been able to successfully determine the suitability of chilli production in Yusipang but has also provided an opportunity to conserve the local variety for the future.

Since the Yangtsepa Ema variety is found to be high yielding with good market opportunities, the centre is planning to further promote this variety in the western region of Paro, Haa and Thimphu on a larger scale.

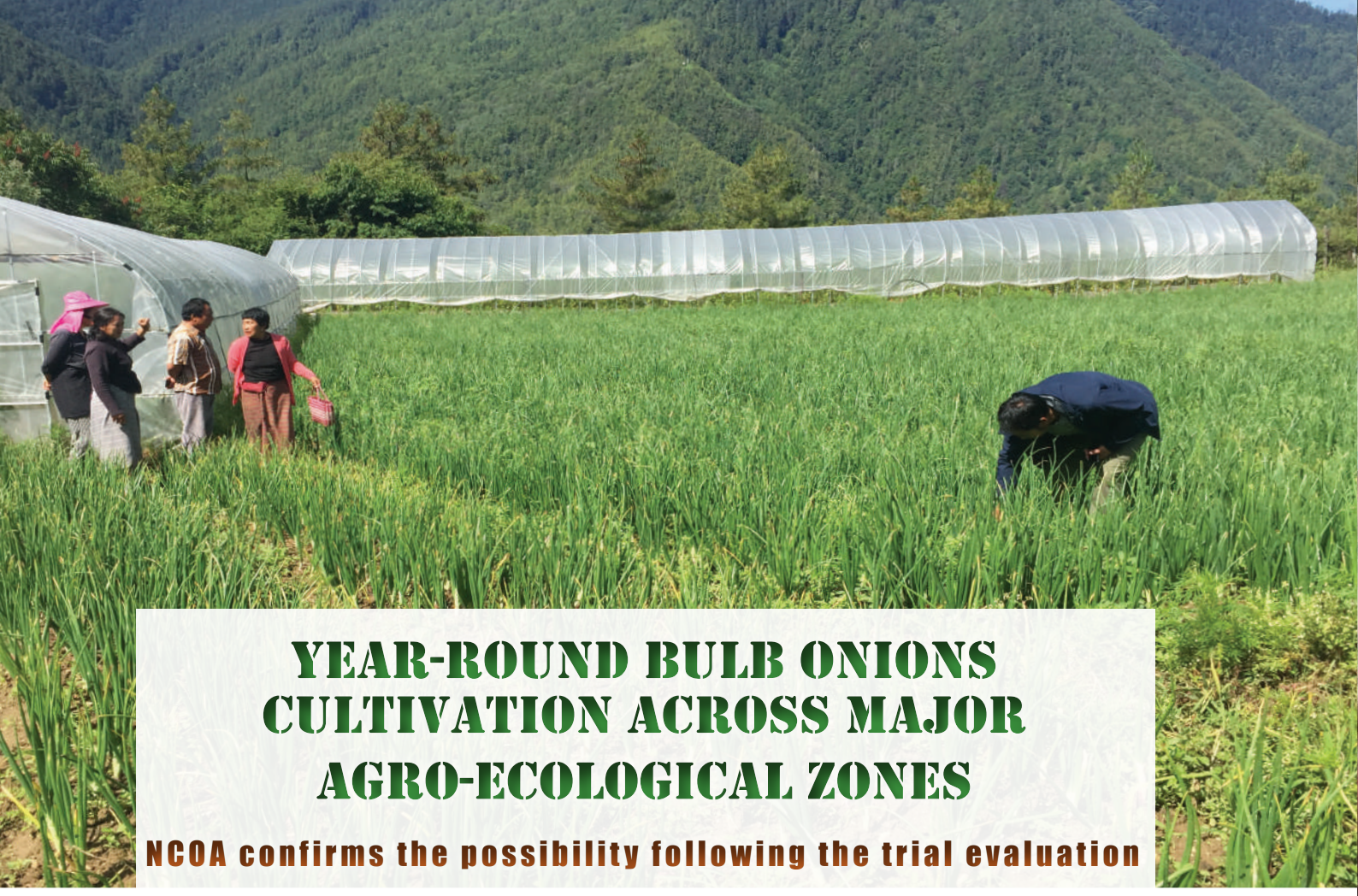
The growing season for eastern Bhutan is usually from spring to summer whereas for other western regions, the growing season is from summer to autumn.

Trashiyangtse identified the Urka Bangla as one of the commodities for enterprise development in 2015 considering its uniqueness and popularity. It has now become one of the primary cash crops in Trashiyangtse with a few value-added products already available at the market.

Yield per plot of chilli varieties



Note: Yangstepa (Trashiyangtse),Nubi Ema (Trongsa), Begup (Khachadrapchu and Begana), Haa local (Mixed of Haa, Thimphu and Paro) and Tamchu and Sha Ema (Paro)



YEAR-ROUND BULB ONIONS CULTIVATION ACROSS MAJOR AGRO-ECOLOGICAL ZONES

NCOA confirms the possibility following the trial evaluation

Laxmi Thapa and D. K Sharma, NCOA-Yusipang
Kinley Dorji, Genekha; Gem Lham, Samphelling and Surja, Chapcha

Bulb onion is one of the major commodities imported by Bhutan with 3308 MT of onion worth Nu.83 M imports in 2019 (BTS, 2019). Owing to a huge shortage of onions in 2020 following the closure of borders due to the pandemic, Bhutan had to make a special arrangement to meet the domestic demand. Realising the rising demand and the potential for local production, the Department of Agriculture has prioritised onion as one of the crops for commercial production.

Bhutanese farmers have been growing both spring and bulb onions on small scales for decades. Onions can be cultivated in winter in humid and dry subtropical zones and from summer to autumn in warm-cool temperate zones. The onions produced in humid and dry subtropical zones will be available in the market from early spring to winter while the production in the western and central regions will hit the market from summer to early winter. Since onions can be stored for six months, their availability can be staggered throughout the year if properly cured, stored and marketed.

The Vegetable Program of the National Centre for Organic Agriculture (NCOA) in Yusipang has started promoting and popularising the cultivation of onion. In 2021, the centre evaluated bulb onion cultivation at three agro-ecological zones: Rangaytung village in Samphelling geog, Arikha and Peeping in Darla gewog, Chhukha representing the humid subtropical low

altitude; Rimtab in Chapcha gewog, Chhukha for medium-altitude and Yusipang in Chang and Zanglaykha in Genekha gewogs, Thimphu and Ramthangka in Tsento gewog, Paro for the high-altitude zone.

The trial was conducted jointly with the gewog agriculture extension office. During the trial, farmers were provided with seeds, seedlings and technical guidance. In addition, irrigation pipes were also provided to Genekha, Chapcha and Bongo farmers with support from the World Food Programme.

Looking at the good trial results, all farmers where the onion was tested showed keen interest to expand onion cultivation. In Genekha, the Zanglakha Women Famers Group who cultivated onion in one acre in 2021 will go for commercial-scale production in 2022. Other growers from the mid and low altitudes will also continue the production however they have requested seed support.

To supplement the production evaluation, the program initiated the nationally coordinated trials and has mandated the Agriculture and Research Development Centre (ARDC)-Wengkhar for the coordination of onion research and development in the country.

A suitable short-duration and high-yielding variety including Blanca Grande, No.1358, Red and White creole are being evaluated in all the four ARDCs to fit into the Bhutanese cropping patterns. The evaluation is expected to be completed by the 2022 end and proposed for release in the same year. These could complement the existing two long-duration varieties, Bombay Red and Pune Red with a crop duration of 150 days. Further, three ARDCs will evaluate the performance of new short-duration varieties under fast-track evaluation for release and provide alternatives to the growers.

Seedling production due to diseases, irrigation and lack of harvesting techniques and storage facilities are some of the pertinent issues raised by farmers across the country. It is recommended to raise nurseries under poly-tunnels as it helps to conserve heat and protect the seedlings from frost in the cooler regions and prevent damping off and damage due to heavy rain in warmer regions.

There is potential for year-round and commercial production of bulb onions in all agro-ecological zones if the production plan, necessary infrastructure and marketing strategies are properly channelised. Farmers expressed that marketing the local onion is a challenge as the imported ones are easily available at the market at cheaper rates which often demotivates growers.

Today, Tsirang is the highest onion producing Dzongkhag producing 30.54 MT from an area covering 32.04 acres followed by Dagana, Trashigang, Sarpang, Pemagatshel and Mongar.

