Guidebook 2018

Planning and Designing of Crop Production Survey

"Let's estimate the total rice production in Tsukuba Hamlet"

22 - 29 August 2018

JICA Knowledge Co-Creation Program on
Agricultural Statistics Planning and Designing
JICA Tsukuba International Center

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Planning and Designing

of

Crop Production Survey

"Let's estimate the total rice production

in Tsukuba Hamlet"

Dear distinguished participants,

It is my pleasure to welcome you to the lecture titled “Planning and Designing of Crop Production Survey”. I would be glad if I could share the idea of crop production survey with you.

Your mission for this training is to estimate the total rice production in Tsukuba Hamlet. In order to accomplish your mission, you learn crop production survey which consists of a planted area survey and a yield survey.

Concerning a planted area survey, the Dot Sampling Method using Google Earth has been developed so that you can estimate a planted area of certain crops easily and efficiently in a target area. In order to apply the Dot Sampling Method to an area survey, the Excel Macros have been developed to put any number of sample dots on Google Earth easily. Though planted area survey has long been a bottleneck to implement production survey so far, the Dot Sampling Method has removed the obstacle all at once.

Lastly, I would like to stress an importance of an actual measurement method. In case of an actual measurement method, a survey object is not a farmer but a field. Many of you may use a hearing method where a survey object is a farmer. A hearing method is popular, but it has a week point: the data you get from a farmer don’t show the real situation, as a farmer often doesn’t know the actual values. In this case, you cannot evaluate a validity of the data.

The training lasts 6 days from August 22 to 29, 2018. On August 29, you are supposed to make a presentation on what you have learned during the lecture including purposes, activities and output.

I would like you to enjoy the lecture. I am glad if this Guidebook 2018 helps you learn “Planning and Designing of Crop Production Survey”.

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Contents

Chapter 1 Expected Daily Output of the Training

In this chapter, you know the schedule of the lecture and learn the expected daily output of the training.

The table below shows the expected daily output of the training:

August	Output
22 **(Wed)**	1) You understand the daily output of the training. 2) You use the Excel Macro for the Dot Sampling Method. 3) You understand the formula: Production = Average yield x Total planted area. 4) You understand the concept of an attribute survey and a rice planted area survey using the Dot Sampling Method.
23 **(Thu)**	1) You conduct a preparatory survey of a rice planted area survey using the Dot Sampling Method. 2) You conduct a field survey of a rice planted area survey using the Dot Sampling Method.
24 **(Fri)**	1) You compile the results of the rice planted area survey. 2) You understand the concept of a rice yield survey and prepare for a rice yield survey such as preparing equipment and making questionnaires.

27 **(Mon)**	1) You conduct a rice yield survey. 2) You compile the results of the rice yield survey.
28 **(Tue)**	1) You compile the results of the rice production survey. 2) You make a report of the rice production survey. 3) You conduct a preparatory land use survey in your country using the Dot Sampling Method.
29 **(Wed)**	1) You make a presentation on a preparatory land use survey in your country using the Dot Sampling Method. 2) You make a presentation on your output during the lecture. Note: In order to prepare for your presentation, it is useful for you to summarize what you learned every day, using the forms explained in 7.2, Chapter 7.

Chapter 2 Putting Dots on Google Earth

In this chapter, you learn how to put dots on Google Earth using the Excel file named “LL Sheet for the dot sampling” which includes Excel Macros.

The Excel file has been developed for the Dot Sampling Method to put dots systematically on Google Earth.

At the beginning, you can enjoy putting dots systematically wherever you like on Google Earth, even if you don’t know the Dot Sampling Method.

2.1 Preparation in advance

Item	Remark
1) Google Earth	Make sure that Google Earth has been installed in your computer.
2) Decimal degree	Make sure geo-coordinates in Google Earth are displayed in decimal degrees, not in degrees, minutes, seconds.

Note: In order to convert coordinates to decimal degrees,

Click on “Tools” on the Google Earth menu bar.

→ Click on “Options” at drop down list.

→ Select “Decimal Degrees” in the “3D View” tab.

2.2 Let’s save the Excel Macro File to your computer

You prepare your computer with the Excel Macro file of “LL Sheet for the dot sampling” by saving it to your computer.

2.3 Let’s open “LL Sheet for the dot sampling”

You open the file of “LL Sheet for the dot sampling”.

Note: Make sure to enable macro in the Excel file on your computer, as you may not be able to run macro because of security setting of your computer.

LL Sheet for the Dot Sampling

1. Fill in blank cells on T-1 Table below

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)	Interval in km (depend on (3))	Necessary Number of Lines	Necessary Number of Rows	Index of Line on the work sheet.	Index of Row on the work sheet.	Area per Dot (km^2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=√((2)/(3))	(9)	(10)	(11)	(12)	(13)=(2)/(3)

1-(1) Click here to check data in T-1

2. Sampling based on the "Sampling design"

2-(1) Click here to complete T-2 table

2-(2) Click here to make a KML file

T-2 Sample dots (Coodinate Values)

Don't change the numbers on yellow cells because the numbers are used for the calculations.

	Name of Longitude → Latitude ↓	0	1
0	0,		
1	1,		

2.4 How to fill in the T-1 Table

You fill in the T-1 Table as follows:

T-1 Basic data to generate sample dots (Sampling Design)

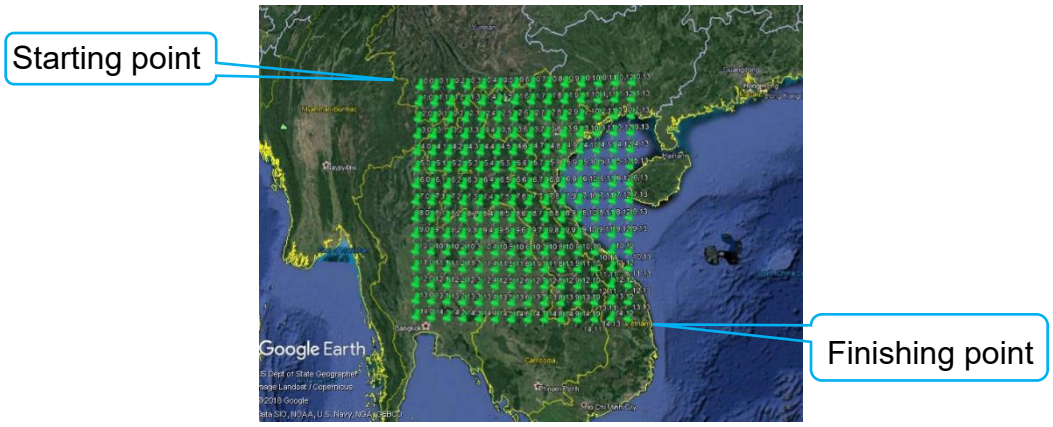
Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)

File name

Density of dots

Starting point

Approximate finishing point



Cell	Explanation	Remarks
(1) File name	appropriate file name to save	
(2) Size of Target Area	total area of a target region	Given area and the number of dots determine the dot density.
(3) Sample size	the number of sample dots you want to put in a target region	
(4) Starting point (latitude)	any latitude to the north of the target region	These figures indicate coordinates of starting point.
(5) Starting point (longitude)	any longitude to the west of the target region	
(6) Finishing point (latitude)	any latitude to the south of the target region	These figures roughly indicate coordinates of finishing point.
(7) Finishing point (longitude)	any longitude to the east of the target region	

Note1: As for latitude and longitude, you need to use decimal degrees.
Note2: Use minus figures in case of south latitude and west longitude.

As for (2) and (3), you also adopt the alternative style below.

Cell	Explanation	Remarks
(2) Size of Target Area	unit of area such as: 1 km^2, 0.01km^2	Using this style, you can put one dot per unit of area.
(3) Sample size	the number of dots per unit of area	

Note1: A purpose of inputting values of (2) and (3) is to determine dot density or the number of dots per unit area.

Note2: Values from (4) to (7) determine a rectangle shape of range for putting dots which covers all area of a target region. Values of (4) and (5) provide coordinates of northwest starting point of systematic sampling, and values of (6) and (7) provide coordinates just before southeast ending point.

Note3: Dots are to be put into rectangle form in a range surrounded by input latitude and longitude.

Note4: The number of dots which are fallen in a target region defined in (2) is almost as same as the number of dots defined in (3) with high probability, though it depends on the starting point of systematic sampling.

2.5 Let's put dots on Google Earth

2.5.1 Let's put sample dots on a target region on Google earth

Suppose you want to put 100 dots in Lao PDR, you fill in T-1 Table as below.

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Laos100	*238000*	*100*	22.52	100	13.88	107.72

After finishing filling in cells, you only click on the buttons. Then Google Earth begins to work and dots will appear on Google Earth automatically.

Note: In some cases, you have to draw a boundary line of the target region on a map.

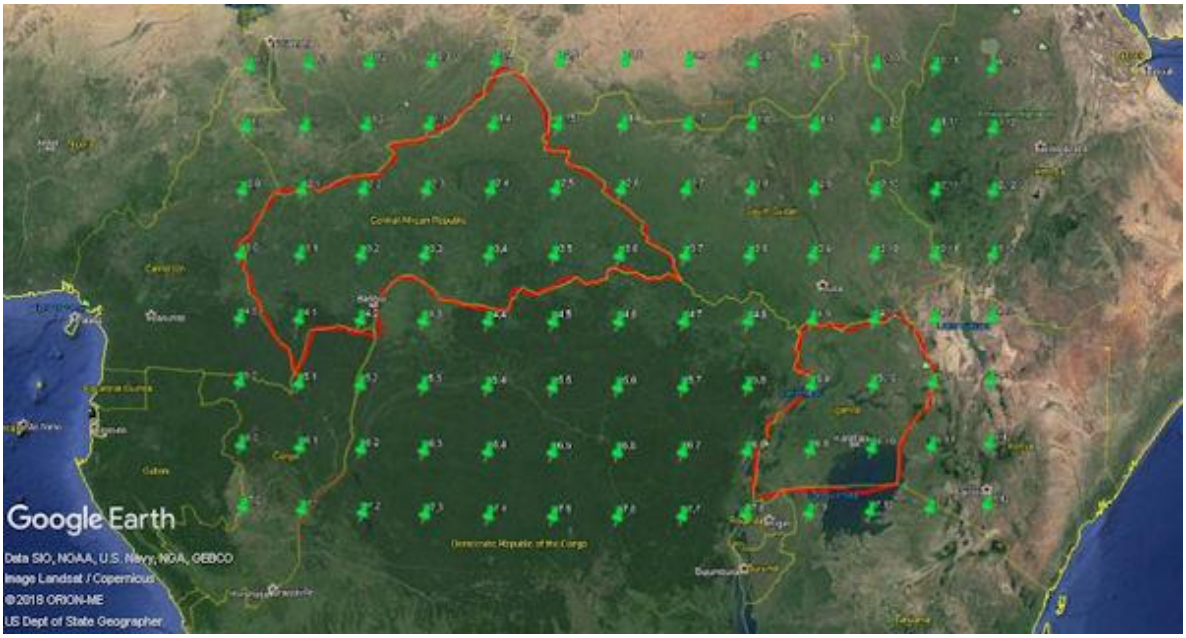
Fortunately, on Google Earth, international boundary lines and large administrative dividing lines are available. In other cases, you need to download shapefiles of the administrative boundaries such as GADM, the Database of Global Administrative Areas, a high-resolution database of country administrative areas. You could even create polygon of your own on Google Earth so that you can set any shape of a target region.

2.5.2 Let's put sample dots on scattered target regions on Google earth

Suppose you want to put totally 20 dots in Central African Republic (623,000km^2) and Uganda (241,000km^2), you fill in T-1 Table as below.

