APCAS/24/A4.2

SIDE EVENT A:

Bhutan Experiences with
EO Data

A4.2: **Evidence based on the validation exercise of the area under paddy cultivation using three different measurement techniques**

Farmer Self-reported (FSR),
Global Positioning System (GPS),
Earth Observation (EO)"

Presenter: Rinchen Dorji

About Butan

Bhutan: is a developing economy country

Located : Between India to the south and China to the north

Country's population :
stands at 770,276 in 2024

GDP Contribution :
In 2022, agriculture, livestock and forestry sector contributed 14.67%

Background Information

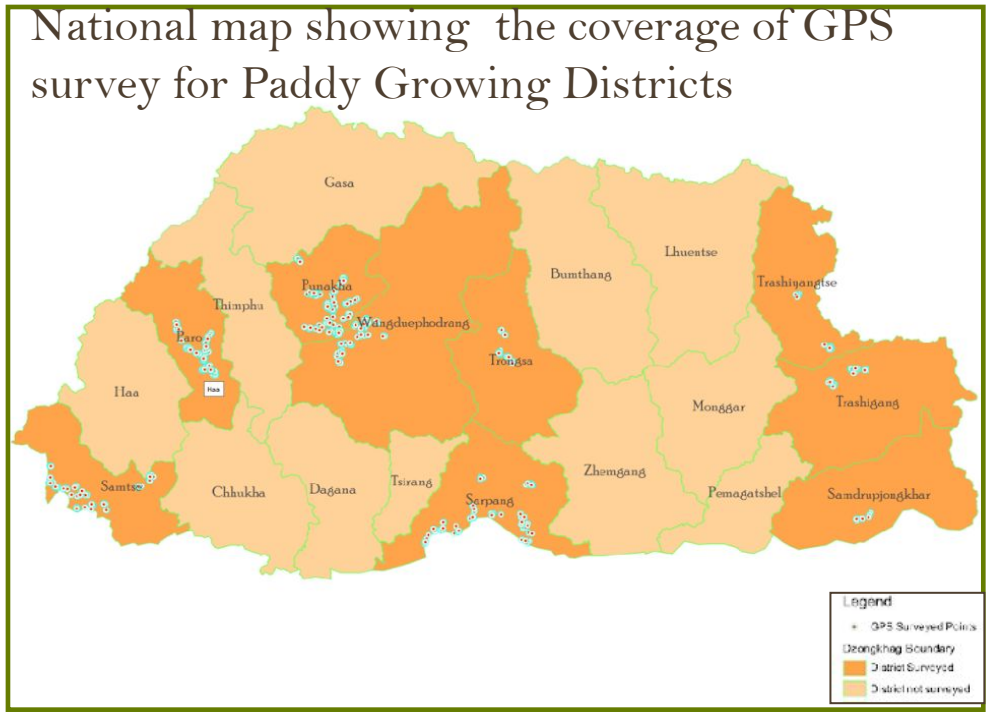
Lead Ministry/Agency	National Statistics Bureau
Policy mandate	Food Self Sufficiency
Legislative mandate (if any)	A person cannot own more the 25 Acers of land in his/her name
Stakeholders involved	Dzongkhag Administration (Agri. Extension), Local Leaders and Farmers
Interagency collaborations	Department of Agriculture, MoAL
Privacy legislation	Person have right to sell the land, if it is (Thram) registered in his / her own name(Self)
Privacy considerations	Protection from Intrusion: Safeguarding individuals' privacy rights against unauthorized intrusion onto private property, including regulations governing surveillance activities and restrictions on access to private land.

Background Information (cont.)

Satellite imagery source(s)	Google Earth Images(On line) .World View -3, GeoEye-1 (NLC)
Type of imagery used (optical, SAR, etc.; including satellite system)	Optical images of World View -3, GeoEye-1
Spatial and Temporal resolution	31cm (8band) , 41cm (4 band). Every Two Days, Dec2022
Ancillary data	Paddy Plot Shape file, National, Dzongkhag and Gewog Boundary from National land commission Bhutan, IALC 2022 & 2023 paddy grower Household, NSB.
Data processing (infrastructure on-site or cloud-based)	QGIS 3.32.3. on –Site, Garmin GPS, Gaia GPS- App, Google earth pro App
Area covered by EO data analysis (national/sub-national)	Sub-National (Area of Interest)

Background Information [cont.]