Performance of bulb onion in three agro-ecological zones in 2020-2021

Agro-ecological zones	Location	Altitude (masl)	Date of transplanting	Date of harvest	Yield (kg/ac) (Pune Red)	Yield (Kg/ac) New Hybrid (1358)
High altitude	Yusipang (Thimphu)	2600	April	August	6300	16307
	Genekha (Thimphu)	2500	April	August	2400	-
	Ramthangka (Paro)	2700	April	August	2000	-
Mid altitude	Chapcha (Chhukha)	1800	May	September	2225	16200
Low altitude	Samphelling and Darla (Chhukha)	600-1200	October	February	4793	-

Crop maturity at NCOA

Crop variety	Date of sowing	Date of transplanting	Date of harvest	Days to maturity
Blanca Grande	24/2/2021	6/4/2021	22/7/2021	100
No.1358	24/2/2021	6/4/2021	5/8/2021	120
Pune Red	24/2/2021	6/4/2021	17/8/2021	134-150

A locally viable technology to cure areca nut

Pit with polyethylene method is proven to be the best one

Pema Chophel and Anand Gurung, National Post Harvest Sub-Centre, Dagapela
Tshering Yangden, Agriculture Research and Development Centre, Samtenling
Chato Lham, National Post Harvest Centre

Bhutan imports most of the food items, but it is putting concerted efforts to reduce the import in the long run. With the pandemic situation, we have a good opportunity to explore the locally viable opportunities.

We export potatoes and oranges and then import the potato chips and orange juice likewise exporting freshly ripe areca nuts and importing cured (Muza) areca nuts are no exception. This indicates that we export the raw materials at cheaper rates and import the value-added products at considerably higher rates causing inflation.

Areca nut or Doma, the locals' favourite is a key part of the Bhutanese culture. It is not good for health but it's a different story with the economy. For many farmers, it is the main cash crop for their livelihoods. Areca nut is not an essential food item but it is among the essentials recorded in the quarterly consumer price indices of the National Statistical Bureau.

The import of cured Doma has been on the rise even during the national lockdowns. According to the trade statistics (2019), Bhutan imported 684.52 MT of cured areca nuts and betel leaves worth Nu.51.22 M. Areca nut is the principal economic crop of southern Bhutanese where they directly export to the neighbouring country right after the harvest. The trick the importers play is that they buy it at cheaper rates and cure the same nut and sell it back at a hefty profit. They know the demand as the Bhutanese cannot live without Doma. Some people wonder why the growers don't cure nuts and sell them.

Most Doma consumers do not prefer to consume freshly ripe areca nut as it will have a bitter taste and will give some sort of tipsiness due presence of excessive alkaloids such as arecoline, guvacine, arecaidine and guvacoline. On the other hand, the cured areca nut will have reduced bitterness and alkaloids due to storage. The areca nut curing is defined as storing areca nut in airtight conditions for a longer duration in such a way that liquid released from the husk will form a mass that has a husk loosening effect on the husk and the alkaloid present in the nut will be reduced.

To explore the best technology for making the areca nut curing possible within the country, the National Post Harvest Centre (NPHC) and the Agriculture Research and Development Centre (ARDC) in Samtenling conducted a comparative study trial of areca nut curing under different storage conditions.

The trial was established at ARDC-Samtenling in 2019. Four treatments were considered based on the farmer's practise and some from the literature review including a pit with polyethylene, a barrel, a jute bag with polyethylene and chemicals. The parametres tested were changed in shape and size of fruits, weight and sensory evaluation. The data collection was done every after one month until the ninth month of storage.

The results showed no significant differences in size, shape and weight. However, the sensory evaluation result showed that the pit with polyethylene method was the best technology. During the curing process in a barrel, jute bag with polyethylene and chemical methods, the loss due to husk and nut drying and sprouting are the main challenges. While in the pit method, losses due to sprouting were found to be negligible. For the barrel method, it was found that curing is possible only in a dark room with airtight conditions.

Further, the pit method was found to be the most cost-effective as compared to other treatments. To validate the findings, NPHC conducted trials at Paro and its sub-centre at Dagapela in 2020 and 2021 which showed similar results.

Upon the request from the Dzongkhag Agriculture Officer, Dagana, NPHC supported one areca nut supplier in curing the areca

nut. Dilip Kumar Chuwan, a resident of Shamdolay in Tashiding has been the cured areca nut supplier for the last 8 years for Dagana, Tsirang and sometimes for Wangdue. He had been importing the cured areca nut from the Gelephu border until the pandemic hit his business with border closures and frequent lockdowns.

In 2021, he approached for technical guidance to cure the areca nut that he collected from Lhamoizingkha, Dagana. The technical team recommended him the pit method. He managed to cure 5000 pons (1 pon= 80 fruits) of areca nut fruits and the return was very good. He expressed his satisfaction with the research findings and he is looking forward to curing areca nuts with the same method in the coming season.

The pit technology has a good potential for up-scaling to help reduce the imported cured Doma and subsequently contribute to achieving food self-sufficiency. The centres are planning to create awareness of this technology for a wider reach to benefit farmers.

For Doma growers who are interested in taking up this technology, one will require a polyethylene bag of at least 2 mm thick, turmeric powder to reduce foul smell, retain and give yellowish colour and a moist pit. While for the method using the barrel, one will require a barrel of desired size, turmeric powder and a dark room to keep the stored barrel.

The curing process differs depending upon the methods. In the pit method, the areca nut gets cured in 3 to 4 months and can be preserved for 8 to 9 months with a good marketing quality. In the barrel method, the fruits get cured in 3 months and can be preserved for 8 to 9 months. The best quality of Muza can be obtained if a sample preserved is stored for 6 months. If stored for more than 11 to 12 months, the areca nut can get rotten and damaged.

For now, the locally cured Doma has a good market because of the importing challenges. But with the opening of borders in the future, the opportunity may be different as the people seem to prefer the imported Doma more because of size and cost factors.

In Bhutan, the Doma growing Dzongkhags include Sarpang, Dagana, Samtse, Samdrup Jongkhar, Pemagatshel and Zhemgang.

Things to remember during the curing process:

· The fruits should be fully ripe.

· The samples stored should be kept in airtight condition.

· For the plastic method, the pit should be kept moist in condition to prevent surface dryness of fruit.

· For the barrel method, the samples should be kept in a dark room with no sunlight to prevent drying the stored areca nut fruits.

NEW DISCOVERY

BHUTAN DISCOVERED NEW SPECIES OF SNAILS

Bhutan discovered new species of snails including Sinoennea bhucylindrica from Pemagatshel, Sinnoennea nimai from Zhemgang and Rahula namgayae.

The news on first two species was published in the Basteria journal in April 2021. They were determined using DNA sequencing along with morphological descriptions.

Sinoennea bhucylindrica has cylindrical shell with the whorls having prominent ribs and Sinnoennea nimai has broad shell above the middle which narrow downs the base. The specimens of the species are deposited at the National Invertebrate Repository Centre in Serbithang.

The discovery of Rahula namgayae was published in a paper titled 'RAHULA REVISITED (PULMONATA: EUCONULIDAE), WITH DATA FOR BHUTAN, INDIA (ASSAM), LAOS, VIETNAM AND INDONESIA, INCLUDING TWO NEW SPECIES' in the Journal of Conchology.

The new data for Rahula species in Bhutan are given including a new species and an extended description of R. trongsaensis based on a newly found fully grown shell. The genus is known from only the eastern half of the country. Two hitherto overlooked nominal taxa of Kaliella from Assam are regarded as Rahula species resembling R. trongsaensis; photographs of syntypes of these taxa are presented. Additions to the species list for Rahula that was published earlier are added, including a new species for Indonesia, Sulawesi. An updated distribution map for the genus is provided in the paper.

hula species. **2** *R. kleini* Gittenberger, Leda & Sherub, 2017 **3** *R. namgayae* sp. nov. da & Sherub, 2017. Scale bar 2mm.

The species study was conducted jointly by the National Biodiversity Centre, Naturalis Biodiversity Center (The Netherlands) and Ugyen Wangchuck Institute for Conservation and Environmental Research.

