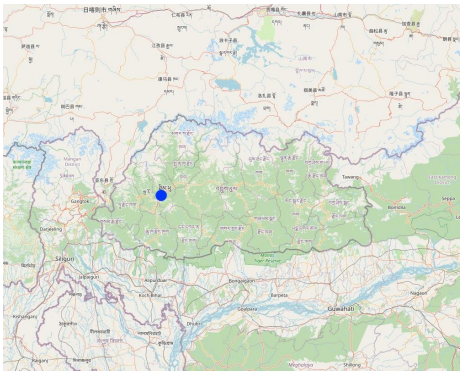
The photo is from the Official Facebook page of Desuung (Guardians of Peace) taken during the launch of the million fruit trees plantation and geocoding that followed after a year. (Desuung Facebook Page)

Geocoding of Million Fruit Trees for Monitoring and Tracking ( )

Shingdrey Changm Saya Zukchong Tatok Gi Dhoen lu Sa Chhai Dhadhoen Dhulen (ཤིང་འཐས་ལྕངམ་ས་ཡ་འཛུགས་སྐྱོང་བལྟ་རྟོག་གི་དོན་ལུ་ས་ཆའི་བརྟ་དོན་བསྟུ་ལེན།)

Geocoding of fruit trees allows remote monitoring and progress tracking of the growth of seedlings. The Smart App MoDA (Mobile Operation and Data Acquisition) is used in geocoding.

Geocoding of the “million fruit trees” initiative has been carried out across Bhutan. Different fruit trees suitable for particular agroecological zones were planted in farmers' fields in twenty districts and each sapling was geocoded.
The main elements of geocoding fruit trees involve assigning unique geographical codes or coordinates to individual trees within an orchard, utilizing technical specifications and equipment such as handheld GPS to accurately determine the location. The potential benefits of this form of geocoding include:
1. Location Mapping: Geocoding allows fruit trees to be accurately located on a map, providing a visual representation of their spatial distribution. This mapping can help identify patterns, clusters, and gaps in tree distribution.
2. Data Integration: Geocoded data can be integrated with geographic information systems (GIS) and other data sources, such as climate data, soil information, and topography. This integration provides a holistic view of the factors influencing fruit tree growth and productivity.
3. Precision: Geocoding provides precise coordinates for each fruit tree, enhancing the accuracy of data collection and analysis. This precision is crucial for making informed decisions regarding tree management and resource allocation.
4. Monitoring and Management: Geocoded fruit tree data enables efficient monitoring of tree health, growth, and potential issues. It facilitates targeted interventions, such as irrigation, fertilization, and pest control, based on the specific needs of individual trees or clusters.
5. Yield Estimation: By combining geocoded data with relevant environmental and growth information, it's possible to estimate the potential fruit yield in specific areas. This information aids in resource planning and harvest predictions.
6. Disease and Pest Management: Geocoded data can help identify patterns of disease or pest infestations. Early detection through geocoded monitoring can enable prompt intervention and prevent the spread of pests or diseases.
7. Biodiversity Analysis: Geocoding allows researchers to study the diversity of fruit tree species in different regions. This analysis can be useful for conservation efforts and understanding the ecological impact of specific tree species.
8. Research and Analysis: Geocoded fruit tree data serves as a valuable resource for scientific research. Researchers can study the effects of climate change, urbanization, and land use changes on fruit tree populations and ecosystems.
9. Decision-Making: Geocoded data assists farmers, agricultural agencies, and policymakers in making informed decisions about land use, tree planting initiatives, and resource allocation for sustainable agriculture.
10. Community Engagement: Geocoded maps of fruit trees can be shared with communities, promoting awareness of local resources, fostering community engagement, and encouraging initiatives like urban orchards or community gardens.
11. Data Visualization: Geocoded data can be visualized using maps and spatial tools, making it easier to interpret and communicate information to various stakeholders.
12. Long-Term Tracking: Geocoded data allows for long-term tracking of changes in fruit tree populations, aiding in the assessment of the success of planting initiatives and the overall health of the environment.
The major activity of the technology is marking the fruit trees with the help of GPS so that these geocoordinates can be useful in tracking down the exact location of the plant. Geocoding is labour-intensive as the field workers need to be physically present in the field while carrying out the activity. Then the data recorded in GPS is transferred to the computer and analyzed using ArcGIS. This information is available to the policymakers and Agriculture