Crops covered	Paddy (Chhuzhing)
Statistics produced (ex. Crop type mapping, area estimation)	Crop area /Yield
Frequency that statistics are produced	1 time
Dissemination of statistics	NSB
Size of geospatial team	6
Roles in geospatial team	Paddy Field Survey using GPS, Downloading ,Editing and Analysis



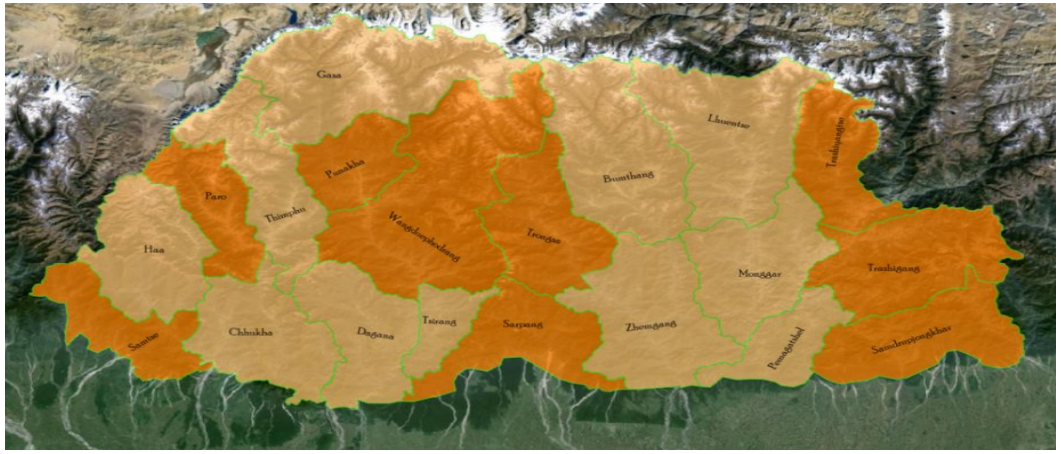
Ground truth data

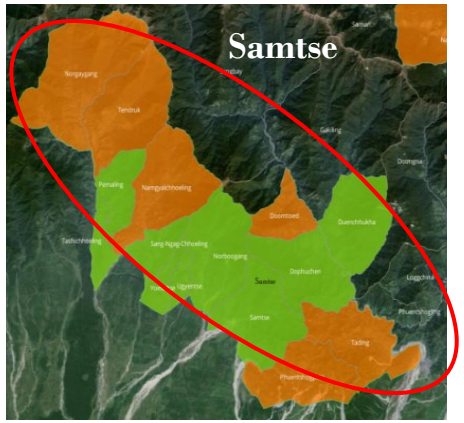
Data/survey source	National Land Commission for Spatial Data, Census and Survey data from NSB
Lead agency	National Statistics Bureau
Sampling approach	The convenient sampling method was Adopted for sample selection.
Data collection approach	◦ Selected 10 to 11 HH paddy growers from every gewog (IALC 2022 and 2023 census). ◦ surveyed 1496 plots of 595 households in 128 chiwogs across 57 different gewogs in nine dzongkhags. ◦ Field measurement using Garmin GPS.
Variables collected	HH Demography, Area cultivated and Production produced.
Frequency of data collection	One time every Dzongkhag