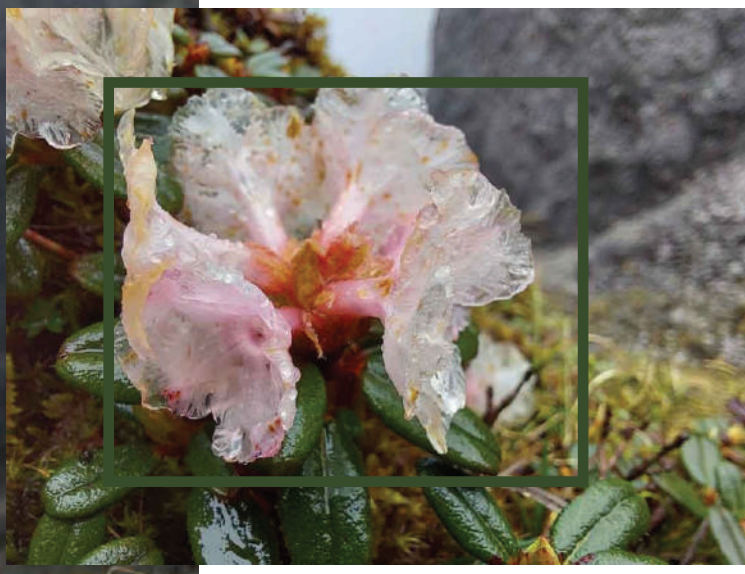
NEW BEGONIA SPECIES DISCOVERED

A Begonia species, new to the world is discovered after investigation of an old herbarium specimens at the Royal Botanic Garden Edinburgh. The species was discovered from Zhemgang by Phub Gyeltshen, a Forest Science student at College of Natural Resources, Royal University of Bhutan; Mark Hughes, Begonia expert, Royal Botanic Garden Edinburgh and Sherab Jamtsho, a Ranger at Zhemgang Forest Division. The first author also added *Begonia Flaviflora, Begonia panchtharensis* and *Begonia gemmipara* species which are new records for Bhutan in 2021.

The new species is named as *Begonia bhutanensis* which is derived from the country of its origin. It is currently known only from Zhemgang but it is likely to be discovered from other Dzongkhags having similar habitats.

The Begonia species at the Royal Botanic Garden Edinburgh was said to be collected from Zhemgang ["Shamgong"] of Bhutan in 1985. The herbarium specimens were mistakenly identified as *Begonia rubella* Buch.-Ham. ex D.Don but it was concluded as a new species only in 2021 after a thorough investigation by authors from Bhutan and Edinburgh. It has pink flowers and grows in the shady areas of warm broadleaved forest at around 1000 masl.

In Bhutan, the genus Begonia is represented by 13 species and with the addition, it has increased to 17 species. Bhutan is likely to harbour around 30 species of Begonia as many parts of the country are still under survey. As per the International Union for Conservation of Nature (IUCN) Red List categories and criteria, the species is Critically Endangered in the country.



RHODODENDRON POGONOPHYLLUM REDISCOVERED IN BHUTAN AFTER 84 YEARS

A team from the Royal Botanic Garden Edinburgh, the Primula World and the National Biodiversity Centre, Bhutan (NBC) rediscovered Rhododendron pogonophyllum at Kyitsugang, Wangdue at an altitude of 4452 masl after 84 years.

The Flora of Bhutan describes a total of 46 species out of which 45 are known to be occurring in Bhutan. The book describes Rhododendron pogonophyllum as a rare endemic plant to Bhutan. Subsequent publication of the book 'Plants Endemic to Bhutan Himalaya' by NBC published in 2015 listed it as one of the endemic plant species found in the country with a herbarium specimen as an evidence.

'Wild Rhododendrons of Bhutan,' a book by Rebecca Pradhan in 1999 has photos of the Rhododendrons found in Bhutan including Rhododendron pogonophyllum with descriptions of its flower, leaf, flowering time, habitat, altitude, distribution and with a remark stating as an endemic and rare plant species not seen since 1937, but without any picture. The book reports a total of 46 Rhododendron species in Bhutan.

Rhododendron pogonophyllum was first collected by George Sherriff, a Scottish plant collector on 7 June 1937 at Tang Chu in Wangdue. His 1937 trip was mainly focused around the central Bhutanese mountains including the Black Mountains. He ventured out

to explore the Pele La range which falls to the east of Dangchu which Sherriff wrote as Tangchu in his specimen locations.

After a night halt at Trashidinkha in Dangchu, he climbed towards Kyitsugang which Sherriff wrote as Chizukang. On his second day, he found many interesting plants including Primulas and the Rhododendron *pogonophyllum* in particular under the collection number 3216. Earlier the specimen collected was thought to be Rhododendron *hypenanthum* which is now considered as a subspecies of Rhododendron *anthopogon.*

Later Cowan & Davidian described it as a new species using the specimen collected by Sherriff from this locality and the specimen currently resides at the Royal Botanic Garden Edinburgh in UK with the catalogue number E00010309. Later in July, Sheriff also collected the same Rhododendron species from Rinchen Chu (Chore) in central Bhutan on 13 July 1937.

Currently, Chore is known as Khero to the locals and the present day Nikachu was known as Rinchenchu. Chore=Khero and Chizukang=Kyitsugang lie on the same mountain range separating the Nikachu and the Dangchu watersheds. Khero [Chore] is located within the aerial radius of around 5 km from Kyitsugang [Chizukang].

With the help of David Long from the Royal Botanic Garden Edinburgh and Pam Eveleigh from the Primula World, the type locality was traced and a team from the National Herbarium and Royal Botanical Garden, Serbithang under NBC made an expedition to the mountain east of Dangchu in June 2021.

During the expedition, the team was faced by incessant rainfall and footpath which was barely noticeable since the cow herders of the Ramno grazing area stopped taking their cattle to the grazing area last year. The team took shelter in the wooden huts of the cow herders from Dangchu and ascended through steep cliffs towards the Kyitsugang the next day.

Despite the incessant rainfall and cold mountain winds, the team finally found the lovely and tiny Rhododendron pogonophyllum flowering beautifully and precariously on the rocks and rocky soils on open hillsides at Kyitsugang at an altitude of 4452 masl. Kyitsugang is considered by the residents of Dangchu to be the abode of their deity Kyitsub. Rhododendron pogonophyllum which was recorded in 1937 is thus rediscovered after 84 years in Bhutan.

The specimens collected is deposited at the National Herbarium of Bhutan. Rhododendron *pogonophyllum* Cowan & Davidian is a creeping sub-shrub which has similar flowers to that of Rhododendron *anthopogon* with small obovate leaves with rounded or retuse apex, rounded at base and scaly leaf underside.

2021 HIGHLIGHTS

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Organic certified products

The National Centre for Organic Agriculture launched various organic certified products including rice from Paro and wheat, wheat flour, buckwheat flour, potato, garlic, coriander, cabbage, cauliflower, sag, radish, chilli and spring onion from Lull village in Wangdue on February 25.

They were certified organic under the local organic assurance system, an organic certification system for the domestic market based on the Bhutan Organic Guarantee System. With the certification, they can now use the Bhutan Organic Mark on their products to market them as certified organic products.

World Wildlife Day

The Department of Forests and Park Services (DoFPS) jointly with the Royal Society for Protection of Nature (RSPN) and WWF Bhutan observed World Wildlife Day on March 3 at the Royal Takin Preserve with a theme 'Forests and Livelihoods: Sustaining People and Planet.'

The day highlighted the central role of forests, forest species, and ecosystem services in sustaining the livelihoods of hundreds of millions of people globally. It also launched the Black-necked Crane Conservation Action Plan (2021-2025) developed by RSPN and DoFPS.

Feed mill established at Thangbi

A medium scale feed mill established at Thangbi, Choekhor in Bumthang was inaugurated on March 11. The 32 MT capacity feed plant will benefit all dairy farmers and dairy groups of Bumthang. Funded by GOI-SDP, it has the capacity to produce about 11,680 MT of cattle feeds annually. It also has the capacity to supply cattle feeds to other Dzongkhags namely Mongar, Trongsa and Zhemgang.

The mill is expected to encourage domestic production of raw materials such as maize and soybean for feed production apart from creating employment for the youths.

Farmers Business Game training

To enhance the farmers' commercial knowledge, the Ministry of Agriculture and Forests organized a simulation training, Farmers Business Game. Nineteen farmers (15 female and 4 male) from Nahi gewog, Wangdue attended it from March 15-17.

It is a board-based business game and a highly interactive training for smallholder farmers and agricultural entrepreneurs who want to improve their skills for a successful and sustainable farm management. The training was also organized in Wangdue, Mongar and Dagana as a part of the Project for Rural Development.

Agromet Decision Support System

The Department of Agriculture launched the Agromet Decision Support System, a web portal accessible at www.agromet.gov.bt on March 16. It is envisioned to generate and disseminate specific crop advisories of precise location based on weather forecast using machine learning algorithm.