: Sigay Chiwog, Mewang Gewog, Thimphu Dzongkhag,

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: 2022

(> 50)

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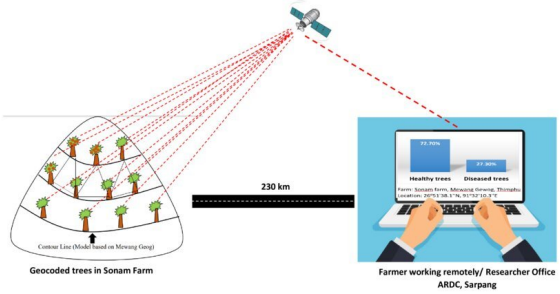
officers and is shared with the Extension Agents through which it is disseminated to the land users.

The photo was taken with the field extension supervisor. (Aum Tshogpa of Sigey Chiwog)

The technical drawing represents the general method of million fruit tree plantation and geocoding done on each tree. It depicts how geocoding enables the researcher or farmer to remotely check the health of the trees using satellite data. ARDC stands for Agriculture Research and Development Center.



Note: Diseased Trees: Trees with brown spots, **Healthy Trees:** Green tree

Technical Drawing of the Geocoding of Million Fruit Trees for Monitoring and Tracking

Author: Nima Dolma Tamang, Singye Dorji, Tshering Gyeltshen

- (**No of Seedlings** volume, length: **8000 seedlings (Only in Mewang Geog)**)
- **Ngultrum (Bhutanese Currency)**
- ( ) 1 USD = 82.62 Ngultrum (Bhutanese Currency)
- 800

Most important factors affecting the costs are seedling and labour cost.

1. Meeting between Gewog leaders and land users (/ : NA)
2. Identified a village for planation (/ : NA)
3. Identified households that wanted the seedings and number of seedlings (/ : NA)
4. Site identification (/ : NA)
5. Orchard layout (/ : NA)
6. Pit digging (/ : NA)
7. Plantation (/ : March- April)
8. Basin making (/ : After planation)
9. Geocoding (/ : After one month of orchard establishment)
10. Growth Tracking (/ : After every six months)

			(Ngultrum (Bhutanese Currency))	(Ngultrum (Bhutanese Currency))	%
Desuup (Guardians of peace) - Volunteers	Person-days	6,0			
Farmers	Person-days	10,0	800,0	8000,0	100,0
Shovel	No.	10,0			100,0
crow-bar	No.	5,0			100,0
Spade	No.	20,0			100,0
GPS remote	No	6,0	12000,0	72000,0	
Tabs/ mobile phones	No.	6,0	15000,0	90000,0	
Apple	No.	3500,0	70,0	245000,0	
Walnut	No.	1000,0	120,0	120000,0	
Almond	No.	500,0	120,0	60000,0	
Peach	No.	1000,0	70,0	70000,0	
Pear	No.	2000,0	70,0	140000,0	
Manure and fertillizers	Metric Tonnes	16,0	1600,0	25600,0	100,0
				830'600.0	
				10'053.26	

1. Weeding (/ : Twice a year)
2. Fertillizer application (/ : Twice a year)
3. Irrigation (/ : Once a week)
4. Replacement of dead plants (/ : After 6 months from plantation)
5. Growth tracking (/ : After every six month)

			(Ngultrum (Bhutanese Currency))	(Ngultrum (Bhutanese Currency))	%
Weeding and fertilizer application	Per year	4,0	1600,0	6400,0	100,0
Irrigation	Litres				
Geocoding	per plant	8000,0			
Replacement of plants	per plant	10,0	70,0	700,0	
				7'100.0	
				85.94	

< 250
251-500
501-750
751-1,000
1,001-1,500
1,501-2,000
✓ 2,001-3,000
3,001-4,000
> 4,000

2076.0

The rainfall data for Mewang Gewog is not available. The provided data is for Thimphu Dzongkhag as Mewang Gewog is under Thimphu Dzongkhag (Gewog is one of the geographic units below Dzongkhag). Thimphu falls under a temperate region and experiences minimal rainfall compared to the other parts of Bhutan. Thimphu had the wettest month in July with 497 mm and experienced the least rainfall in December with 5 mm.