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
CAfUgan20	***864000***	***20***	11.05	14.36	−1.56	35.07

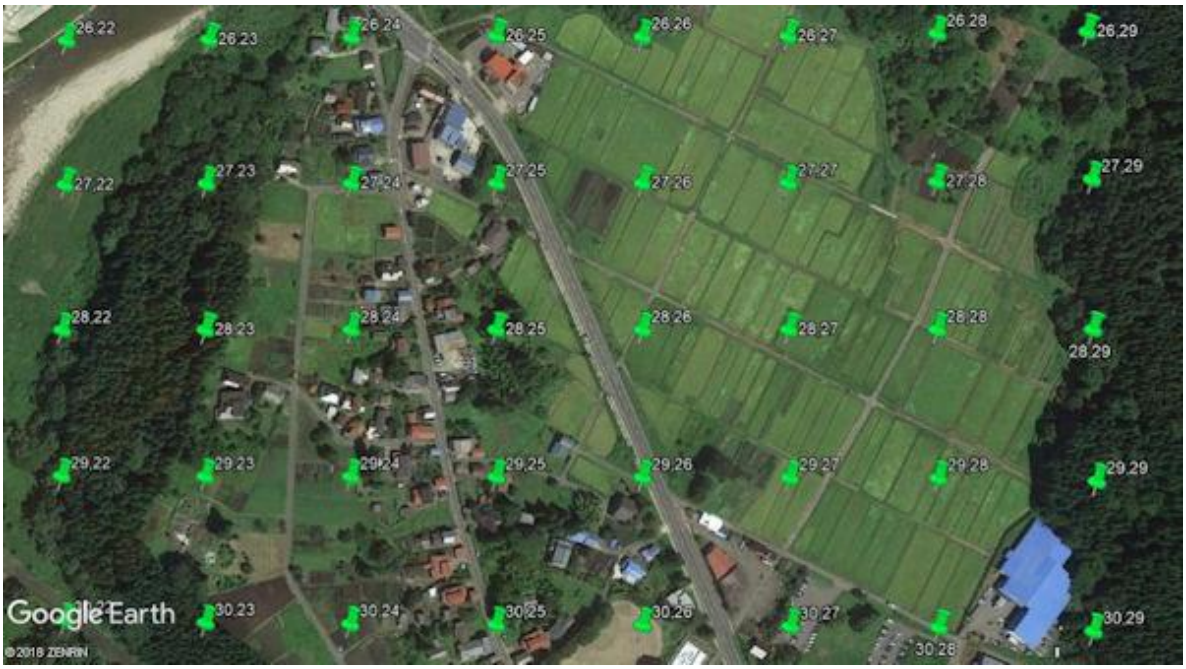


2.5.3 Let's put one dot per unit of area

Suppose you want to put 1 dots per 1 ha (=0.01km^2), you fill in T-1 Table as below.

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Aga1dot=1ha	*0.01*	*1*	37.686	139.447	37.655	139.48



2.6 KML files in a Dot-1 folder in C drive in your computer

If you want to share the geographic data of dots on Google Earth with your colleagues or enumerators, you can email the data in the form of a KML file to them.

Please note that KML file is saved at Dot-1 folder in C drive automatically in your computer by default.

Chapter 3 Package of Crop Production Survey

In this chapter, you learn the package of crop production survey, especially the calculating formula “the average yield times the planted area” with actual measurement survey.

3.1 Let’s share the method of the production survey of your country among participants

Let’s share the method of the production survey adopted in your country among participants!

Please explain how you get the data of total production of rice or important crops in your country.

3.2 Method of Estimating Production

In the lecture, a production survey consists of two surveys: a yield survey and an area survey.

Production survey = Yield survey + Area survey

Note: “Yield” is used as “production per unit area”

In order to estimate the amount of rice production in a region, you multiply **average yield** of rice in the region and total **planted area** of rice in the region together.

Total production of rice in the target region
=
Average yield of rice in the target region
×
Total planted area of rice in the target region

Note1: A target region or an estimation unit is usually a nation’s administrative subdivision.

Note2: Planted area is almost as same as harvested area, when you check planted area at the time of harvesting.

The formula is a package of a rice production survey. This is the reason why you should plan and design a yield survey and an area survey together.

Note1: Usually yield is calculated without dyke, so area must exclude dyke. Please don't mix a case with dyke and another case without dyke. In many cases, area include dyke and yield is calculated without dyke by mistake, so production become overestimated.

Note2: Even when survey sample is mix cropping field such as being planted maize and rice mixed together, please neglect maize, just focus on rice, if it is a case of a rice production survey.

3.3 Actual Measurement Method

In order to get average rice yield and total rice planted area, you have to adopt actual measurement methods in which you don't ask farmers but survey rice fields to collect data.

You might think that it seems to be common to ask farmers to get such data through interpersonal hearing method.

This hearing method is popular in some cases, but it has a week point that you cannot evaluate a validity of the data, as you get the data through hearing from farmers without any evidence. It has been often happened that such data doesn't show the real situation. It is often the case with farmers that they don't know the precise figure so that you cannot evaluate a validity of the data.

Chapter 4 Planted Area Survey using the Dot Sampling Method

In this chapter, you learn the concept of rice planted area survey using the Dot Sampling Method which is an application of attribute survey.

4.1 Concept of planted area survey using the Dot Sampling method: Application of an attribute survey

The Dot Sampling Method has been developed on the basis of traditional statistical theory together with the new technology “Google Earth”. The Dot Sampling method is an application of an attribute survey such as public opinion poll. So what you have to do is only to confirm if the sample dot is fallen on rice planted spot or not.

The basic idea of the Dot Sampling Method is:

1) you put sample dots (the number of sample dots = n) in a target region;
2) you count the number of sample dots (n_1) which fall on rice planted spots;
3) you estimate rice planted area （$\hat{T}$） by multiplying area of the target region (W) by the ratio （$\hat{p}=\frac{n_1}{n}$） .

Item	Estimation Formula
Rice planted area ($\hat{T}$)	$\boldsymbol{\hat{T}=\frac{n_1}{n}\times W=\hat{p}W}$
Standard error (SE)	$\mathbf{SE}=\sqrt{\frac{\hat{p}\times\hat{q}}{n}}$ where $\hat{q}=1-\hat{p}$
Coefficient of variation (CV)	$\mathbf{CV}=\frac{SE}{\hat{p}}$

Note: How amazing an attribute survey is! you calculate SE and CV only with p.

Item	Main characteristics of the Dot Sampling Method
Actual measurement	Survey object is not a person but a land.
No need of population	It doesn’t require population composition.
Easy to conduct	What you have to do is only check if the sample dots fall on rice planted area or not.
No non-sampling error	Non-sampling errors hardly occur, as it is not a variable survey but an attribute survey.

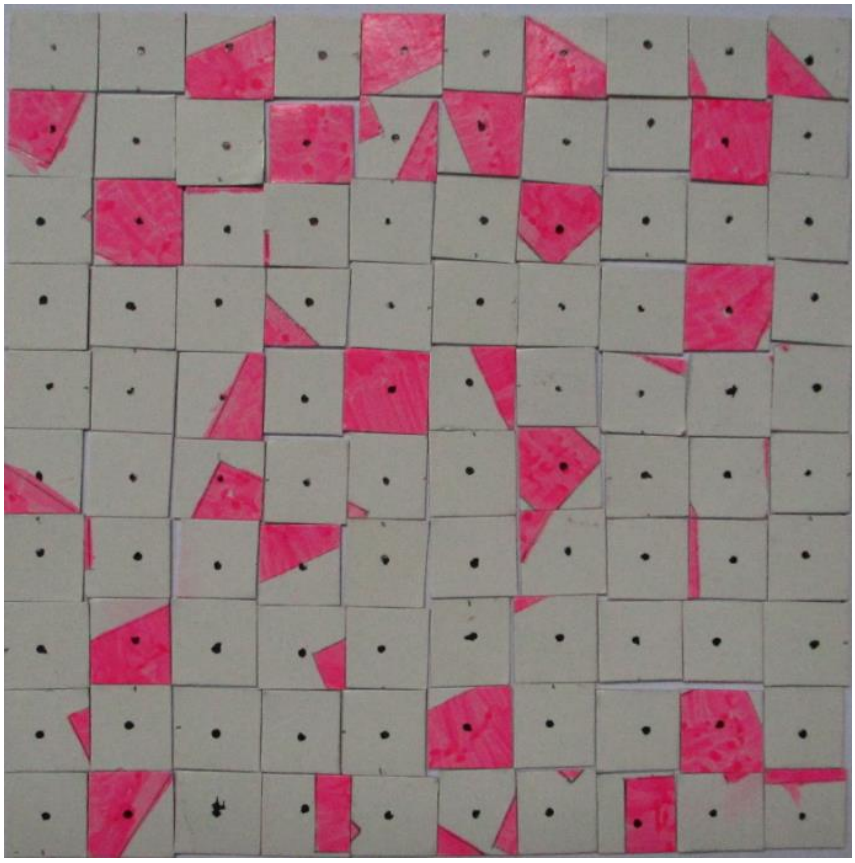
Note: Empirically, the Dot Sampling Method generates more precise results than theoretical precision. The reason has not been solved yet, but one reason might be the way to put sample dots systematically in a grid pattern rather than putting them in simple random way.

(For more information)

The concept of the Dot Sampling method is as follows:

The figure below shows a target region of 100 ha (W).

You are going to estimate area of red fields using the Dot Sampling Method.



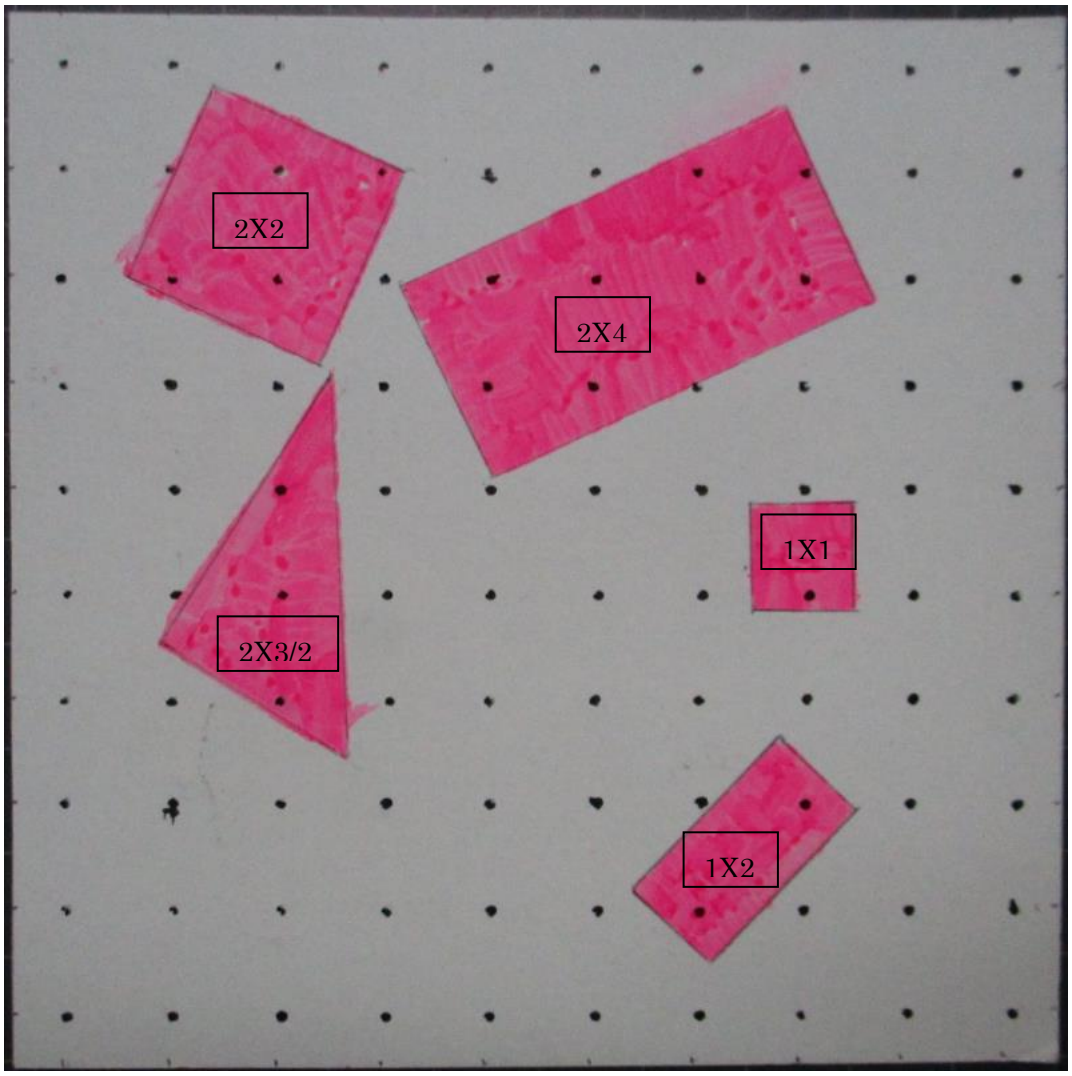
Let's estimate area of red fields above.

1) you put 100 sample dots (n) in a target region;
2) you count the number of sample dots which fall on red fields
   => the number of sample dots(n_1) is 18;
3) you estimate red field area $(\hat{T})$ by multiplying area of the target region (W) by the ratio $(\hat{p} = \frac{n_1}{n})$.

   => $\hat{T}$ = $\frac{18}{100} \times 100\text{ha}$ = 18ha

Area of red fields in below picture is as same as that in the picture above, as you can divide the picture below to make the picture above.