It was developed mainly to strengthen agro-met services which integrates weather forecast from NCHM and RIMES forecast. It would provide, real time monitoring, data analysis and comprehensive analytical tools and statistical information to support decision making across a range of temporal and spatial scales.

Biodiversity bill

The Hon'ble Sanam Lyonpo introduced the Biodiversity Bill of Bhutan 2021 at the Fifth Session of the Third Parliament of Bhutan on March 31.

The Bill affirms the national sovereignty and secures the trusteeship of the Bhutanese people over its genetic resources. It also promotes the conservation and sustainable use of biological resources and secures the value of Bhutan's biological resources and associated traditional knowledge. Among others, the Bill outlines the mechanism for accessing and utilizing Bhutanese genetic resources in a fair and equitable manner.

Tenth annual agent meeting for Karma Feeds

The tenth annual agent meeting for Karma Feeds in Pemagatshel was convened on April 2 to create awareness to livestock farmers on Karma Feeds, Karma One Stop Shop, and Karma Pharmaceuticals and Medicine Supply. It also discussed various feed issues and the way forward.

The company has initiated a bag identification for various feed types to let even illiterate farmers make the right choice of feed from the bag colour as there were issues on feeding wrong feed to the animal in the past.

Ranger recognized during International Ranger Award Day

In the first of its kind, the prestigious award for the rangers coordinated by IUCN WCPA received over 130 nominations from 43 countries including Bhutan.

It was a pride moment for Bhutanese rangers to have our own Norbu Yangdon being listed amongst the highly recommended rangers which were announced on April 7. Norbu bagged the recognition based on her dedicated and selfless leadership in conservation and for her commitment towards protecting the highly fragile and threatened biodiversity in the Sakteng Wildlife Sanctuary.

Rice Fortification Workshop

A workshop on 'Rice Fortification: An awareness on food safety and quality management' was held in Punakha on April 15-16. Around 27 participants including students attended it with experts from Delhi, Bangladesh and Thailand and other participants joining the meeting virtually.

The meeting shared the progress that Bhutan has made till date in food fortification, create awareness on this important intervention as well as gain the regional experience from experts. The rice fortification task force and the World Food Programme, Bhutan jointly organized the meeting with.

BAFRA officials trained on pests and diseases management

The Bhutan Agriculture and Food Regulatory Authority (BAFRA) organized a training for the plant regulatory and quarantine officials on April 15-16 in Thimphu. The training on 'Plant Inspection and Pest and Disease Diagnostics' enhanced the competency of the inspectors for timely detection and management of quarantine importance of plant pests, diseases and invasive alien species.

A total of 18 officials from the western region attended the training physically while 17 officials from the entry point offices attended it virtually.

Scheme of Testing and Inspection Manuals

A workshop to finalize the Scheme of Testing and Inspection (STI) manuals for Cottage and Small Industries (CSI) based food products was held in Bumthang on April 19-20.

The workshop finalized the STI manuals on buckwheat flour, butter, datshi, herbal tea and paneer which will serve as a basis for the implementation of the standard by the CSIs for self-monitoring and internal controls. The workshop was organized by BAFRA as a part of the CSI Flagship Program.

Dangdung Water Project in Trongsa

The completed Dangdung Water Project in Langthel gewog, Trongsa was handed over to the beneficiaries on April 8 including 1 intake structure, 1 reservoir of 20,000 litres, a total pipe length of 9.5 km and 9 tap stands.

The project will benefit 65 households and 285 individuals in Dangdung chiwog by supplying them safe and reliable drinking water. Around 40 De-suups trained on water resource management were involved in the project costing around Nu.2.4 M. To ensure the scheme ownership, operation and maintenance, a water user association has been formed.

Access and Benefit Sharing scheme

A benefit sharing ceremony between the Bio Bhutan Pvt. Limited and the Jom Dagam Ngomen Tshogpa was held on May 11 at Dagala. The Bio Bhutan and National Biodiversity Centre through the project, 'Promoting the Application of the Nagoya Protocol on Access to Genetic Resources and Benefit Sharing in Bhutan' had implemented the Access and Benefit Sharing scheme with the Tshogpa.

The Bio Bhutan has been granted access to leaves of the Rhododendron anthopogon (Dz Balu) for the production of Drizang perfume, Tshalung massage oil and a natural handmade soap.

International Biodiversity Day

The International Biodiversity Day was celebrated on May 22 at the Royal Botanical Garden in Serbithang with a theme, 'We are part of the solution.'

To mark the day, the Biodiversity Interpretation Centre, a one-stop hub for Bhutan's biodiversity was inaugurated. The centre is expected to educate and inspire a love of nature, provide an interactive learning forum and raise awareness on Bhutan's rich biodiversity as well as encourage the general public to value biodiversity. In addition, a user manual for the Bhutan Biodiversity Portal (https://biodiversity.bt) was launched.

Creche facility to support the working mothers

A creche facility was inaugurated on May 28 at the National Centre for Organic Agriculture in Yusipang, Thimphu to support the working mothers in performing their responsibilities efficiently and reduce their burden as well as have a gender sensitive and responsive working environment for achieving gender equality.

The facility will also help educate the children who are not eligible for enrollment in the school and contribute in addressing the gender issues at work place. Twenty-nine children (18 girls and 11 boys) were enrolled on the first day.

FSAPP funded four irrigation schemes

Food Security and Agriculture Productivity Project (FSAPP) has funded the construction of four irrigation schemes- Rateykhola and Laringkhola in Sarpang and Thareykhola and Birkhola in Samtse.

The main channels were completed and handed over to the beneficiaries in June 2021. Upon completion of the distribution networks, it is expected to irrigate a total of around 2000 acres of area. The irrigation source of the 7.1 km Rateykhola reaches a command area of over 476 acres of land benefiting some 240 households.

Tree plantation to commemorate the Birth Anniversary of Her Majesty

To commemorate the 31st Birth Anniversary of Her Majesty The Gyaltsuen on June 4, the Ministry organized a tree plantation at Samarzingkha in Thimphu. The Hon'ble Sanam Lyonpo, the Hon'ble Member of Parliament, Dasho Dil Maya and the Hon'ble Agriculture Secretary participated among others.

The team planted around 31 tree species of oak, walnut and cypress covering an area of around 30-40 decimals. The plantation site will be managed by Thimphu Forest Division for sustainability.

New Recreational Park at Dangrina

A new recreational park was inaugurated at Dangrina in Thimphu on June 4 for people to enjoy and appreciate the beautiful green landscape.

It was developed under one of the royal projects, Urban Greenery Re-vitalization. It is spread over 2.80 acres of area and is enriched with a total of 381 nos. of ornamental plants. The Royal Project Coordination Office developed the park to represent the neighbourhood nodes into a recreational park with fund support of Nu.1.6 M from the Bhutan Trust Fund.

Renewing the bio-gas plant on World Environment Day

The National Piggery Research and Development Centre in Gelephu celebrated the World Environment Day on June 5 by renewing the bio-gas plant with paint.

The plant is one of the largest biogas plants in Bhutan with a 75 CC capacity which was established in 2015 as a climate smart initiative. The plant is fueled by the farm manure collected from 700 pigs. The farm has experienced cleanliness and less odour after connecting the manure to the biogas plant inlet tanks.

Third World Food Safety Day

Bhutan observed the third World Food Safety Day on June 7 with a theme 'Safe food now for a healthy tomorrow' by emphasizing that there can be no health, no nutrition and no food security without food safety.

To mark the day, Bhutan Agriculture and Food Regulatory Authority launched two series of 'Zhego Delek' articles to educate the Bhutanese consumers on food safety, food quality and food adulteration. The third series is a food label literacy video online at https://youtu.be/c0z5wR1ypdY.

APC signed between MoAF, MoF and SOEs

A tripartite Annual Performance Compact (APC) was signed on June 7 between the Ministry of Agriculture and Forests (MoAF), Ministry of Finance (MoF) and four State-Owned Enterprises (SOEs): Bhutan Livestock Development Corporation Limited, Food Corporation of Bhutan Ltd., Farm Machinery Corporation Limited and Green Bhutan Corporation Limited.

As per the government directives, beginning 2021, in line with the Corporate Governance Guidelines for State Enterprise 2019, the relevant SOEs are required to sign a tripartite APC with the Portfolio Ministry and MoF.