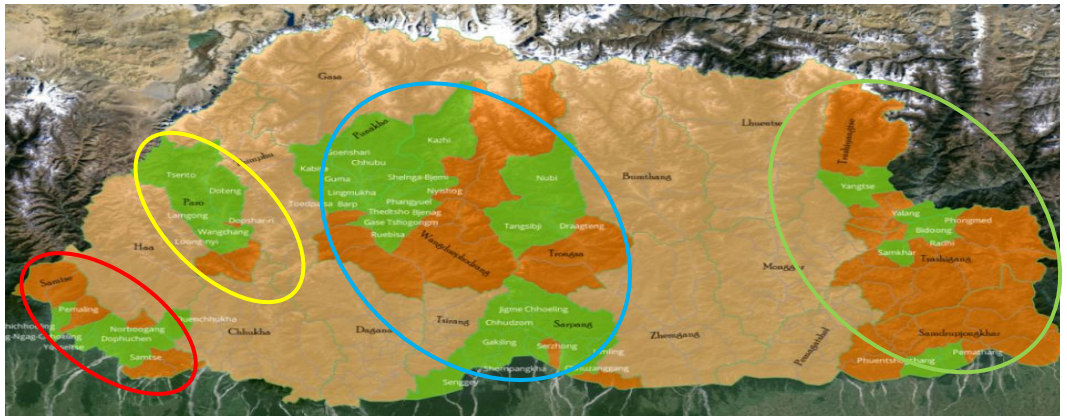
Objective of Study

- Validate the farmers self-reported paddy cultivated area collected through the census against the actual area
- Scale up the use of technologies to promote data efficiency, reliability, reduce data collection costs and increase frequency and Geographic granularity of the statistics produced relative to pure survey-based data collection.
- To raise awareness and strengthen the application of GIS, GPS and RS technology in survey and Census data collection processes

Plot Location Map







Districts surveyed

Districts Not surveyed

Sub- Districts surveyed

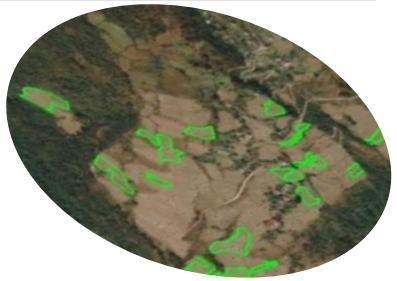
Data Capturing Process

1: Conduct Training

2: Field Enumeration

3: GPS HH Location

4: GPS Survey



5: GPS Surveyed Plots

6: Shift in GPS Data

7: Adjust & Area Calculation

8: Digitizing over Google Image & Area calculation

9: Survey Covered Area Map

Statistical Finding

1. The farmers' self-reported bias relative to GPS measures is significant either in levels or log of area

2. The findings indicate that the magnitude of farmers' self-reporting bias varies across dzongkhags with the largest magnitude of farmers' self-reporting bias in Punakha, Samtse ,Wangdue Phodrang, Trashigang and Trongsa dzongkhags