Red fields' area is 18ha (= 4ha + 8ha + 3ha + 1ha + 2ha).



(For more information)

I hope you understand that you can estimate a planted area of minor crops or scattered field in a target region with the Dot Sampling Method.

With the Method, sample dots are selected in proportional to planted area. Every dot has same probability, so the appearance ratio of each crop is to be proportional to the planted area of the crop.

You only need to put the number of dots required for the survey. You learn how to determine the number of sample dots in 4.7 of this Guidebook.

4.2 Four procedures for a planted area survey using the Dot Sampling Method

Procedure		Instruction
1	**Put sample dots on Google Earth.**	Decide the number of sample dots.
		Input density of sample dots (values of area and number of sample dots) in T-1 table of “LL Sheet for the dot sampling”.
		Input latitude and longitude in T-1 table for a range of sample dots.
		Click buttons according to the instruction on LL sheet.
2	**Conduct a preparatory survey on Google Earth**	Examine attributions of sample dots on Google Earth.
		Categorize attributions of sample dots into two categories, one is sample dots which you need to conduct a field survey to check if rice is planted or not, and another category is sample dots which you don’t need to conduct field survey.
3	**Conduct a field survey**	Visit sample dots which you need to conduct a field survey and examine their attributions. You check whether rice is planted or not at a spot of each sample dot.
4	**Estimate rice planted area**	Estimate rice planted area by using the formula below: $\widehat{\boldsymbol{T}} = \frac{\boldsymbol{n_1}}{\boldsymbol{n}} \times \boldsymbol{W} = \widehat{\boldsymbol{p}}\boldsymbol{W}$

4.3 Let’s put sample dots on Google Earth for a rice planted area survey

You conduct a rice production survey using the Dot Sampling Method in the target region, Tsukuba Hamlet, near JICA Tsukuba International Center.

Please look at the figure below. The target region in the training is shown with a red polygon. Area of the region is only 0.2 km^2.

At first you put sample dots on Google Earth for a rice planted area survey. In Chapter 2 you've already learnt how to put a certain number of dots on Google Earth. Suppose you would like to put 80 sample dots in the target region, you open a file "LL Sheet for the dot sampling" and input following data into T-1 table.

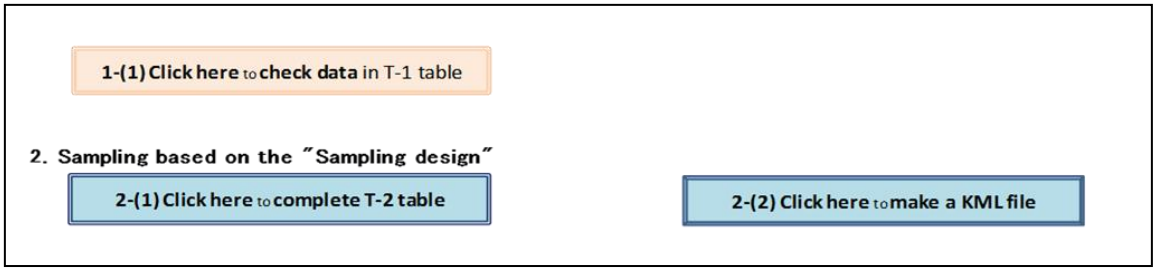
T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
JICA Training	*0.2*	*80*	36.032451	140.1226	36.026	140.1329

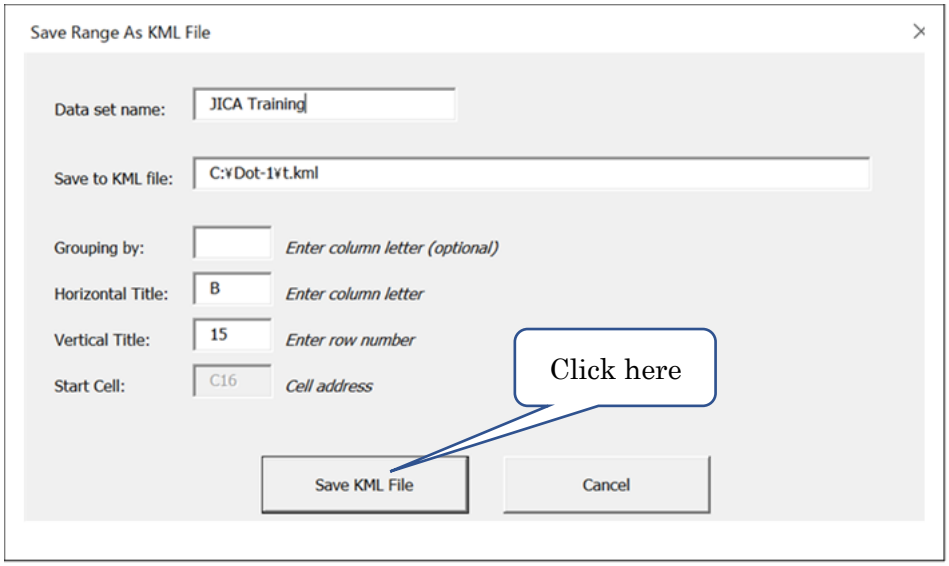
Note	
1	Concerning the value of area of target region of (2), you have to get it from other sources.
2	Concerning the number of sample dots required for value of (3), you have to decide the number according to the calculation explained in 4.7 and available resources.
3	A purpose of inputting values of (2) and (3) is to determine dot density or the number of dots per unit area.

4	The number of dots which are fallen in target region defined in (2) is almost as same as the number of dots defined in (3) with high probability, though it depends on the starting point of systematic sampling.
5	Please remember you need to use decimal degrees for inputting latitude and longitude.
6	Values from (4) to (7) determine a rectangle shape of range for putting dots.

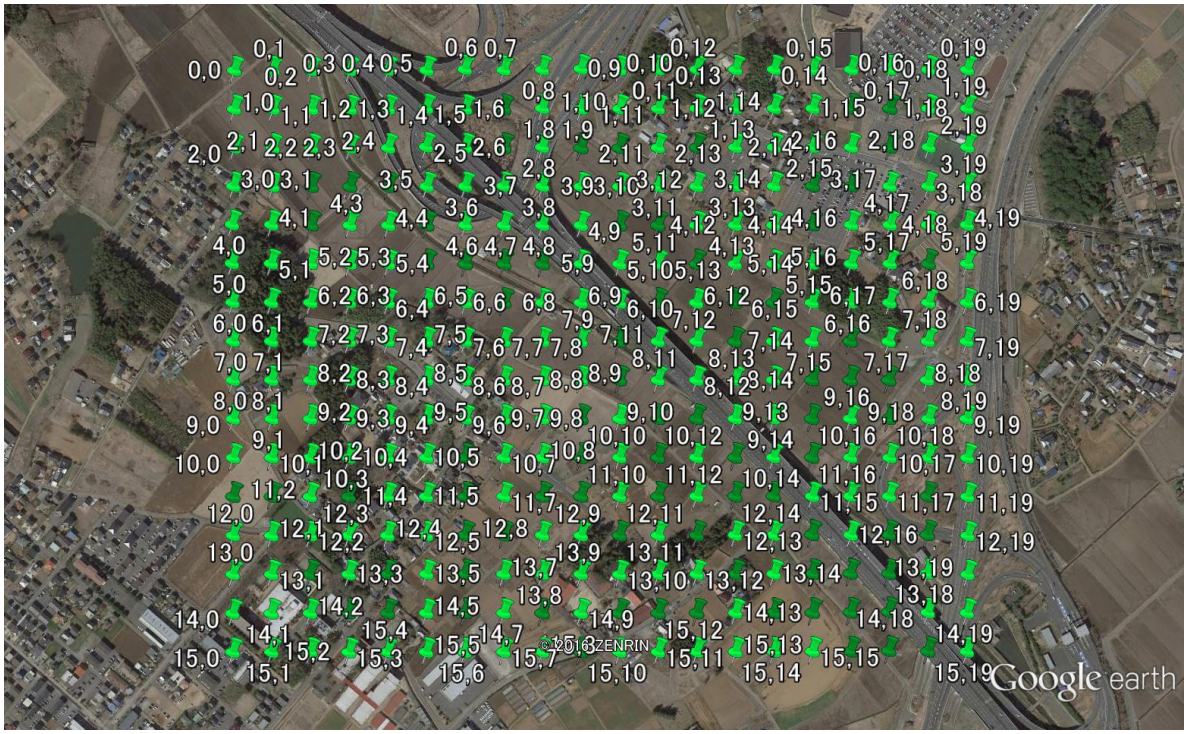
After finishing filling in cells, you click on the buttons according to instructions under the T-1 Table.



When “Save Range As KML File” appears, just click on Save KML File.



Finally, Google Earth begins to work and sample dots appear on Google Earth automatically.



Please note that dots are put into rectangle form in a range surrounded by input latitude and longitude. Target region must be covered by the rectangle shape of dots.

Note: In the above case, the number of dots which are fallen in the target region is 80 with high probability, because you put sampling dots with a density of 80 dots per 0.2 km^2. Please note the actual number of dots in the target region varies depending on a starting point of systematic sampling.

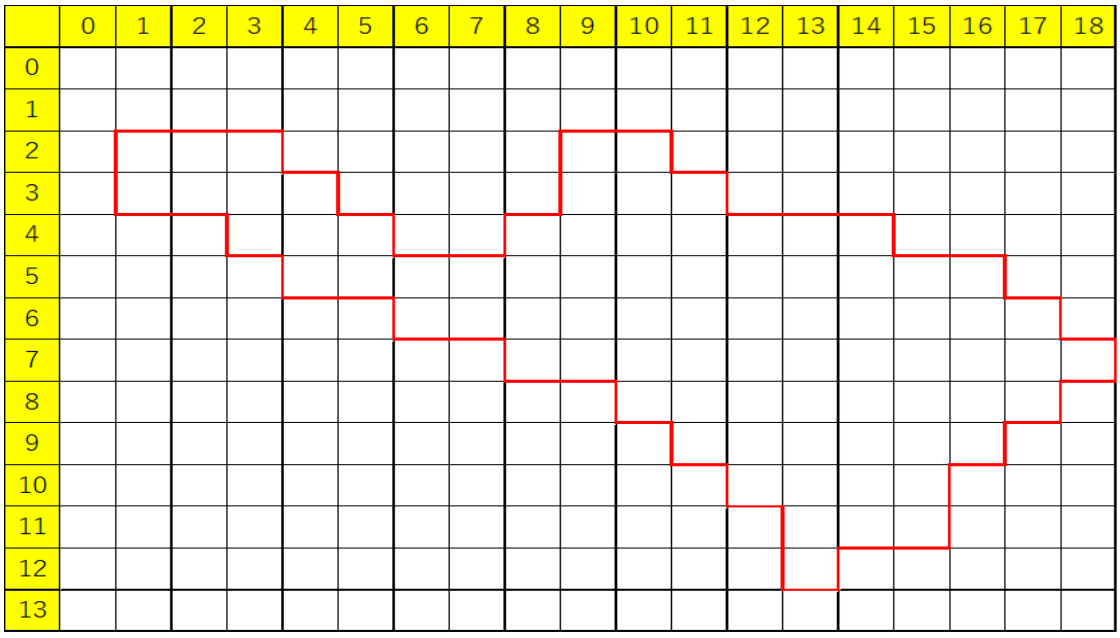
4.4 Let's conduct a preparatory survey of a rice planted area survey on Google Earth

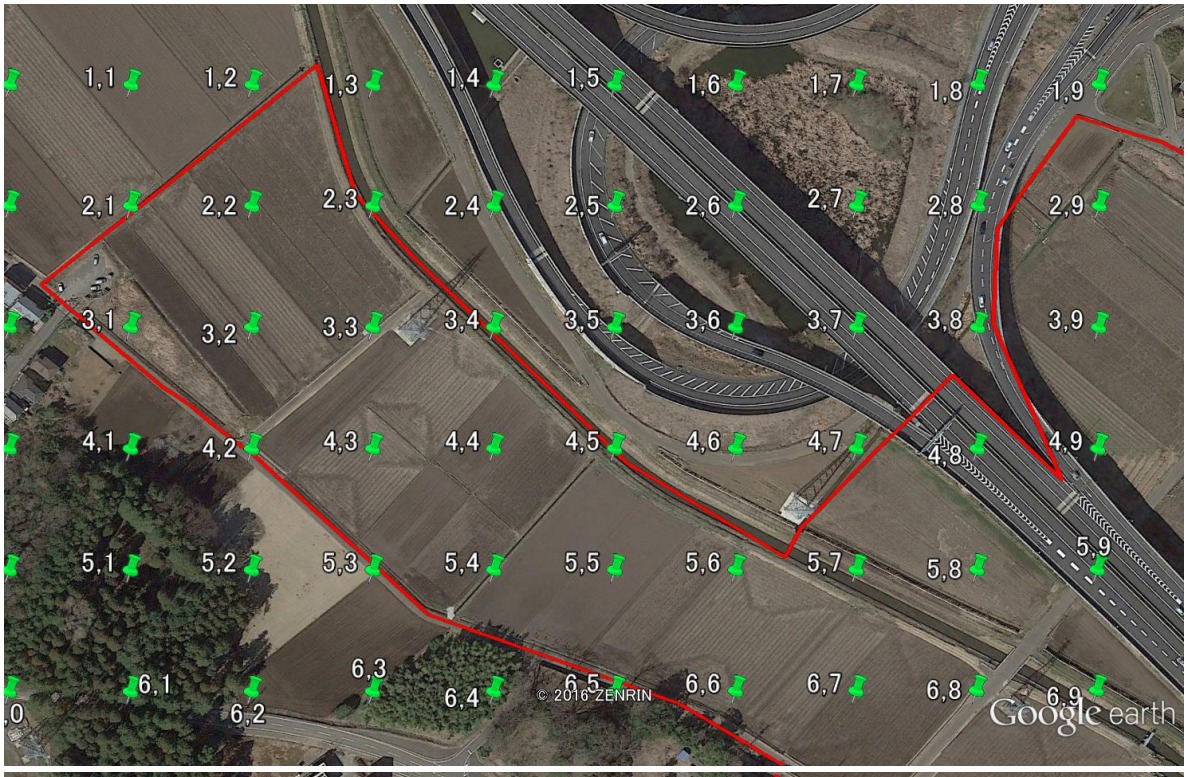
A preparatory survey of a rice planted area survey on Google Earth is a desk work. You conduct a preparatory survey on Google Earth.