Nubi gewog received tractors and power tillers

Bumthang Forest Division handed over 5 nos. of tractors/power tillers to the communities of 5 chiwogs under Nubi gewog in Trongsa on 20 June 2021. A simple ceremony was convened to recognize the loss of 296 cattle to tigers from 2018 till date.

A total number of 345 households will be benefited through this holistic approach which will help them sustain their livelihood with better farming practices. To minimize human-wildlife conflicts and enhance conservation, the Division is restoring the degraded habitat to prevent visit of prey species.

New tomato variety

The Agriculture and Research Development Centre-Wengkhar released a new tomato variety, Wengkhar Lambendha 1 in July. It was endorsed by the Ministry's 23rd Variety Release Committee on June 23. The new variety is an indeterminate type suitable for both open field and protected cultivation structures.

The released crop varieties in the country are evaluated as per the Standard Evaluation Guidelines for Field and Horticultural Crops of Bhutan. They are then proposed by research centres and seed agencies to the Variety Release Committee.

ARDC-Wengkhar established hydroponics for research and development

The Agriculture and Research Centre (ARDC)-Wengkhar with fund support from the CARLEP established hydroponics for research and development. The centre will begin evaluating the crops suitable for hydroponics, develop nutrient formation for different crops and carry out production economics study. It will also provide technical assistance and promote these commercial farming technologies in the region.

A vertical hydroponics and substrate-based cultivation of vegetables model was established at the centre as a part of the De-Suung Skilling Program.

Cluster Finance Services

The Cluster Finance Services for the Ministry of Agriculture and Forests was launched on July 8 jointly with the RCSC and the Ministry of Finance. It is a collaborative initiative of the RCSC and finance based on the concept of sharing services by leveraging the use of ICT.

The initiative will bring together all finance personnel working in various regional/autonomous/branch offices under one cluster office to provide all finance-related services from one roof. However, this initiative does not include the finance sections of the Dzongkhag Administration.

Dessung Skilling Program on Hydroponics and Organic Fertilizer

The Hon'ble Agriculture Secretary, Dasho Rinzin Dorji graced the closing ceremony of the Dessung Skilling Program on Hydroponics and Organic Fertilizer at ARDC-Bajo on July 9.

Congratulating the 31 Dessups, Dasho said such a precious gift from His Majesty should not be wasted but translated into projects and start the implementation. He assured to provide the Ministry's full support including the technical assistance in taking up the agri-business.

Organic certified seeds

The Ministry launched the organic certified seeds of beans, quinoa, buckwheat, chilli, ginger and turmeric on July 14 at the National Seed Centre in Paro, the first of its kind in the country. Around 6.6. MT of seeds was certified organic.

The centre initiated the organic seed production during the financial year 2019-2020 with support from the National Organic Flagship Programme to make organic seeds available to the organic farmers in the country. As of now, there are 215 registered seed growers from Gasa, Wangdue, Sarpang and Paro.

Sixth PSC meeting for EU-TCP

The sixth project steering committee (PSC) meeting for the EU-Technical Cooperation Project (TCP) in support of RNR Sector was virtually held on July 22.

The meeting shared the project achievements and impacts, evaluation findings and lessons learned. The project, the first of its kind in the Ministry was aimed at improving the skills and knowledge of the RNR staff in terms of agriculture, livestock, forest, market and administration. With a total budget of 4.6 M Euro, it funded 7 master's programme, 606 advanced training and 526 basic training for the RNR staff.

Revised Guidelines on Cost-Sharing Mechanism

The Ministry of Agriculture and Forests shared the revised Guidelines on Cost-Sharing Mechanism (CSM) for the RNR Sector 2021 on July 28.

The CSM aims to streamline the practice of support provisions for various RNR related activities and intends to encourage individuals, farmer groups, cooperatives, youth and youth groups to take up RNR sector activities across value chain (production to marketing). This is expected to contribute to achievement of the sector's objectives of accelerating food and nutrition security and self-sufficiency of RNR products.

Thirty-one new drivers join the Ministry

A one-day induction programme for 31 newly appointed Drivers was held at the Ministry's conference hall on August 4. They were selected through an open competition for deployment in various field offices.

During the programme, the Chief Human Resource Officer highlighted the importance of upholding civil services values and code of conduct while carrying out the duties and responsibilities. The programme also covered topics on multitasking, basic asset management, basic concepts on Driglam Namsha and Zacha Dro Sum (practical example and demonstration).

Twenty-seven new graduates join the RNR Family

The Ministry of Agriculture and Forests conducted a graduate orientation for the 27 Bhutan Civil Service Examination selected graduates who were recruited at the Ministry.

During the program which concluded on August 9, the respective departments and agencies presented their organizational mandates, 12th five-year plans and programmes and other relevant topics to the graduates besides familiarizing them with values, code of conduct and overall mandates of the RNR Sector.

Improved variety asparagus saplings for Bongo farmers

Fourteen households in Toktokgom village under Bongo gewog in Chhukha received 2000 numbers each of improved variety asparagus saplings on August 17 from the Dzongkhag Agriculture Sector. The initiative will help farmers to earn a good income and enhance their livelihoods.

Although the village is one of the remotest gewogs, it has a huge potential for a high value crop like asparagus because of its geographical location and a good vegetation coverage.

Training on improved pig breeding and management

A hands-on training on improved pig breeding and management was held for 12 Big Ticket Initiatives clients including 8 educated youths, 2 laid-off employees and 2 piggery CSI loan beneficiaries under Sarpang from August 23-29.

The training was aimed to substitute the import of livestock products and help increase food security in the country. It was also aimed to engage youths and COIVID19 laid off employees in livestock farming as well as improve and revive the national economy.

YERE capacity building program

Youths from Wangdue attended the Youth Employment and Rural Entrepreneurship (YERE) capacity building programme in August-September. Participants learned about the entrepreneurship basics, communication skills, financial plan and writing a business proposal that is crucial to start any new business.

The YERE project trained around 500 unemployed youths in six project sites of Chhukha, Dagana, Haa, Samtse, Trongsa and Wangdue. The training encouraged youths to take up entrepreneurship and create employment as youth employment is becoming a challenge in the country.

National Dialogue on Bhutan's Food Systems

To prepare Bhutan for the UN Global Food Systems Summit, the Ministry of Agriculture and Forests convened the National Dialogue on Bhutan's Food Systems on September 13-14 at Thimphu.

Around 30 participants from the government, private sector, CSOs, youth, women and development partners came together to identify unique pathways to transform the nation's food systems and the RNR sector through multi-stakeholder consultations. The Ministry also conducted the sub-national dialogues on Food and Food Systems at Wangdue, Mongar and Paro in August covering various Dzongkhags.

BAFRA achieving leadership in the codex process

Around forty participants attended an advocacy workshop with a theme 'Achieving leadership in the codex process' at Lobeysa from September 20-22.

The workshop was aimed at strengthening the national Codex programme in Bhutan, increasing the understanding on the importance of Codex standards for consumer protection and fair practices in food trade, and enhancing engagement in international standard setting process among the relevant agencies. It was facilitated by experts from India, WHO South East Asia Regional Office, New Delhi and FAO Regional Office for Asia and the Pacific, Bangkok.

Awareness training on e-RNR Crop Advisory

Sixteen participants including youths from urban farming program and teachers from the School Agriculture Program attended an awareness training on e-RNR Crop Advisory on September 27 in Thimphu.

The crop advisory is a mobile app on farming targeted for youths to help them take up farming for their livelihoods. It is a platform with easy access to instructions on growing various crops and other useful farming information. Participants learnt to install the app and how to access the app features. Similar training was also organised in Wangdue and Punakha.

Pet Dog Census in Thimphu

The Accelerated Dog Population Management and Rabies Control Program under the Department of Livestock conducted the door-to-door pet dog census from September 29 to October 1 in Thimphu. The census was conducted using the Epicollect5 mobile application.

As per the census, a total of 7292 pet dogs (3838 male and 3454 female) were registered in Thimphu as of October 3. It recorded that 3831 pet dogs in Thimphu are sterilised with about 3461 unsterilised pet dogs. There are 1286 free-roaming pet dogs in Thimphu.

Gomphu Water Project in Zhemgang

Gomphu Water Project under Trong gewog in Zhemgang was handed over to the Dzongkhag Administration of Zhemgang on October 6. The project completed with a budget of Nu.2.5 M will benefit about 84 households and 800 people by supplying them safe and reliable drinking water. One water reservoir of 6000 litres capacity, transmission length of 4.2 km pipe line and 31 household water tap stands was constructed under the project.

Around 46 officials including 43 DeSuups were deployed for completing the project that started in May 2021.