National Center for Hydrology and Metoerology, Thimphu.

There are six Agro-ecological Zones (AEZ) in Bhutan and the current place of study falls under warm temperate zone which occurs between 1,800 – 2,500 m. Rainfall is low but the temperature is moderately warm in summer with frost in winter.

(0-2%)
✓ (3-5%)
(6-10%)
(11-15%)
(16-30%)
(31-60%)
(>60%)

0-100
101-500
501-1,000
1,001-1,500
1,501-2,000
2,001-2,500
✓ 2,501-3,000
3,001-4,000
> 4,000

✓ (0-20)
(21-50)
(51-80)
(81-120)
(> 120)

( )
/ ( )
✓ (,)
/ ( )

(> 20)
/ ( )
✓ (,)
/ ( )

(>3%)
✓ (1-3%)
(<1%)

< 5
5-50
> 50

✓
/

( )
✓
( )

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/
✓
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✓

SLM

10%
10-50%
50%

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(,)

< 0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
> 10,000

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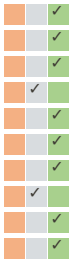
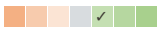
Internet

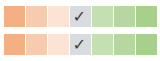


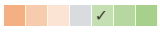
The drinking water is insufficient as some households face scarcity of drinking water.



The technology aids in the monitoring and improves health and ease management of the already established orchard. Therefore, it indirectly increases crop production.

Remote or constant monitoring ensures timely management to prevent biotic and abiotic factors deteriorate the crop quality.





Geocoding enables land user to determine potential risk so that the land user can use appropriate methods to prevent crop failure.

The technology is not directly related to the product diversity. However, it provides data on existing fruit tree diversity so that the land user can plan and plant different fruit trees based on the market need which indirectly increases diversity.

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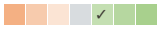
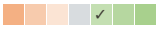


Geocoding enables the land user to remotely view the cropped area and the area where the crop failed (could be due to dying of the seedlings/diseased). It enables the land user to narrow their focus on the specific area, learn about

		the issues causing the crop loss, provide appropriate management, and conduct plantation in that area which indirectly increases production area.
		Due to increased production area with no increase in the quantity of irrigation water, water availability is likely to reduce.
		There is increased demand for irrigation water for new plantations. However, with the use of technology land users can monitor the water requirement and use efficiently based on the need of the tree whereby the land users can avoid watering the trees that require less water and provide to those that require more water.
		Minimal increase in expenses on agriculture inputs as planting materials (except manure) were provided to the land users for free of cost.
		Once the fruit trees starts bearing fruits, income is expected to increase.
		The technology is expected to reduce economic disparity by providing equal opportunity for the land users to generate income.
		Workload for the project implementors or land users are significantly reduced as they need not go to the actual site to determine the progress of the Million Fruit Trees Plantation Project.
/		
		The technology indirectly aids in the increased production making an individual land user and the nation self-sufficient in fruits.
		With reduced workload, land users can engage in recreational activities.
SLM /		
		The technology will enable the project implementors to determine specific knowledge gaps and provide training in that particular field to the land users. Improving knowledge of both project implementors and land users.
( )		Land users willing to be involved in fruit tree plantation are supported without discrimination of their social status or economic background and geocoding services are provided. This leads to the improved situation of socially and economically disadvantaged groups.
		The total water quantity remains same. However, the available water per tree or sapling is reduced.
		Due to the absorption of water by the roots of the fruit trees, surface run-off is decreased.
		Evaporation will be decreased due to an increase in the vegetation cover from the plantation of the fruit trees.
		Slight increase in the soil moisture in long run due to addition of soil organic matter and monitored irrigation.
		The technology enhances easy monitoring of the trees and encourages increased soil cover.

The technology enhances soil cover reducing the soil loss from erosion.

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Geocoding enables the land user to have overview of the nutrient content of the production area aiding land users to add nutrient based on the need.

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Generally, there will be an increase in the soil organic matter due to an increase in production area and management practice such as the addition of manures by the land user.

Increase due to the scheduled irrigation applied to the fruit trees.

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Slight increase due to proper management and care provided to the orchard.

Animal diversity in the case of pollinators such as bees increases as the fruit trees mature and start flowering.