Now you conduct a preparatory survey:

1) You examine attribution of each sample dot on Google Earth in the target region.
2) In this lecture, you use the following code as an attribution of each sample dot.

Code	Attribution	Remark
1	Non-cultivated land	The sample dot has clearly fallen on non-cultivated land such as forest, river, road, building. You don't need to visit the dot at the time of a field survey.
2	Cultivated land	There is a possibility that the sample dot has fallen on rice field. You need to visit the dot at the time of a field survey.
3	Dyke (including, tree, rock, pool, border etc.) in cultivated land	
9	Unidentified land use	

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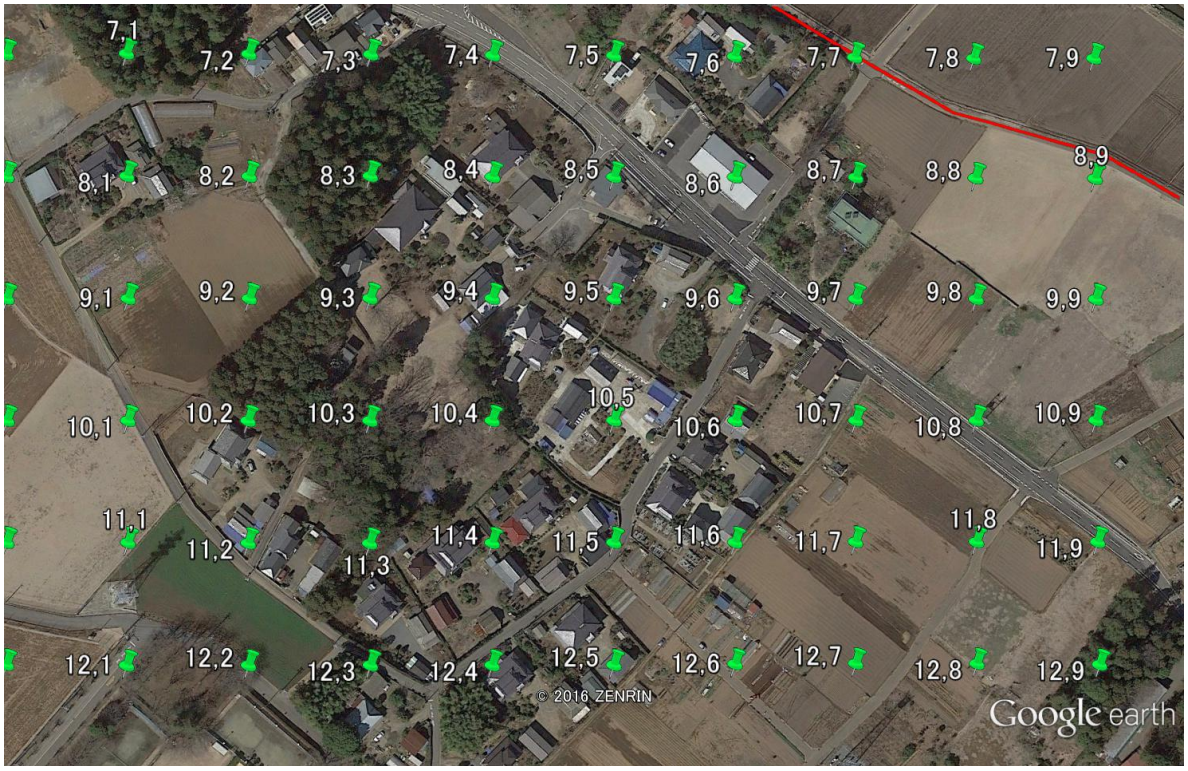
Google earth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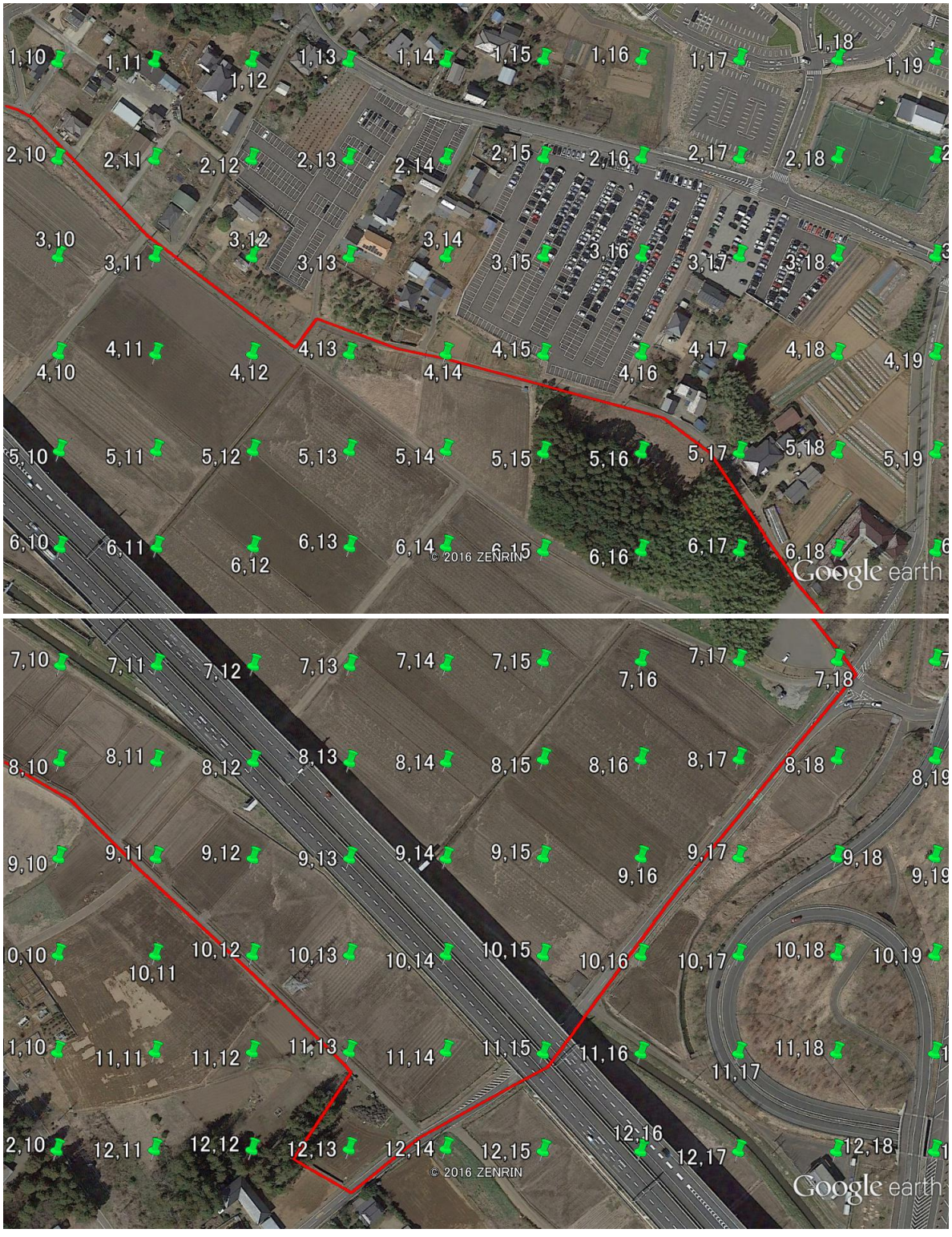
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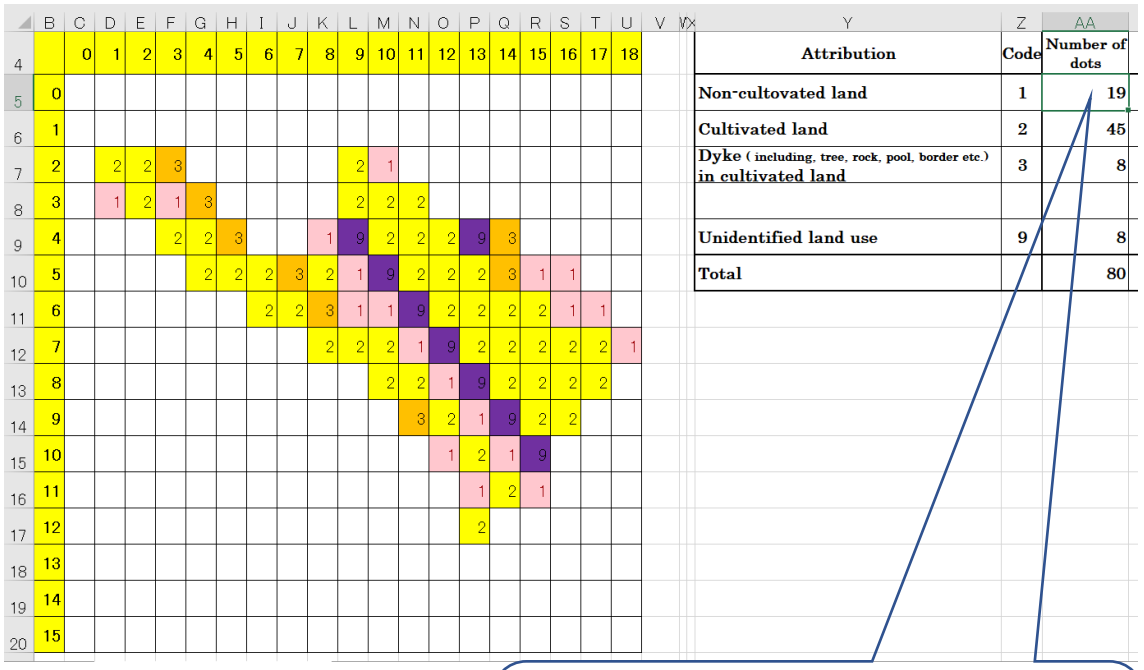
© 2016 ZENRIN
Google earth

3) You fill in the table below.

Attribution	Code	Number of dots	Share	Estimate (ha)
Non-cultivated land	1			
Cultivated land	2			
Dyke (including, tree, rock, pool, border etc.) in cultivated land	3			
Unidentified land use	9			
Total			1.000	20.0

(For more information)

COUNTIF, one of the statistical functions, helps you count the number of each code on excel files.



The figure and table below show an example of the results of the preparatory survey

You judge from the preparatory survey on Google Earth that 19 dots fell on non-cultivated field such as forest, river, road, building which you don't need to visit at the time of a field survey.