Milk processing unit at Balamna in Haa

A milk processing unit at Balamna in Haa which will be operated by a youth group of four members was inaugurated on October 6. The unit was constructed with fund support from Small Development Project, Government of India.

The Dzongkhag Livestock Sector trained the youth group and the group leaders of all five dairy groups under Samar gewog for five days on handling/operation of processing equipment, milk testing, processing of butter, cheese, yogurt, paneer and clarified butter (ghee).

World Food Day

Bhutan celebrated World Food Day on October 18 with a global theme, 'Our actions are our future. Better production, better nutrition, a better environment and a better life.' The celebration included the lighting of butter lamps, offering of Zhabten, video speech from FAO Director General and keynote address from the Hon'ble Sanam Lyonpo.

The day reinforced the need to encourage awareness on sustainable agricultural practices and to celebrate the 'Food Heroes' who work tirelessly to provide food for the world despite exigencies like the COVID19 pandemic.

First bio-fertilizer company

Bhutan will have its first bio-fertilizer company at Athang gewog in Wangdue. To implement the initiative, the Farm Machinery Corporation Limited and the B&B Korea Co., Ltd signed a memorandum of understanding on October 28 in Thimphu.

The joint venture is a business idea committed to fulfilling the nation's aspiration of becoming 100% organic in agriculture for assuring safe and nutrition security. The company has planned for initial investment of Nu.40 M and start with about 20 youth employment opportunities in the value chain.

Agriculture Minister represents Bhutan at COP26

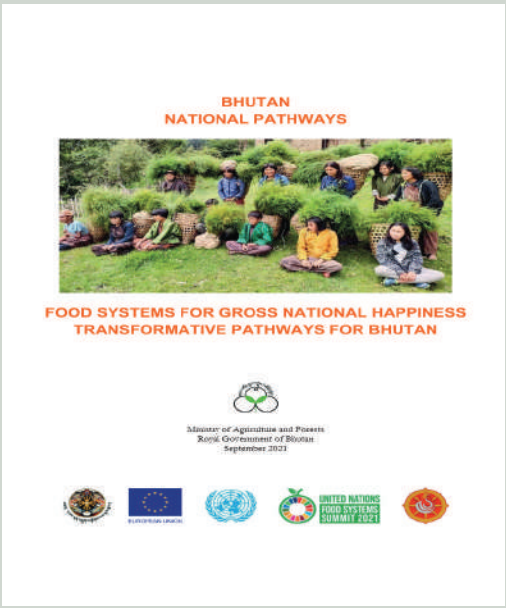
Speaking at the opening of the High-Level Segment of the COP26 conference on November 9, the Hon'ble Sanam Lyonpo highlighted that under the strong environmental stewardship of the Monarchs, Bhutan continues to lead the way towards sustainable development and a low emission climate-resilient development pathway.

As the Chair of the Least Developed Countries Group for Climate Change, Bhutan called upon Parties to reaffirm their commitment to the 1.5°C temperature goal and to the Paris Agreement. COP26 was held in Glasgow, UK from 31 October to 12 November 2021.

Farmers' Sales Outlet at Gedu

A Farmers' Sales Outlet (FSO) was inaugurated on November 16 at Gedu, Chhukha. Chhukha Farmers' Cooperatives with 32 members (9 females, 22 males) will operate the FSO based on the standard operating procedure developed by the Dzongkhag.

The FSO will have a 'Chhukha Natural' product sale counter and a restaurant to offer services at a reasonable cost. It was constructed by Chhukha Dzongkhag Administration with funds from the Food Security and Agriculture Productivity Project. The project has also supported the construction of similar structures in Dagana, Haa, Samtse and Sarpang.



www.moaf.gov.bt

Bhutan's National Pathways towards Food Sector

Bhutan published the National Pathways towards Food Sector on November 24 with eight ambitious and transformative pathways. It will help to build and achieve a high-performance food system and catalyses the maximization of GNH and the achievement of SDGs by 2030.

These pathways will ensure that Bhutan's food systems: Assure access to affordable and safe food, eradicate malnutrition and hunger, double smallholder incomes, empower women and children, reduce drudgery, contribute to meaningful employment creation, remain ecologically benign and carbon-neutral, and build resilience to shocks across the food system network.

BAFRA launched three documents

Bhutan Agriculture and Food Regulatory Authority (BAFRA) launched three documents on November 26 including the Bhutan Biosecurity and Food Safety Strategy and Action Plan (2021-2028), Plant Biosecurity Contingency Plan 2021 and the Annual Report.

The Strategy and Action Plan will help the country to address future biosecurity challenges in a better way which outlines five prioritised goals. The Contingency Plan will help all the key players to have clear roles and responsibilities during an emergency. The Annual Report for 2020-2021 highlights major achievements in biosecurity and food safety domains among others.

First-ever Quinoa processing plant

The first-ever Quinoa processing plant was launched on December 11 in Phuentsholing to supply well-packaged Quinoa to the market and to the school feeding programme. The Food Corporation of Bhutan Ltd. set up the plant with fund support of Nu.3.4 M from the Department of Trade.

The plant can process 500 kgs of Quinoa per hour improving the quality of final products which will come in a packet of 1 kg. Quinoa often called as 'Superfood' is one of the world's popular foods. It is gluten-free and rich in protein.

Ministry celebrates Royal Civil Service Award

Coinciding with the auspicious day, the Ministry of Agriculture and Forests celebrated the Royal Civil Service Award ceremony on December 15. About 349 civil servants under the RNR Sector received the awards. Out of 349, 59 received the Lifetime Achievements Award, 38 received the gold, 99 received the silver and 153 received the bronze medals.

The Hon'ble Sanam Lyonpo graced the award ceremony held at Thimphu Residency Conference Hall. It was also attended by the Hon'ble Agriculture Secretary and Heads of departments, non-departments and agencies.

RNR TIPS

HYDROPONICS

What is hydroponics?

Hydroponics is the soilless method of growing plants using nutrient solutions.

Why go for hydroponics?

Year-round production

Gender-friendly technology

Produce more from a small area

Decreased pest and disease incidence

Increase peri-urban agricultural production

Produce safe food

Reduce weed growth

Reduce drudgery

Efficient use of water and nutrients

Efficient use of space as it involves vertical cultivation

High value crops

Challenges of hydroponics

High initial investment cost

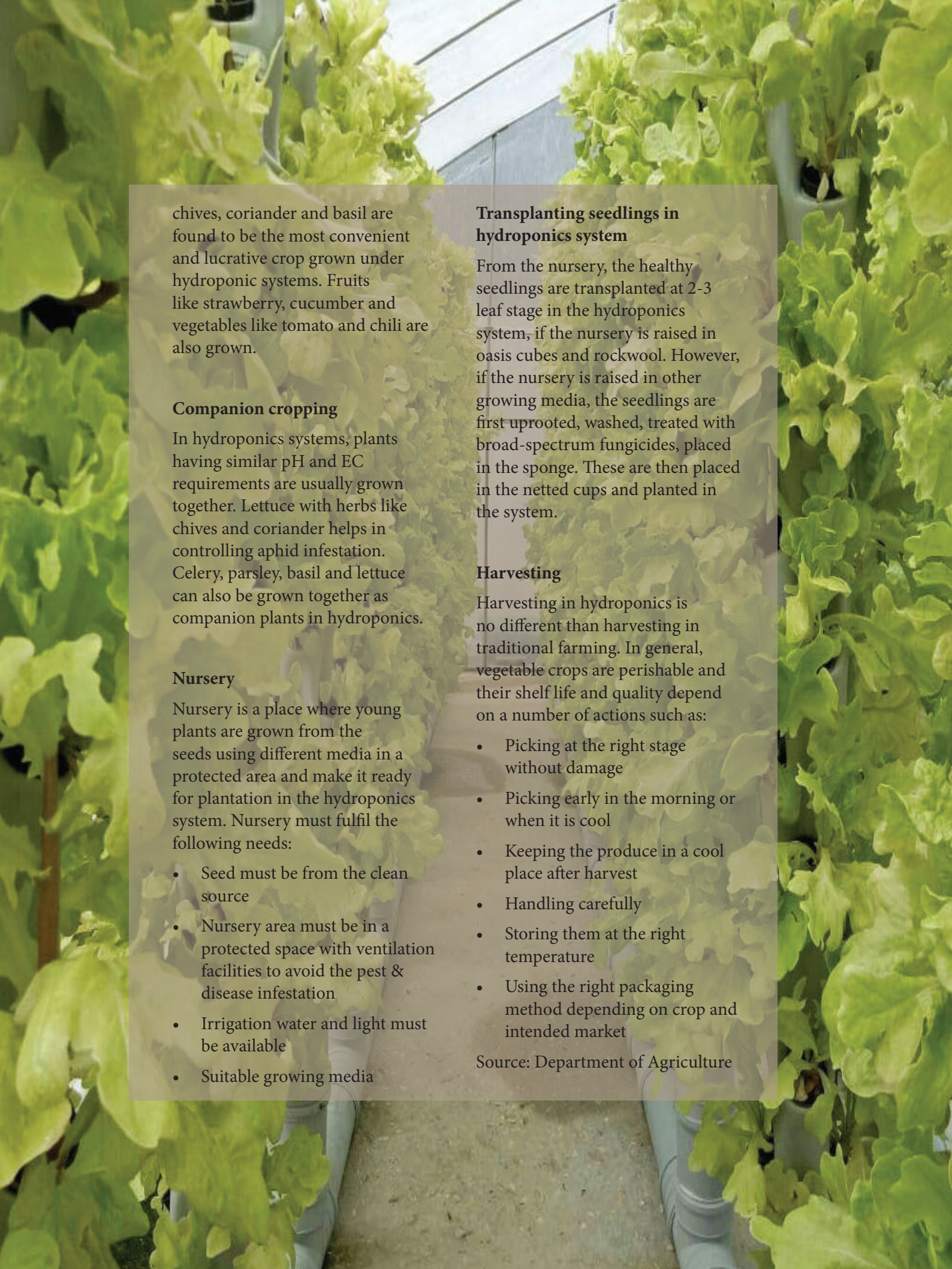
Technical skill and knowledge are necessary for operating the system