3. There is over-reporting for smaller sized plots and under reporting for larger sized plots

4. There is no significant difference between GPS and Google (remotely sensed satellite data)

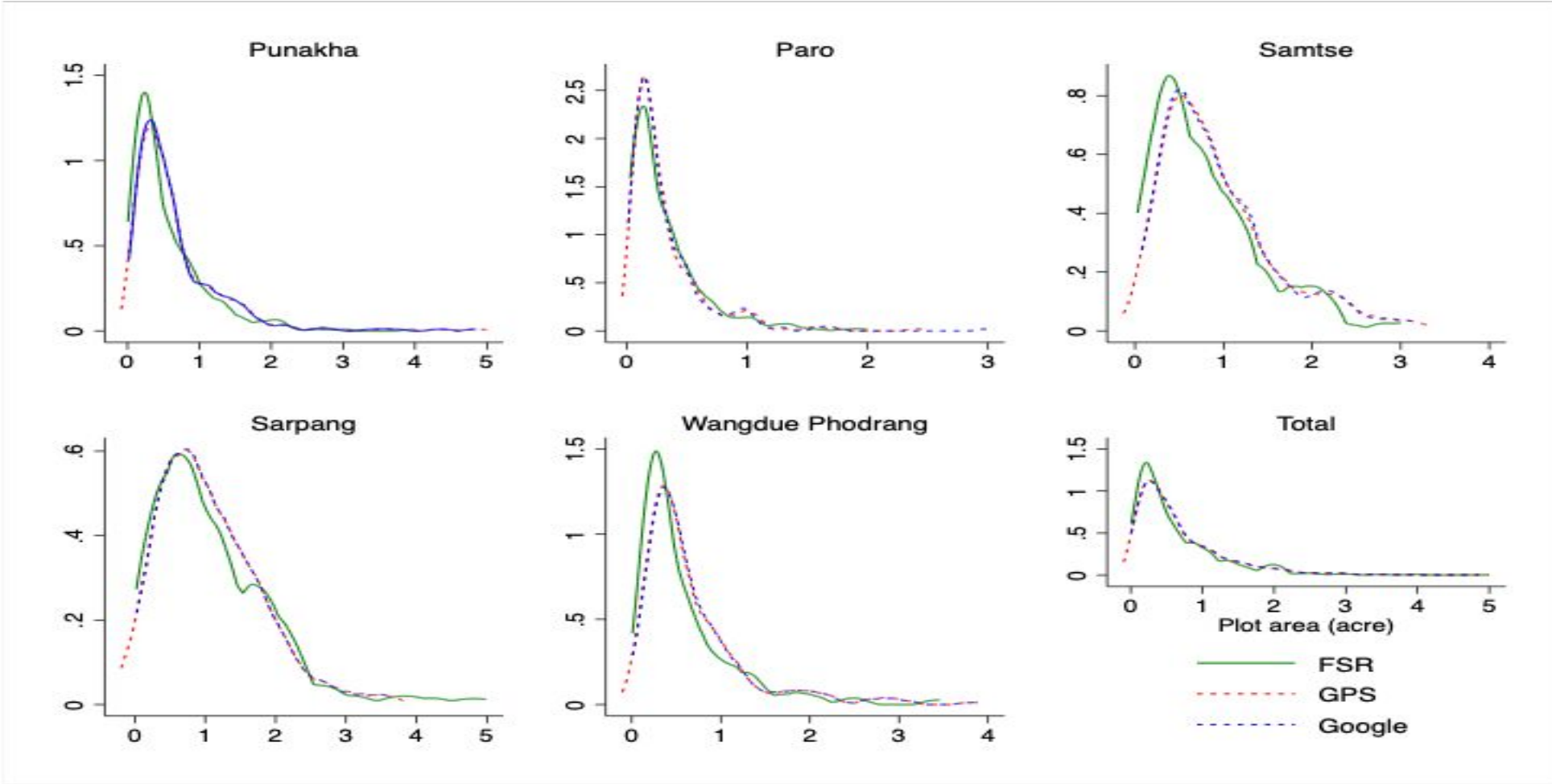
IALC & GPS Survey

Table 1. Abstract of the difference in area noted between 2022 and 2023 IALC and GPS survey

Dzongkhag	Gewog	Chiwog	Total HHs interviewed	Total Plots measured by GPS	Area 2022IALC (Acre)	AreaGPS survey (Acre)	Difference in Area (Census-GPS)	Statistical Significance (5% level)
Paro	7	22	67	275	86.62	88.82	(2.20)	0.68
Punakha	11	28	109	333	132.78	171.93	(39.15)	0.0005***
Samtse	10	18	105	151	121.25	141.02	(19.77)	0.0104***
Sarpang	11	27	123	212	200.03	197.26	2.77	0.69
Wangdue Phodrang	7	18	79	230	134	155.05	(20.96)	0.0085***
Samdrup Jongkhar	2	3	19	21	34.14	28.69	5.45	0.32
Trashigang	4	6	42	147	34.49	68.66	-34.17	0.0000***
Trashi Yangtse	2	2	20	64	20.91	26.52	-5.61	0.057
Trongsa	3	4	31	63	28.25	45.96	-17.71	0.02***
Total	**57**	**128**	**595**	**1496**	**792.55**	**923.9**	**(27.27)**	**0.0000*** **