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Beneficial species such as bees are attracted to the orchards.

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Pest and diseases control improves with the use of remote monitoring facilitated by this technology.

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Once the fruit trees establish themselves, landslides can be reduced significantly due to vegetation cover.

This technology could potentially reduce greenhouse gas as trees utilize carbon dioxide for photosynthesis.

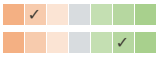
In the long run, a well-established orchard can act as a windbreak and reduce wind velocity and damage it poses to the property.

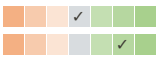
An orchard can act as a micro-climate harbouring many plants and insect species.

(-springs)

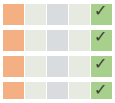
Fruit trees require irrigation which reduces the availability of water for other purposes.

Having a land cover with vegetation compared to barren land reduces greenhouse gases.





Although the initial establishment of the orchard is costly considering the labour charge, it is expected to have positive income and impact once the fruit trees start bearing.



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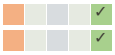

/

1-10%
11-50%
> 50%

?

0-10%
11-50%
51-90%
91-100%

/

Total 8000 fruit trees are planted in the five Chiwogs (third level administrative division under Gewog) under Mewang Gewog.

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( )

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- 1. Precision Mapping: Geocoding allows for accurate mapping and identification of fruit trees. By assigning specific geographic coordinates to each tree, it becomes easier to locate and monitor individual trees or orchards.
- 2. Efficient Resource Allocation: Geocoding helps optimize resource allocation by providing information on tree density and distribution. Land users can identify areas with high fruit tree concentrations and strategically allocate resources such as labour, water, fertilizers, and pesticides, leading to improved productivity and reduced costs.
- 3. Data-driven Decision Making: Geocoded data on fruit trees can be analyzed to gain insights into their distribution patterns, growth rates, and health status. This information enables land users, researchers, and policymakers to make informed decisions regarding fruit tree cultivation, pest control, and disease management.

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- 1. Conservation and Biodiversity Analysis: Geocoded fruit tree data aids in the conservation and analysis of biodiversity. By mapping the locations of different fruit tree species, experts can assess the distribution and abundance of specific varieties, identify endangered local or traditional landraces varieties, and develop strategies for their preservation.
- 2. Targeted Marketing and Distribution: Geocoded fruit tree data facilitates targeted marketing and distribution strategies. By understanding the location of fruit trees and their yields, producers can identify potential markets and plan transportation logistics more effectively, minimizing waste and ensuring timely delivery to consumers.

/ / :

- Geocoding large numbers of fruit trees can be a time-consuming and resource-intensive task, particularly when manual processes are involved. It may require extensive fieldwork and manual data entry, making it impractical or costly for large-scale fruit tree inventories.
- Privacy Concerns: Geocoding fruit trees raises privacy concerns, particularly when tree locations are associated with specific individuals or properties. Care must be taken to ensure that privacy is respected and sensitive information is appropriately handled An updated and secured security-protected website can be used.
- Lack of knowledge of geocoding by the farmers. Provide awareness trainings

/ / :

- The higher expense of the geocoding in terms of labour cost for geo-coding Train land users on geocoding, instead of using trained professionals.
- Difficult to constantly update information on time.

Editors

Nima Dolma Tamang | Haka Drukpa | William Critchley, Rima Mekdaschi Studer, Joana Eichenberger

: 6 2023 : 30 2024

Thuji Penjor - Agriculture Extension Officer

https://qcat.wocat.net/km/wocat/technologies/view/technologies_6829/

SLM

- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) -
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

- De-suung National Service (DNS). (n.d.). Million Fruit Trees Plantation: https://desuung.org.bt/25978-2/#:~:text=In%20order%20to%20monitor%20the,from%20the%20date%20of%20plantation.
- Million Fruit Trees Plantation Initiative launched: http://www.bbs.bt/news/?p=166763
- Kuensel. (2022). Million Fruit Trees Plantation Initiative launched. Thimphu.: Website: https://kuenselonline.com/414000-fruit-trees-planted-in-45-days/
- Geocoding of trees from street addresses and street-level images: https://www.fs.usda.gov/psw/publications/vandoorn/psw_2020_vandoorn001_laumer.pdf