Requires strict sanitation to avoid pest and disease incidence

Daily monitoring is necessary

Suitable crops for hydroponics

Leafy vegetables like lettuce, spinach, kale, mustard greens and herbs like celery, parsley,



chives, coriander and basil are found to be the most convenient and lucrative crop grown under hydroponic systems. Fruits like strawberry, cucumber and vegetables like tomato and chili are also grown.

Companion cropping

In hydroponics systems, plants having similar pH and EC requirements are usually grown together. Lettuce with herbs like chives and coriander helps in controlling aphid infestation. Celery, parsley, basil and lettuce can also be grown together as companion plants in hydroponics.

Nursery

Nursery is a place where young plants are grown from the seeds using different media in a protected area and make it ready for plantation in the hydroponics system. Nursery must fulfil the following needs:

- Seed must be from the clean source
- Nursery area must be in a protected space with ventilation facilities to avoid the pest & disease infestation
- Irrigation water and light must be available
- Suitable growing media

Transplanting seedlings in hydroponics system

From the nursery, the healthy seedlings are transplanted at 2-3 leaf stage in the hydroponics system, if the nursery is raised in oasis cubes and rockwool. However, if the nursery is raised in other growing media, the seedlings are first uprooted, washed, treated with broad-spectrum fungicides, placed in the sponge. These are then placed in the netted cups and planted in the system.

Harvesting

Harvesting in hydroponics is no different than harvesting in traditional farming. In general, vegetable crops are perishable and their shelf life and quality depend on a number of actions such as:

- Picking at the right stage without damage
- Picking early in the morning or when it is cool
- Keeping the produce in a cool place after harvest
- Handling carefully
- Storing them at the right temperature
- Using the right packaging method depending on crop and intended market

Source: Department of Agriculture

DRAGON FRUIT

Dragon fruit is a fruit of several cactus species, most importantly of the genus, Hylocereus. It is native to south and central America and belong to perennial epiphytic plant. It is also commercially cultivated in subtropical to tropical Asian countries. Dragon fruit is gaining popularity in Bhutan.

Climate and soil requirement

It is mostly cultivated in the tropical region of the world where the region experiences hot and wet summer. The crop can be grown in Bhutan from 300-1700 masl where there is no-frost. The plant can be grown in wide range of soils. However, soils that are well drained and high in organic matter are recommended.

In Bajo at 1200 masl, the dragon fruit plants grow well in summer but need to be protected from cold in the winter.

Propagation

The crop can be propagated through cutting. However, it can also be propagated through seeds.

Planting and layout

Planting is done on the onset of spring season (March-May) with spacing maintained at 4-5 m × 4-5 m. Plant stem directly into the soil at the depth of at least 2 inches and provide staking and mulching.

Trellising

Dragon fruit plant usually has their fruits on the top of the dropping stems. So, the plant needs to be planted nearby a trellising prop and hang down on the purpose. It generates aerial roots on the stem for holding the plant body on support trellis.

Training and pruning

The vine should be consistently monitored and bound to the pole till it reaches around 5 ft. Uniform spreading in umbrella shape is encouraged. Excess, dead and diseased vines should be cut off.

Fertiliser and irrigation

Apply with 10-15 kg of farmyard manure, 150 g of Suphala per plant at least once before the flowering and during the peak fruiting period. It belongs to cactus family and tolerates to dry condition; however, it should be irrigated based on the soil moisture or once/2 weeks interval during fruiting period.

Harvesting

Flowers start to bloom at night when temperature is above 25° C from mid of June in Bajo and the harvest comes 35-40 days after the blooming. Harvest the fruit when it turns full red and hole appears inside the cavity of the fruit.

Source: ARDC Bajo

ONION

Onion is commercial crop and one of the important vegetables. It is used as salad or cooked in various ways in all curries, fried, boiled or baked. It is also used in processed form such as flakes, powder, paste, crush and pickles.

Onion has great therapeutic value. They are stimulants and mild counter-irritant. It has been used as herbal remedy for centuries in colds, coughs, bronchitis and many other diseases. It is used both in raw and mature bulb stage as vegetable and spices. The pungency in onion is due to a volatile oil known as ally-proopyldisulphide.

Available varieties

There are only two varieties of onion released in our country namely Pune Red and Bombay Red.

Soil

To get the good yield, sandy loam soil having sufficient organic matter is required. It can be well grown on light loam, deep fertile and fertile soil rich in organic matter.

Land preparation

One deep ploughing is required after that 2-3 ploughing of rotavator.

Climate

The ideal temperature for vegetative growth 12.8-23o C but requires little higher temperature 20-25o C for bulb development.

Sowing time and seed rate

The seed is generally sown in raised nursery bed. The surface beds should be smooth and well levelled. The best time for seed sowing is October-

November with seed rate of 10-12 kg per ha.

Seed treatment

Seed treatment with 3 gm Captan is recommended.

Manure and fertiliser

Application 20-25 tonnes of farmyard manure/ha in soil is considered adequate. The manure should be applied one month before transplanting and mixed in the soil.

A dose of NPK (150:60:60:kg/ha) is applied for better bulb development. A whole quantity of phosphorus, potash and half nitrogen should be mixed before the transplantation.

The rest half doses of nitrogen should be given as top dressing in two equal split doses, first dose should be applied at 30 days after transplanting whereas second dose at 45 days after transplanting. The top dressing must be completed before initiation of bulbing.

Transplanting

The best time of transplanting is in between December end to first week of January. The planting spacing of 15 x 10 cm is considered to be the best.

Weed control

2-3 times manual weeding.

Irrigation

First irrigation after transplanting and irrigation should be provided in 10 to 12 days interval

thereafter.

Disease

Purple blotch is a common disease that affects onions. In order to manage, spray Dithane M-45 @0.25 % after mixing sendovit 1.0 ml per litre of water.

Insect

Thrips is a major insect pest in onion. Spray Dimethoate 2 ml per litre of water to manage the pest.

Harvesting

The crop generally is ready to harvest in 100-120 days after transplanting.

Average yield

300-400 quintal/ha.

Source: Department of Agriculture

Oyster Mushroom

Oyster mushroom (Pleurotus ostreatus) is known by the name Naki shamong in Dzongkha. It is one of the most commonly cultivated mushrooms in Bhutan and by far the easiest to cultivate. In Bhutan, it is commonly grown on paddy straw. Besides, paddy straw, other materials like saw dust, wheat straw, banana leaves and dried grasses are being used.

It is widely grown in both lower and higher elevations as it is cultivated in a controlled environment. Oyster mushroom farming in Bhutan to a large extent is organic.

Site requirement

Oyster mushroom farm should be established in places without contaminants and pollutants. The shed can be made of various materials depending on the altitude. Floor of the shed should be cemented and structure like shelves should be constructed for better management and higher yield.