You also understand that you have to visit remaining 61 dots out of 80 dots to confirm whether dots fell on rice planted spots or not.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0																			
1																			
2		2	2	3						2	1								
3		1	2	1	3					2	2	2							
4				2	2	3			1	9	2	2	2	9	3				
5					2	2	2	3	2	1	9	2	2	2	3	1	1		
6							2	2	3	1	1	9	2	2	2	2	1	1	
7									2	2	2	1	9	2	2	2	2	2	1
8											2	2	1	9	2	2	2	2	
9												3	2	1	9	2	2		
10													1	2	1	9			
11														1	2	1			
12														2					
13																			

Attribution	Code	Number of dots	Share	Estimate (ha)
Non-cultovated land	1	19	0.238	4.8
Cultivated land	2	45	0.563	11.3
Dyke (including, tree, rock, pool, border etc.) in cultivated land	3	8	0.100	2.0
Unidentified land use	9	8	0.100	2.0
Total		80	1.000	20.0

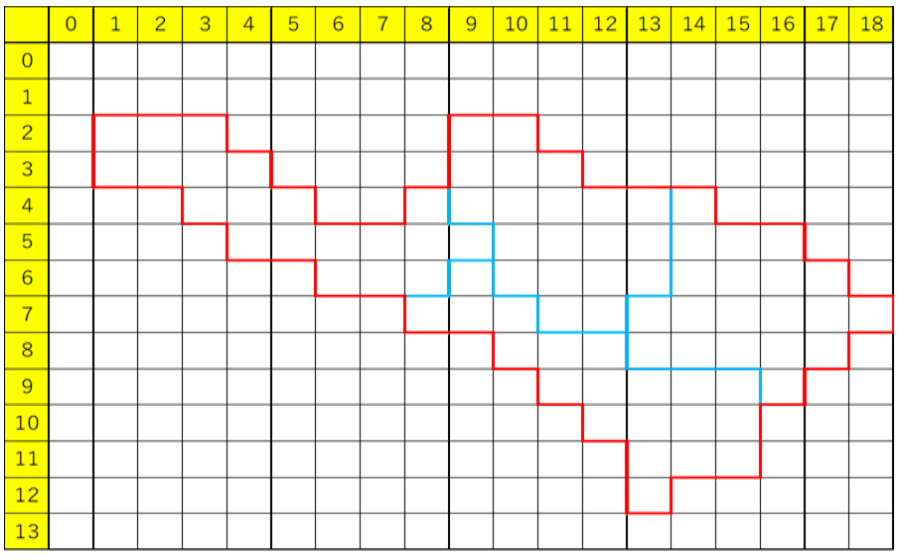
4.5 Let's conduct a field survey of a rice planted area survey on Google Earth

A field survey of a rice planted area survey on Google Earth is not a desk work. You visit sample dots of Code 2, 3 and 9 which have been categorized to be visited for a field survey.

Now you conduct a filed survey as follows:

1) You make guide maps which lead you to the sample dots which have been classified as Code 2, 3 and 9 through a preparatory survey.
2) You bring guide maps and visit the sample dots.
3) You examine the attribution of each sample dot. Especially, you check whether rice is planted or not at a spot of each sample dot.
4) In this lecture, you use the following code as an attribution of each sample dot.

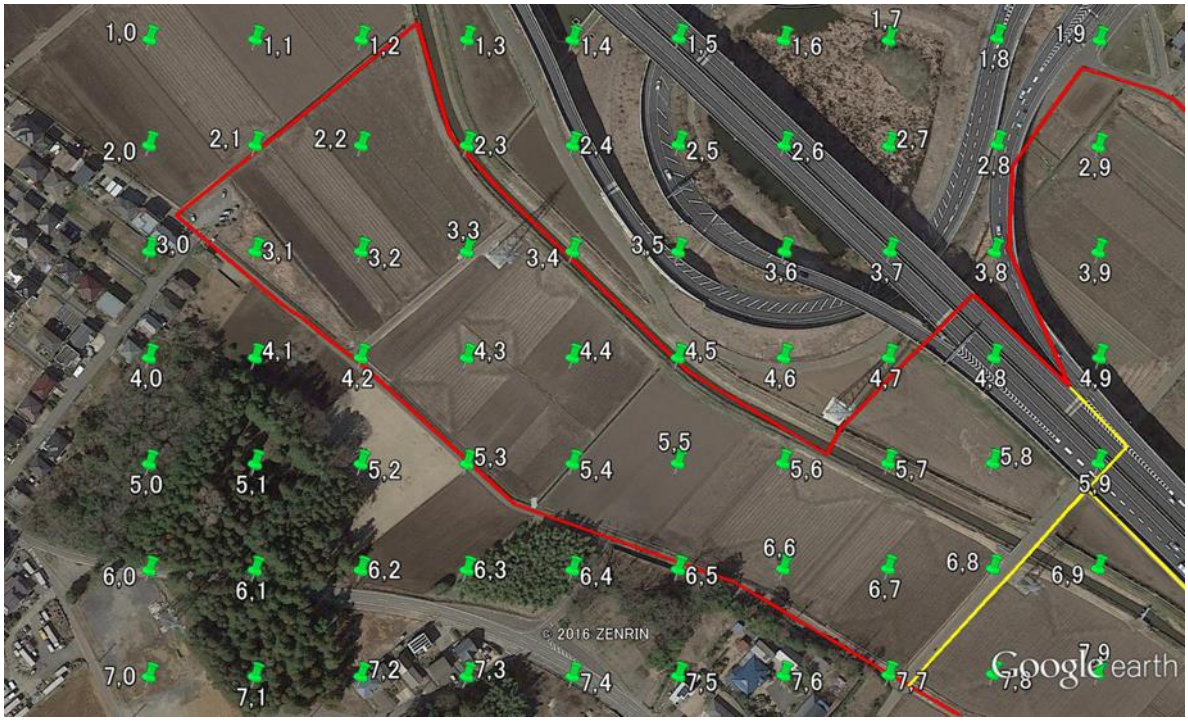
Code	Attribution
1	Non-cultivated land
4	Dyke (including, tree, rock, pool, border etc.) in rice field
5	Dyke (including, tree, rock, pool, border etc.) in field of crops other than rice
10	Unplanted field (in two years or more)
11	Unplanted field (temporarily)
12	Rice
13	Other crops



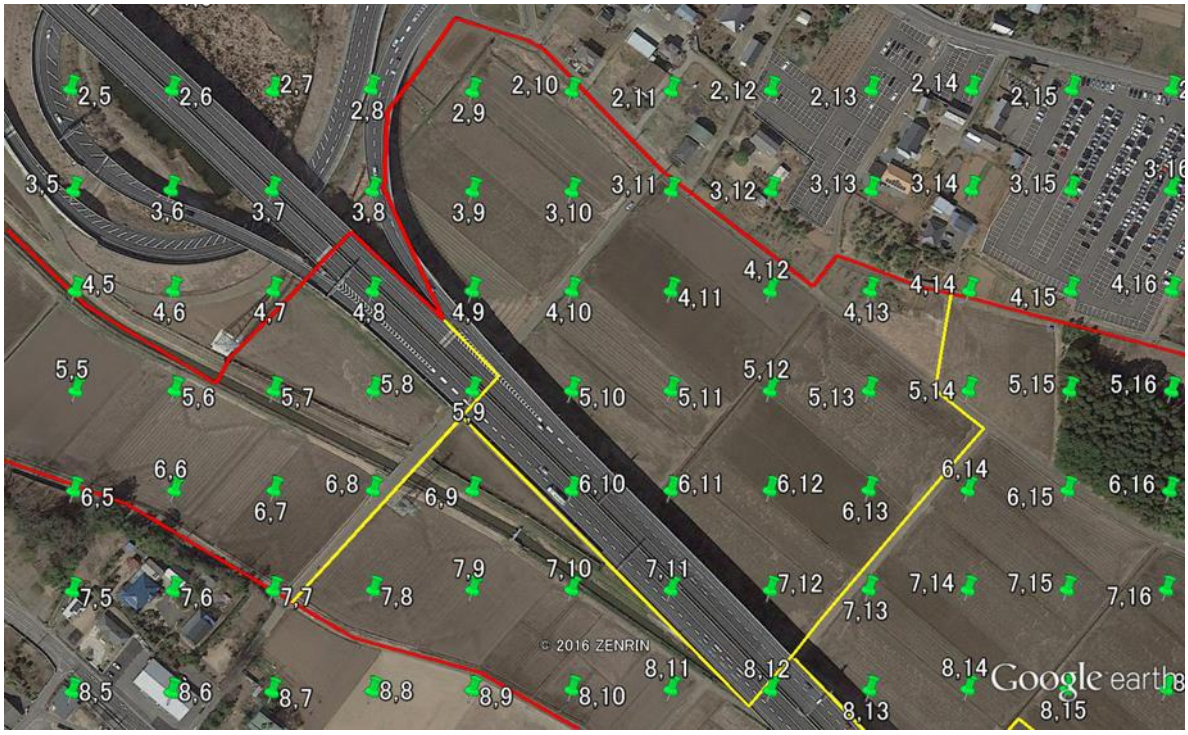
5) You fill in the table blow.

Attribution	Code
Non-cultivated land	1
Dyke (including, tree, rock, pool, border etc.) in rice field	4
Dyke (including, tree, rock, pool, border etc.) in other field	5
Unplanted field (more than 2 years)	10
Unplanted field (temporarily)	11
Rice	12
Other crops	13

Zone 1



Zone 2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Google earth

Zone 3


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Google earth

Zone 4

(For more information)

In the lecture you conduct a field survey for a planted area survey. But in the future, you might be able to conduct a field survey on a desk. <u>It is a drone that holds the key</u>.

The Dot Sampling Method has a possibility to have affinity with a drone. It is expected that a drone would take pictures of spots of sample dots automatically by storing coordinates of latitude and longitude of sample dots into a drone.

4.6 Let's estimate rice planted area

Since you have finished a field survey for a rice planted area survey, the next step is estimation of rice planted area.

Now you complete the table below:

Attribution	Code	Number of dots	Share	Estimated Area	Variance	Standard error	Precision (%)	Error(ha)	
		n = 80	p	20 × p	p × (1−p)	$\sqrt{\frac{p \times (1-p)}{n}}$	$\frac{standard\ error}{p}$	20 × standard error	Estimated area × precision
Non-cultivated land	1								
Dyke in rice field	4								
Dyke in other crops' field	5								
Unplanted field (more than 2 years)	10								
Unplanted field (temporarily)	11								
Rice	12								
Other crops	13								
Total		80	1.000	20.0					

Item	Formula
Rice planted area ($\hat{T}$)	$\boldsymbol{\hat{T} = \frac{n_1}{n} \times W = \hat{p}W}$
Standard error (SE)	$\mathbf{SE} = \sqrt{\frac{\hat{p} \times \hat{q}}{n}}$
Coefficient of variation (CV)	$\mathbf{CV} = \frac{SE}{\hat{p}}$

where

n: The number of total sample dots

n_1 : the number of dots which falls on rice planted spots

W: area of the target region

$\hat{p} = \frac{n_1}{n}$

$\hat{q} = 1 - \hat{p}$

The figure and the table below show the results of the field survey conducted in 2017: rice planted area, precision and standard error are estimated 12.25ha, 8.9% and 1.1ha respectively.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0																			
1																			
2		1	12	1						12	1								
3		1	12	1	1					12	12	12							
4				12	12	1			1	12	12	12	12	1	4				
5					4	12	12	1	12	1	12	12	12	12	1	1	1		
6							12	12	1	1	1	12	12	12	12	12	1	1	
7									12	12	12	1	12	12	12	12	12	12	13
8											12	12	1	12	12	12	12	12	
9												4	12	1	12	12	12		
10													1	12	1	12			
11														1	12	1			
12														13					
13																			

Attribution	Code	Number of dots	Share	Estimated Area	Variance	Standard error	Precision (%)	Error(ha)	
		n = 80	p	20 × p	p × (1−p)	$\sqrt{\frac{p \times (1-p)}{n}}$	$\frac{standard\ error}{p}$	20 × standard error	Estimated area × precision
Non-cultivated land	1	26	0.325	6.50	0.2194	0.052	16.1	1.0	1.0
Dyke in rice field	4	3	0.038	0.75	0.0361	0.021	56.6	0.4	0.4
Dyke in other crops' field	5	0	0.000	0.00	0.0000	0.000	#DIV/0!	0.0	#DIV/0!
Unplanted lfield (more than 2 years)	10	0	0.000	0.00	0.0000	0.000	#DIV/0!	0.0	#DIV/0!
Unplanted field (temporarily)	11	0	0.000	0.00	0.0000	0.000	#DIV/0!	0.0	#DIV/0!
Rice	**12**	**49**	**0.613**	**12.25**	**0.2373**	**0.054**	**8.9**	**1.1**	**1.1**
Other crops	13	2	0.025	0.50	0.0244	0.017	69.8	0.3	0.3
Total		80	1.000	20.00	0.0000	0.000	0.0	0.0	0.0

4.7 How to determine the number of sample dots for a preparatory survey

Now, you learn how to determine the number of sample dots for a preparatory survey of a planted area survey using the Dot Sampling Method.