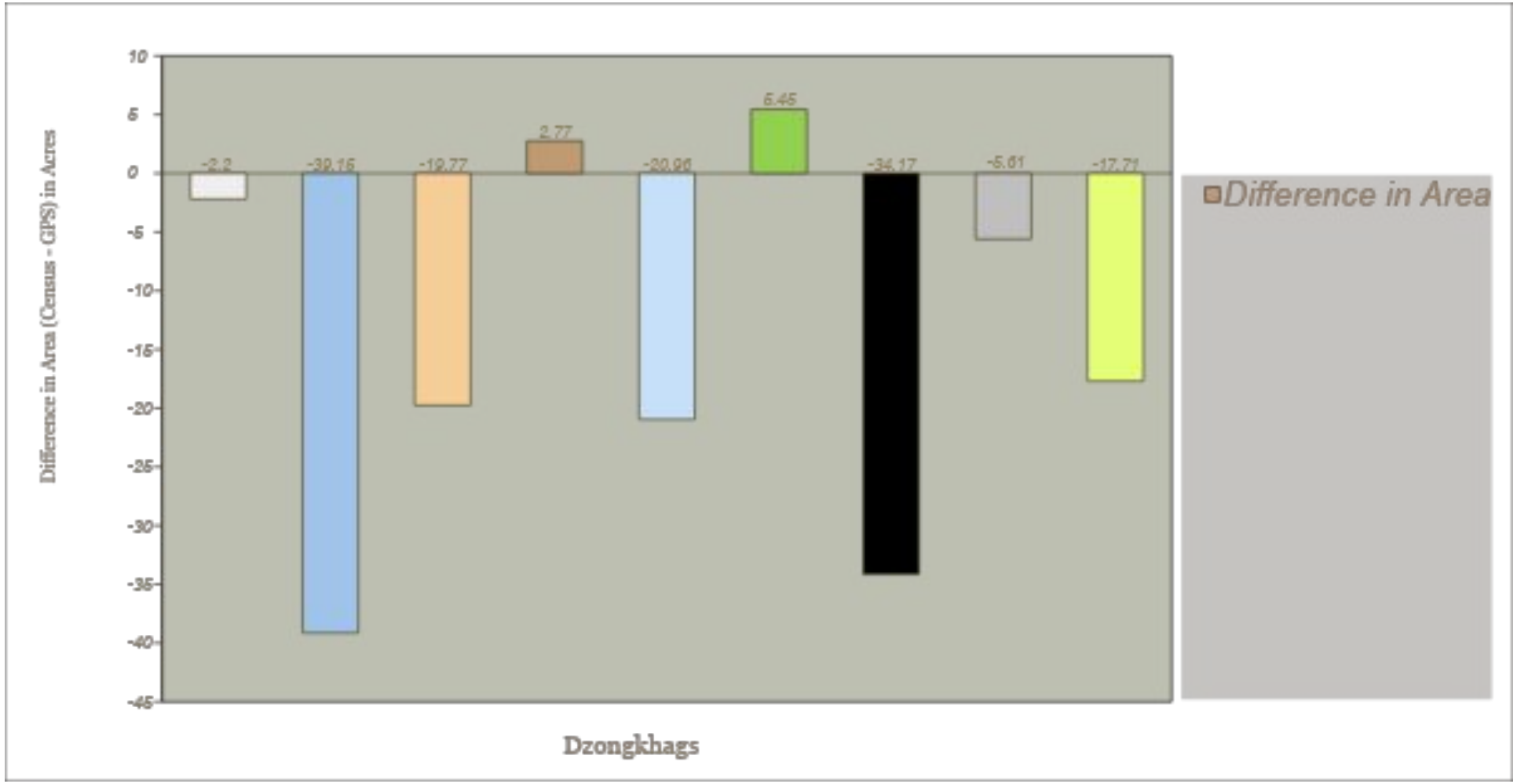
Kernel Density Plot

Kernel Density of plot area by three different measures



Difference in Report

Farmers self reporting vs. GPS measurement



Potential Factor for the Observed Difference

- ✔ Several respondents lacked accurate knowledge regarding the actual area of paddy cultivation they had planted, resulting in reported figures being estimations rather than precise measurements.

- ✔ Various Non-Standard Measurement Units (NSMUs) like Zhikha chig, langdo, Soen-drey , half-day plough by tractor/power tiller/mini power tiller, utilized based on locality. These NSMUs have introduce reporting biases due to their diversity and lack of standardization.

- ✔ The failure of respondents to report the leased-in areas.

Potential Factor for the Observed Difference

- ✔ The respondents lack data literacy
- ✔ Data-literate individuals are often overwhelmed with additional data collection tasks from both government entities and researchers.
- ✔ In certain instances, during survey or census respondents may withhold accurate information, despite being aware of it, for various reasons.
- ✔ Often interviews are conducted with individuals who are not directly responsible for agricultural activities.

Limitations

a) Farmers' availability to accompany the team to visit the cultivated plots due to their engagements. This posed a challenge during the GPS survey as some plots were dispersed over a considerable distance.

b) Agriculture lands in the country are smaller and fragmented and often located far from the place of residence. For instance, some holders reside in location 'A' while their cultivated paddy plots are in location in location 'B'.

Limitations

c) Although, the difference in area was observed for certain dzongkhags between the 2022 and 2023 IALC and the GPS survey, the area difference couldn't be incorporated as study was limited to nine dzongkhag. Consequently the sample size was inadequate enough for making statistical adjustments at the national level census report.

d) Due to resource and manpower constraint, the intensive ground truthing or field validation for whole country was not possible at one time period.

Recommendation

- NSB should continue with the similar exercise in the remaining dzongkhags to determine the actual difference in the area under paddy cultivation.

- The difference noted for area under paddy cultivation between the 2022 and 2023 IALC and GPS study from nine dzongkhag may not give enough evidence to statistically adjust for now in the census data due to inadequacy of the sample size

Tashi Delek

Thank you!