To prevent contamination, the shed should be disinfected with organic disinfectants like bleaching power, Neem oil and other available organic disinfectants. The cemented floor sheds can be washed properly before cultivation in order to avoid the contamination.

Cultivation and management practices

Selection of substrates

Oyster mushroom can be grown on wide number of substrates such as saw dust, wheat straw, paddy straw, banana leaves and even on dry grasses. Whatever material one chooses to use, the materials should be organic, free of pests and diseases and of superior quality.

Chopping of the substrates

Irrespective of the types of substrate materials used, the substrate should be cut to a length of 5-6 cm.

Soaking

The main aim of soaking is to bring the moisture content of the substrate to 65%. Normally, for paddy straw, the time of soaking is about 15 to 20 minutes.

Heaping

The soaked materials are heaped together to remove excess water overnight under shade.

Sterilisation

The materials are filled in netted bags and sterilised in a drum. A small amount

of water is poured into the drum and wooden frame is placed in the drum. The netted bags are kept on the frame to avoid the bags from getting soaked. Sterilisation is carried out to remove competitive and disease- causing micro-organisms. Although sterilisation can be done in boiling water, it is not preferred as it could lead to dissolving and loss of nutrients and additives. Sterilisation begins once the water starts to boil and at this time opening of the drum is sealed with a plastic sheet.

The materials should be sterilised for duration of 2-3 hours in summer (more contamination) and 1 hour in winter (less contamination). Using inorganic methods of sterilisation should be prevented.

Cooling

After sterilisation, the materials are taken out and let to cool down in a clean room overnight.

Inoculation

In plastic bag inoculation, a layer of straw is added which is pressed down and a small quantity of organically produced spawn is added to it. Inoculation should be carried out in a clean room to avoid contamination. The amount of spawn added is 2% of total weight of the materials. Number of layers depends on the size of the plastic being used.

Normally, it reaches 3 to 4 layers. The mouth of the plastic is closed by using a rubber band and small holes are made after 7 to 10 days for aeration.

The plastic should be stored in a room away from direct sunlight. The ideal temperature required is between 20 to 25oC.

Incubation

The plastic bags are then incubated for 21 to 30 days in a clean room for the mycelium to recover. Plastic bags are hanged or kept on shelves.

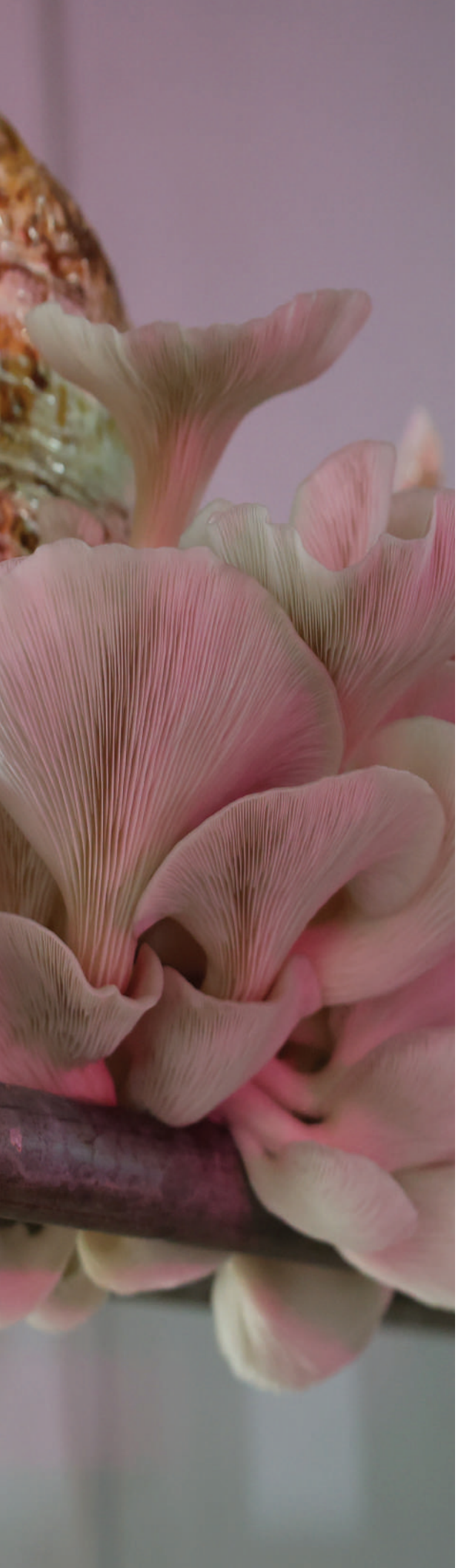
Fruiting

In 1 to 2 weeks, white cotton like fluffy mass will form in the substrate. This is a sign of good mycelium run. After 3 weeks, the whole substrate should turn white signalling the completion of spawn run. The temperature should be brought down by watering to initiate pinhead formation.

A small cut should be made at the place where pin heads has formed to enable mushroom (fruiting body) to grow. Water should be from an uncontaminated source and watering should be carried out depending on the humidity level of substrate and the environment. However, care should be taken to prevent the water from collecting at the base as it could lead to disease development.

Harvesting

After the mushroom fully



develops, harvest the mushroom without causing damage to the substratum. Oyster mushrooms are harvested when the fruiting body becomes curled under the edges and gills are well-formed. Hand picking is not encouraged as it damages the cap of the mushroom. Harvesting is done with a sharp tool such as knife.

Resting

After the first harvest, the substratum should be stored in cool and dry place for about 10 to 15 days for resting after which it can be made to sprout again by watering (flush). There can be about 3rd to 4th flush after which the substratum can be thrown away or used as manure. The size of the substratum will keep on decreasing after each flush as it is consumed by the mycelium.

Pest and disease management

Oyster mushrooms are generally very prone to pests and diseases due to inattentiveness and the incorrect management practices.

There are many good cultural management practices which can be adopted for organic mushroom production which include:

- Good sanitation practices
- Use of disease and pest free substrates
- Sanitation of equipment and tools after every use
- Keep the shed free from any infected mushroom debris
- The cultivation shed should not be over wet and humid
- The cultivation shed should not be over dry in wet seasons
- Allow good ventilation in the shed
- Proper watering methods and amounts
- The surroundings of the shed should be cleaned
- Workers should stay clean
- Prevent entry of the flies in the shed
- Avoid exposure of substratum to direct sunlight
- Sterilise the shed
- Remove infected bags

Source: Department of Agriculture

e-RNR Crop Advisory

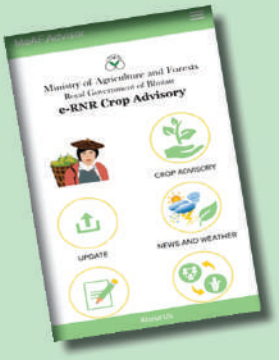
A one-stop platform for farming

What is e-RNR Crop Advisory?

The e-RNR Crop Advisory is a mobile app with easy access to repository of instructions on agricultural practices. It was launched on 4 November 2020. The information is shared through textual, picture and video contents.

Who are the targeted audience?

1. The app is targeted for the Bhutanese youths to help them take up farming for their livelihoods.
2. It can be also used by urban dwellers to start kitchen gardens.



What are the features?

1. The app disseminates information on **technical know-how of growing various crops** starting from nursery management to the harvesting.
2. It features useful **farming tips including the tutorial videos** for interested individuals to help them with crop management.
3. It highlights the **crop calendar** displaying information on planting, sowing and harvesting periods of crops in specific agro-ecological zones.
4. The app links to the websites of the **market price information** (http://www.agrimarket.gov.bt) and the **weather forecast** (https://www.nchm.gov.bt).

How to install the app?

Please visit the link to know: https://youtu.be/16VQAUcjfVw

Where to access the app and contents?

1. The app is available on Google playstore for download.
2. The contents can be also accessed on the Ministry's YouTube channel at https://www.youtube.com/c/MoafGovBt

Who are the development partners?

The app content is developed by Information and Communication Technology Division in collaboration with the Department of Agriculture and the Agriculture and Research Development Centres at Yusipang, Bajo and Wengkhar with the financial support from EU-TACS project, funded by the European Union and implemented by DAI. The technical support for the app was provided by Sunrise Computer Software Pvt. Ltd in Pune, India.

Published by Ministry of Agriculture and Forests
Website: www.moaf.gov.bt | Email: ictd@moaf.gov.bt

Funded by the European Union

Project implmenented by DAI human dynamics