Two factors for determine the number of sample dots:

#1 **aimed precision**

#2 **coefficient of variation** (CV) of population

Note1: You estimate population CV using results of past survey or pretest, as you cannot get a value of population CV at the time of survey,
Note2: A size of a target region does not matter to determine the number of sample dots.

The formula of the number of sample dots required for a preparatory survey is as follows.

The number of sample dots required for a preparatory survey

$$= \frac{(\boldsymbol{population\ CV})^2}{(\frac{\boldsymbol{aimed\ precision}}{\boldsymbol{100}})^2}$$

or

$$= \frac{(\boldsymbol{population\ standard\ deviation})^2}{(\boldsymbol{aimed\ standard\ error})^2}$$

where

population CV = $\frac{\sqrt{p \times (100-p)}}{p}$

p % = share of rice planted are in a target region

CV % = aimed precision

population standard deviation = $\sqrt{p \times (100-p)}$

aimed standard error = $p \times \frac{CV}{100}$

Note: The number of sample dots mentioned above is for a preparatory survey which is more than the number of dots to be visited at the time of a field survey. At the time of a field survey, you only visit the sample dots which have been categorized to be visited.

Let's calculate the number of sample dots required for a preparatory survey in Tsukuba Hamlet using the formula above, though you have distributed 80 sample dots in the lecture.

Suppose you know the share of rice planted area in Tsukuba Hamlet is about 60 % according to a pretest already conducted and you want the results with 10% precision, the number of sample dots required for the planted area survey is as follows:

$$\frac{(\boldsymbol{population\ CV})^2}{(\boldsymbol{aimed\ precision})^2} = \frac{\left(\frac{\sqrt{60\times(100-60)}}{60}\right)^2}{\left(\frac{10}{100}\right)^2} = 67$$

or

$$\frac{(\boldsymbol{population\ standard\ deviation})^2}{(\boldsymbol{aimed\ standard\ error})^2} = \frac{\left(\sqrt{60\times(100-60)}\right)^2}{\left(60\times\frac{10}{100}\right)^2} = 67$$

Note: A size of a target region does not matter to determine the number of sample dots. Suppose you know the share of rice planted area in country Z is about 60 % and you want the results with 10% precision, the number of sample dots required for the planted area survey in country Z is 67.

The table below shows the number of sample dots required for a preparatory survey calculated by the formula above.

The Number of Sample Dots Required by Aimed Precision for a Preparatory Survey

Share of rice planted field in a target region	Aimed Precision		
Share = p%	CV = 3%	CV = 5%	CV = 10%
1	110,000	39,600	9,900
2	54,444	19,600	4,900
3	35,926	12,933	3,233
4	26,667	9,600	2,400
5	21,111	7,600	1,900
6	17,407	6,267	1,567
7	14,762	5,314	1,329
8	12,778	4,600	1,150
9	11,235	4,044	1,011
10	10,000	3,600	900
20	4,444	1,600	400
30	2,593	933	233
40	1,667	600	150
50	1,111	400	100
60	741	267	67
70	476	171	43
80	278	100	25
90	123	44	11

Note: Calculation fomulas are as follows:

$$\text{Sample size for Preparatory Survey} = \frac{(population\ standard\ deviation)^2}{(aimed\ standard\ error)^2}$$

$$= \frac{\frac{p}{100} \times \left(1 - \frac{p}{100}\right)}{\left(\frac{p}{100} \times \frac{CV}{100}\right)^2} = \frac{p \times (100 - p)}{\left(p \times \frac{CV}{100}\right)^2}$$

Precision by the Number of Sample Dots for a Preparatory Survey

Share of rice planted field in a target region	Precision by the Number of Sample Dots (%)					
p %	100 dots	200 dots	500 dots	1000 dots	5000 dots	10000 dots
0.5	141.1	99.7	63.1	44.6	19.9	14.1
1	99.5	70.4	44.5	31.5	14.1	9.9
2	70.0	49.5	31.3	22.1	9.9	7.0
3	56.9	40.2	25.4	18.0	8.0	5.7
4	49.0	34.6	21.9	15.5	6.9	4.9
5	43.6	30.8	19.5	13.8	6.2	4.4
6	39.6	28.0	17.7	12.5	5.6	4.0
7	36.4	25.8	16.3	11.5	5.2	3.6
8	33.9	24.0	15.2	10.7	4.8	3.4
9	31.8	22.5	14.2	10.1	4.5	3.2
10	30.0	21.2	13.4	9.5	4.2	3.0
15	23.8	16.8	10.6	7.5	3.4	2.4
20	20.0	14.1	8.9	6.3	2.8	2.0
30	15.3	10.8	6.8	4.8	2.2	1.5
40	12.2	8.7	5.5	3.9	1.7	1.2
50	10.0	7.1	4.5	3.2	1.4	1.0
60	8.2	5.8	3.7	2.6	1.2	0.8
70	6.5	4.6	2.9	2.1	0.9	0.7
80	5.0	3.5	2.2	1.6	0.7	0.5
90	3.3	2.4	1.5	1.1	0.5	0.3

Note: Calculation are as follows:

$$\text{Precision} = \frac{Standard\ error}{p} \times 100\ (\%)$$

$$\text{Standard Error} = \sqrt{\frac{p(100-p)}{n}}$$

where
n = number of sample dots
p = Share of rice planted field in a target region

(For more information)

The table on the next page shows the number of sample dots (theoretical values) required for a field survey by aimed precision.

According to the table, the number of sample dots for field survey doesn't increase so sharply as those for preparatory survey, when the value of p become smaller. This is one of characteristics of the Dot Sampling Method. You can keep high precision with small number of sample dots for a field survey.

The formula of the number of sample dots required for a preparatory survey is as follows.

The number of sample dots require for a field survey

= the number of sample dots required for a preparatory survey $\times \frac{p}{100}$

Let's calculate the theoretical number of sample dots required for a field survey in Tsukuba Hamlet using the formula above.

The theoretical number of sample dots require for a field survey is around 40 (= 67$\times \frac{60}{100}$), as the number of sample dots required for a preparatory survey is 67 with 10% precision and the share of rice planted area is about 60 %.

Note: At the time of field survey, you need to visit all sample dots which have possibilities to fall on rice planted spots, so the number of sample dots you have to visit is somewhat more than theoretical value shown in the next table.

The Number of Sample Dots Required by Aimed Precision
for a Field Survey (theoretical values)

Share of rice planted field in a target region	Aimed Precision		
Share = p%	CV = 3%	CV = 5%	CV = 10%
1	1,100	396	99
2	1,089	392	98
3	1,078	388	97
4	1,067	384	96
5	1,056	380	95
6	1,044	376	94
7	1,033	372	93
8	1,022	368	92
9	1,011	364	91
10	1,000	360	90
20	889	320	80
30	778	280	70
40	667	240	60
50	556	200	50
60	444	160	40
70	333	120	30
80	222	80	20
90	111	40	10

Note: Calculation fomulas are as follows:

The number of dots for a field survey = Sample size for a preparatory survey $\times \frac{p}{100}$

Sample size for a preparatory survey = $\frac{(population\ standard\ deviation)^2}{(aimed\ standard\ error)^2}$

$$= \frac{\frac{p}{100} \times \left(1 - \frac{p}{100}\right)}{\left(\frac{p}{100} \times \frac{CV}{100}\right)^2} = \frac{p \times (100 - p)}{\left(p \times \frac{CV}{100}\right)^2}$$

4.8 Let's conduct a preparatory land use survey in your country

Let's enjoy putting sample dots in your country and conduct a preparatory survey of a land use survey using the Dot Sampling Method.

In the lecture, follow the procedure below:

1) You put 100 dots in your country on Google Earth.

2) You examine the attribution of each sample dot.

3) You use the following code as an attribution of each sample dot.

Code	Attribution	Remark
1	Non-cultivated land	The sample dot has clearly fallen on non-cultivated land such as forest, river, road, building. You don't need to visit the dot at the time of a field survey.
2	Cultivated land	There is a possibility that the sample dot has fallen on rice field. You need to visit the dot at the time of a field survey.
3	Dyke (including, tree, rock, pool, border etc.) in cultivated land	
9	Unidentified land use	

Note: You can add other categories such as forest, road, lake, residential land, if you need.

3) You fill in the table below.

Attribution	Code	Number of dots	Share	Estimate (ha)
Non-cultivated land	1			
Cultivated land	2			
Dyke (including, tree, rock, pool, border etc.) in cultivated land	3			
Unidentified land use	9			
Total			1.000	

One example of a preparatory survey is shown below. A staff member of the government of Lao PDR conducted the land use preparatory survey during the JICA training course 2014 in Japan. A target region is Savannaket prefecture whose area is 2,177,400ha.

Category	Number	Share (%)	Estimate (ha)	SE (point)	CV
Paddy	**10**	**10**	**217,740**	3.0	0.30
Dyke	2	2	43,548	1.4	0.70
Residential Land	7	7	152,418	2.6	0.36
Road	2	2	43,548	1.4	0.70
River	1	1	21,774	1.0	0.99
Forest	75	75	1,633,050	4.3	0.06
Cutivated Land	3	3	65,322	1.7	0.57
Total	100	100			

Note1: Area of Savannaket: **2,177,400**ha

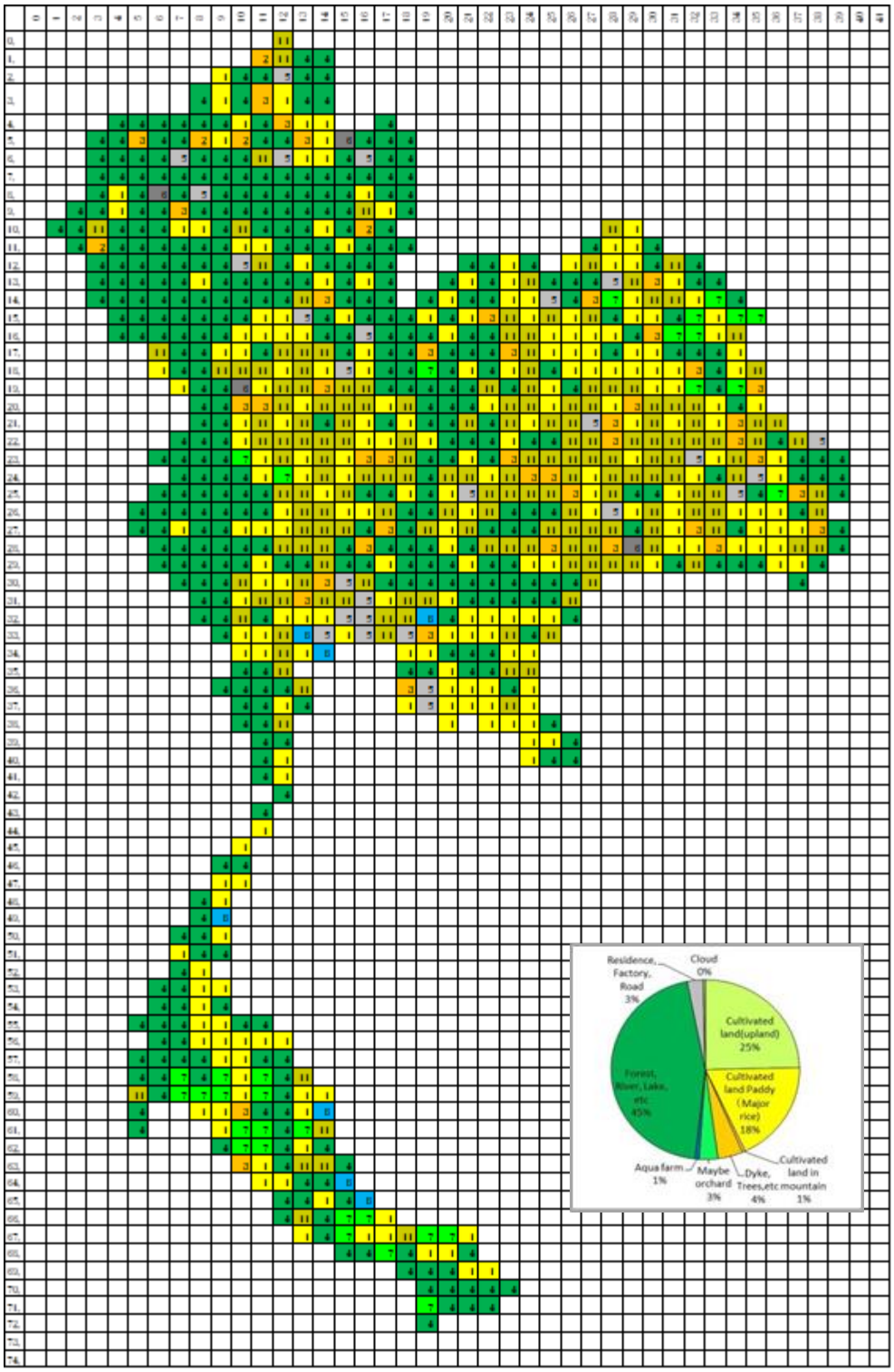
Note2: Agricultural Statistics 2013: Paddy Area: **212,840**ha

source： Mr.Senpachanh Khounthikoummane, Lao PDR, August, 2014

He put hundred sample dots in Savannaket prefecture. The results were that the number of sample dots which have some chance of falling on rice field was ten.

Preparatory survey has examined only spots which have possibility of rice field and you need to conduct a field survey to visit each sample dot to estimate area. However, if you calculate rice field area from the results of the preparatory survey as an experiment, rice field area is calculated to be 217,740ha, as the ratio of rice field is 10 % and area of Savannaket prefecture is 2,177,400ha. On the other hand, official statistics shows rice field area is 212,840ha in 2013. Don't you think the results of preparatory survey is somewhat similar to official statistics?

One more example of a preparatory survey is shown below. This example was conducted by Mr.Issei Jinguji. He put 999 sample dots in Thailand



Category		Code	Number of dots	Rate(%)	Area(ha)	SE	CV
Cultivated land		・・・	517	51.8	26,554,859	1.6	3.1
Cultivated land/Breakdown	Cultivated land(upland)	1	246	24.6	12,635,387	1.4	5.5
	Cultivated land Paddy (Major rice)	11	184	18.4	9,450,859	1.2	6.7
	Cultivated land in mountain	2	5	0.5	256,817	0.2	44.6
	Dyke, Trees,etc	3	43	4.3	2,208,625	0.6	14.9
	Maybe orchard	7	32	3.2	1,643,628	0.6	17.4
	Aqua farm	8	7	0.7	359,544	0.3	37.7
Forest, River, Lake, e		4	451	45.1	23,164,877	1.6	3.5
Residence, Factory,		5	27	2.7	1,386,811	0.5	19.0
Cloud		6	4	0.4	205,453	0.2	49.9
Total			999	100.0	51,312,000	・・・	・・・

Category		Code
Cultivated land		・・・
Cultivated land/Breakdown	Cultivated land(upland)	1
	Cultivated land Paddy (Major rice)	11
	Cultivated land in mountain	2
	Dyke, Trees,etc	3
	Maybe orchard	7
	Aqua farm	8
Forest, River, Lake, etc		4
Residence, Factory, Road		5
Cloud		6
Total		

Category		Number of dots	Rate(%)	Area(ha)	SE	CV
Paddy field	Pure planted area (Major rice)	184	18.4	9,450,859	1.2	6.7
	Dyke, Trees,	31	3.1	1,592,264	0.5	17.7
Total		215	21.5	11,043,123	1.3	6.0

Source: Issei Jinguji, Dot Sampling Method for Area Estimation, Feb. 2014

The results of the preparatory survey conducted by Mr. Jinguji are as follows:

Total number of sample dots is 999.

The number of sample dots on rice field is 184 and the number of sample dots on dyke of rice field is 31. The ratio of rice planted area is 21.5% (= $\frac{215}{999}$).

In actual survey, next step is conducting a field survey to visit each sample dot to check and after a field survey you calculate the rice planted area. So you cannot calculate the rice planted area from the results of a preparatory survey, but you could calculate the rice planted area from the results of the preparatory survey as an experiment as follows:

Rice field area including dyke is calculated to be 11,043,000 ha, as the ratio of rice field is 21.5 % and national land area is 51,312,000ha.

Please compare 11,043,000ha with official statistics 10,400,000ha. Don't you think the results of preparatory survey is somewhat similar to official statistics? You can get results of the preparatory survey without resources in a short time on Google Earth, though the government has get official statistics using lots of monetary and human resources.

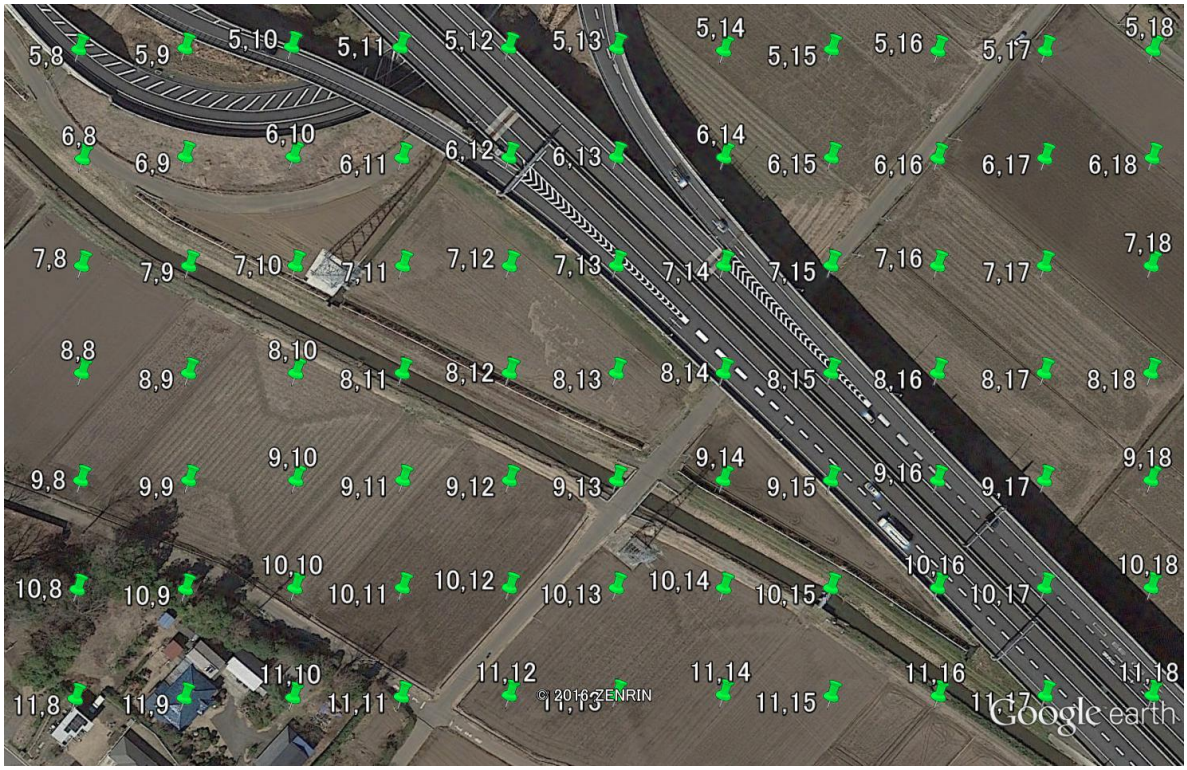
4.9 Let's use dots as a two-dimensional ruler for measuring area

Let's learn how to use the Dot Sampling Method as a two-dimensional ruler for measuring area.

In the lecture, you put one dots per 10a. You open a file "LL Sheet for the dot sampling" and input data as follows:

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
JICA1dot=0.1ha	*0.001*	*1*	36.032451	140.1226	36.026	140.1329



In above case, each dot represents 10a. If you count the number of dots in a target region, then the area is calculated by 10a times the number of dots in a target region. For example, if the number of dots within a target area is 10, area is estimated 1ha or (10a x 10 = 100a).

You can measure area by counting the number of dots. You can use dots as if dots are divisions on a scale. You can measure area by counting the number of dots as same as you measure length by counting number of divisions on a

scale.

You've already learnt the way to use the Dot Sampling Method as a two-dimensional ruler or a ruler for measuring area.

(For more information)

Some of you may have been already familiar with Dot Grid Plate which is a transparent film with printed points arranged in grid pattern. Putting a Dot Grid Plate on map, you count the number of points which are on target area and estimate the area by multiplying the number and coefficient (=area per one point) together.

You can apply area estimation method with a Dot Grid Plate to the Dot Sampling Method as a two-dimensional ruler.

4.10 Comparison of process for a rice planted area survey using the Dot Sampling Method between the first year and the next year

You can conduct a rice planted area survey in the second year more efficiently than in the first year. Firstly, you can use same sample dots as the first year. Secondly, you know which sample dots have fallen on non-cultivated land from the survey in the first year.

The followings are the comparison of process for a rice planted area survey using the dot Sampling Method in the first year and the next year:

	First Year	Next Year
Central Officer	To put sample dots on Google Earth for a preparatory survey.	(No need to put sample dots) To use same samples as the previous year.
Central Officer	To examine attribution of each sample dot on Google Earth.	(No need to examine attribution)
Central Officer	To decide sample dots for a field survey which have possibility to fall on rice fields from the preparatory survey.	To decide sample dots for a field survey which have possibility to fall on rice fields considering the results of the previous year and other information such as newly irrigated field,
Central Officer	To print out maps around sample dots for a field survey to guide enumerators to visit them and send guide maps to enumerators. Note: Instead of printing out maps, you could send KML file to enumerators.	To print out new sample dots, only when sample dots are newly categorized into sample dots for a field survey.

Enumerator	To find sample dots using a guide maps sent by a central officer.	To find sample dots, only when previous year's sample dots are newly categorized into sample dots for a field survey.
Enumerator	To visit a sample dot for a field survey and check whether rice is planted or not.	(As same as the first year)

Chapter 5 Yield Survey

In this chapter, you learn the concept of rice yield survey. You select sample spots for a crop cutting using the Dot Sampling method.

5.1 Concept of Yield Survey

Please remember the package of a production survey mentioned in 3.2:

Total production of rice in the target region
=
Average yield of rice in the target region
X
Total planted area of rice in the target region

The purpose of a rice yield survey and the method you use in the lecture is as follows:

Item	Explanation	Remark
Purpose of a rice yield survey	You estimate average yield of rice in Tsukuba Hamlet.	
Method you use	You use a crop cutting method.	It is an objective survey method.
	You also use the Dot Sampling Method to select samples for crop cutting.	You can dramatically streamline the process of selecting samples.

Major advantages of applying the Dot Sampling Method to a yield survey is as follows:

No.	Advantages
1	You can select sample spots for crop cutting, even when you don't have any information on rice planted area of each village or you don't have a list of farmers in the village.
2	You can select sample rice field with perfect probability proportional to

	size, as a spot which a sample dot falls on is exactly a crop cutting spot with probability proportional to size.
3	You can conduct crop cutting not only at a spot which a sample dot falls but also at other spots around the spot in a prearranged way.
4	You can avoid complicated sampling process for selecting a crop cutting spot.
5	You can estimate average yield by simple average without taking into account a size of a rice filed for crop cutting sample, as fields for crop cutting are selected with probability proportional to size
6	You can rotate sample dots without difficulty, as you can select samples easily with the Dot Sampling Method.

Note: For crop cutting, you need to select sample fields with probability proportional to size.

With a conventional method, you are supposed to select spots for crop cutting in a way such as: 1) you have to calculate accumulated rice planted area of villages and select villages with probability proportional; 2) you make a list of farmers of selected villages, and systematically select farmers from the list; 3) you select fields of selected farmers systematically; 4) you select spots for crop cutting.

Even with a conventional method, it is difficult to select sample field precisely with probability proportional to size.

5.2 Three procedures for a Rice Yield Survey using the Dot Sampling Method

Procedure	Instruction	Remark
1	Select sample spots for crop cutting.	This is a core part of yield survey. In the training you learn the Dot Sampling Method to select sample spots.
2	Cut rice, thresh, cleanse, dry and weigh.	In the lecture, you neglect the moisture of rice because of limitation of time.
3	Estimate an average yield of rice in a target region	

5.3 Let's select sample spots for crop cutting

At first, you need to calculate a size of a sample for crop cutting.

Suppose you know that the coefficient of variation of rice yield in Tsukuba Hamlet is about 18% from the past data and you want to get data with 10% precision, the sample size is as follows:

$$\text{The number of samples} = \frac{(population\ CV)^2}{(aimed\ precision)^2} = \frac{18^2}{10^2} \fallingdotseq 4$$

Secondly, you need to select sample spots for crop cutting with probabilities proportional to size. In the lecture, you are going to use the Dot Sampling Method so that you can select sample spots for crop cutting with probabilities proportional to size. You don't need to prepare a list of farmers with planted area in Tsukuba Hamlet for selecting sample rice fields.

In the lecture, we select 6 sample spots for crop cutting using the Dot Sampling Method. You are divided into 3 groups. Each grope conducts crop cutting for 2 sample spots.

Let's select 6 sample spots.

Suppose you know the results of a planted area survey and 49 dots out of 80 dots fall on rice planted spots, you extract six sample dots for crop cutting at random out of 49 dots (Code No12 in the figure below) using systematic sampling method.

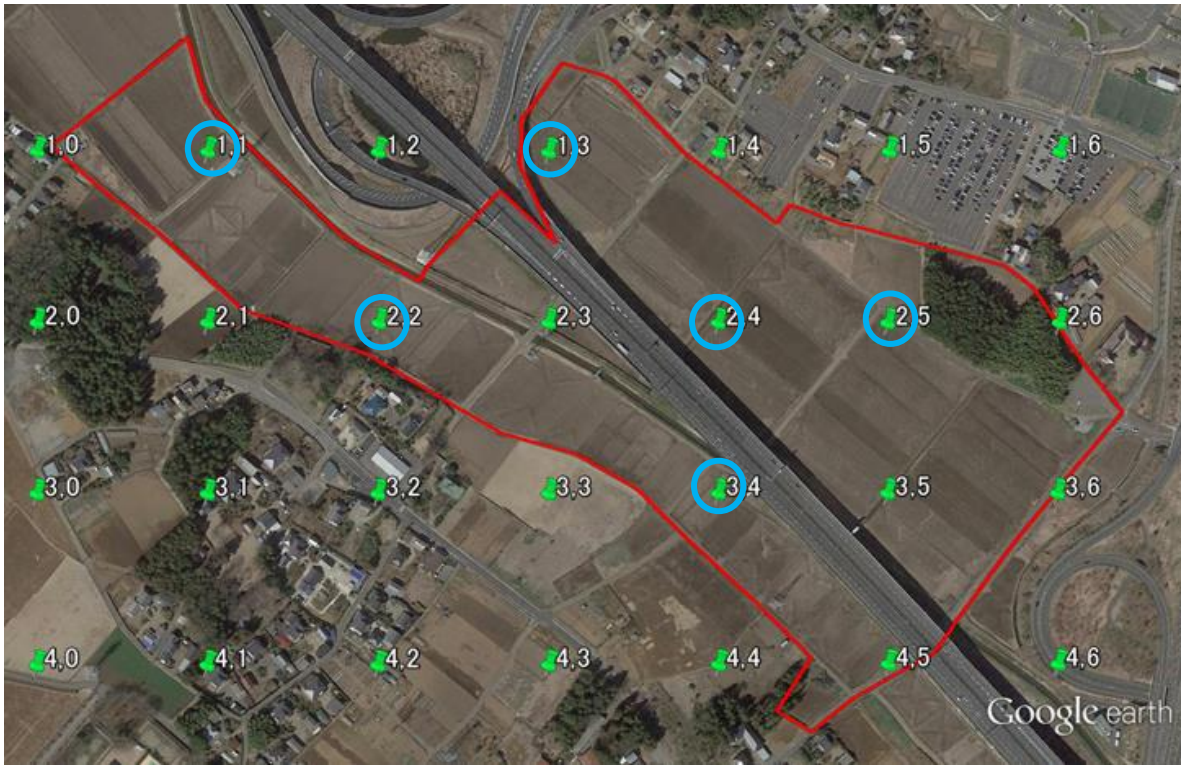
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0																			
1																			
2		1	12	1						12	1								
3		1	12	1	1					12	12	12							
4				12	12	1			1	12	12	12	12	1	4				
5					4	12	12	1	12	1	12	12	12	12	1	1	1		
6							12	12	1	1	1	12	12	12	12	12	1	1	
7									12	12	12	1	12	12	12	12	12	12	13
8											12	12	1	12	12	12	12	12	
9												4	12	1	12	12	12		
10													1	12	1	12			
11														1	12	1			
12														13					
13																			

If you haven't conducted a planted area survey with the Dot Sampling Method but conducted in other way, you can use an alternative way.

Suppose you know that area of rice field in the target area is 0.1225 km^2, you fill in necessary data in “LL Sheet for the dot sampling”.

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
JICA 6 (0.1225)	*0.1225*	*6*	36.032451	140.1226	36.026	140.1329



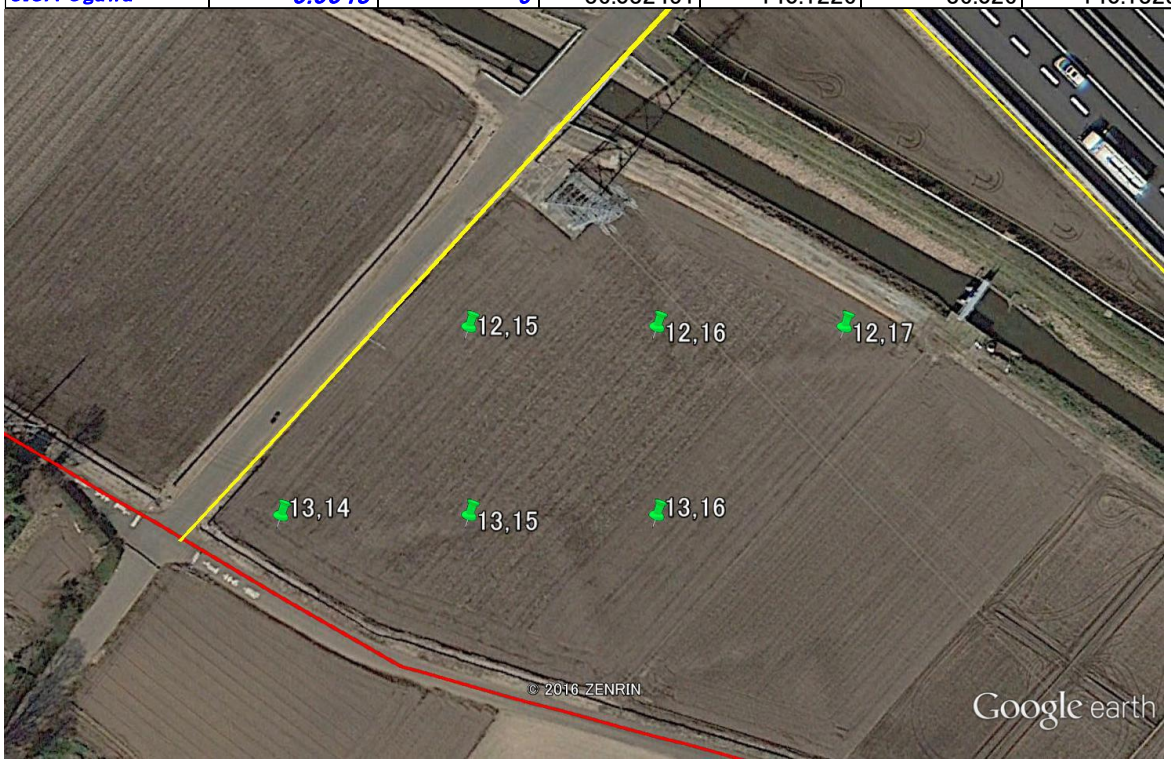
5.4 Let's cut rice, thresh, cleanse, dry and weigh

In the lecture, you cannot conduct crop cutting at spots you selected randomly in 5.3, as you have not got permissions from 6 farmers. In the lecture, you use Mr. Ogawa's rice field that JICA has got permission already. This means you cannot calculate the average yield of JICA Hamlet in the lecture, but please say that the results are the average yield of Tsukuba Hamlet as a makeshift.

Let's select sample spots in Mr. Ogawa's rice field as follows:

T-1 Basic data to generate sample dots (Sampling Design)

Target area	Size of the Target area km^2	Sample size	Starting point (latitude)	Starting point (longitude)	Finishing point (latitude)	Finishing point (longitude)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
JICA Ogawa	*0.0043*	*6*	36.032451	140.1226	36.026	140.1329



Before conducting a rice yield survey, you prepare equipment for crop cutting as follows:

	Equipment	Remark
1	Guide Map	Guide map leads you to crop cutting spots.
2	Questionnaire (Rice crop Cutting Survey Form)	You collect related information from a farmer.
3	Crop cutting frame (1m^2)	You thresh the sample rice within a crop cutting frame.

4	Sickle	You use a sickle for cutting rice.
5	Sheet	You thresh the sample rice on a sheet.
6	Winnower	You use a winnower to cleanse the sample rice.
7	Bag	You use a bag for carrying the sample rice to a lecture room.
8	Label	You put a label into a bag for identifying the sample rice.
9	Balance (1kg) and basket	You put the sample rice in a basket and weigh the sample rice in a basket.
10	Calculator	You calculate yield with a calculator.
11	Manual for crop cutting	

Let's go to the field where a sample dot falls on.
You conduct crop cutting as follows:

Procedure	**Activity**
1	You interview a farmer using a questionnaire or Rice Crop Cutting Survey Form.
2	You visit a sample dot spot and conduct crop cutting using $1m^2$ frame at a spot. Note that you harvest the sample rice with normal attention or in a same way as a normal farmer does.
3	You thresh the sample rice on a sheet and cleanse the threshed sample rice with winnower.
4	You put the sample rice into a bag with a label.
5	You carry the sample rice to a lecture room.
6	You dry the sample rice to a defined moisture content. In the lecture, however, you ignore moisture content because of time restriction.
7	You measure the weight of the sample rice.
8	You fill in Rice Crop Cutting Survey Form with the results.

Rice Crop Cutting Survey Form

Sample name	Province	Pefecture	District	village	Hamlet	Crop Season

Enumerator	Tel:

Name of Farmhoushold	

(Interview Items)

Date of interview:

Total area of cultivated land (ha)	total rice planted area (ha)	Area of sample field (ha)	irrigation of rainfed	Planting method
			1 irrigation 2 Rainfed 3 Upland	1 seeds broad casting 2 Transplanting 3 Upand panting

Variey			Planting date	Havesting date	Grwing condition	Reason of bad conditon or very bad conditon	Quantity of seeds per ha (kg)
Shape	Name	Glutinous					
1 Short 2 Midium 3 Long		1 Glutinous 2 Others			1 Very bad 2 Bad 3 Normal 4 Good 5 Very good	1 Disease 2 Insect 3 Drought 4 Heavy rain	

Organic fertilizer	Chemical Fertilizer	Pesticide	caltivating machine	Harvesting Mchine	Purpose of rice production	Techinical assistance from		Estimated yeild in this year (t/ha)	Yield in last year (t/ha)
1 Used 2 Not used	1 Used 2 Not used	1 Used 2 Not used	1 Used 2 Not used	1 Used 2 Not used	1 Commerce 2 Not for sale				

(Crop Cutting Yield Survey)

Date of survey:

Item	result of crop cutting
(1) Weight of cleaned&dried rice (g)	g/(1mx1m)
(2)Yield per ha (t) = (1)/100	t/ha

Memo

5.5 Let's estimate an average yield of rice in Tsukuba Hamlet

You can estimate an average yield in Tsukuba Hamlet with simple average of samples. You don't need to take into account a size of rice field for each sample, as each sample has been selected with probability proportional to size.

The table below shows a format to calculate a sample mean, sample variance, sample standard error and sample CV.

Sample number (n = 6)	Symbol	Yield(t/ha)	$(X_i - \bar{X})$	$(X_i - \bar{X})^2$
No1	X_1			
No2	X_2			
No3	X_3			
No4	X_4			
No5	X_5			
No6	X_6			
Total	$\sum X_i$		$\sum (X_i - \bar{X})^2$	
Sample mean (Estimated Yield)	$\bar{X}$		$s^2 = \frac{1}{n-1}\sum (X_i - \bar{X})^2$	
			$s = \sqrt{s^2}$	
			$CV_{\bar{X}} = \frac{s}{\bar{X}} \times 100$	

Item	Symbol	Formula	Results
Sample variance	s^2	$\frac{1}{n-1}\sum (X_i - \bar{X})^2$	
Sample standard deviation	s	$\sqrt{s^2}$	
Sample coefficient of variation(%)	$CV_{\bar{X}}$	$\frac{s}{\bar{X}}$	

Let's estimate an average rice yield in Tsukuba Hamlet.

An average yield in Tsukuba Hamlet is estimated to be a sample mean:

$$\bar{X} = \frac{\sum X_i}{n}$$

A standard error of an average yield is calculated by the formula bellow:

$$s_{\bar{X}} = \sqrt{\frac{s^2}{n}}$$

when $s^2 = \frac{1}{n-1}\sum (X_i - \bar{X})^2$

Sample mean variance	$s_{\bar{X}}{}^2$	$\frac{s^2}{n}$	
Standard error (sample error)	$s_{\bar{X}}$	$\sqrt{s_{\bar{X}}{}^2}$	
Sample mean coefficient of variation(%)	$\mathrm{CV}_{\bar{X}}$	$\frac{s_{\bar{X}}}{\bar{X}}$	

A table below shows the results of the yield survey conducted in 2017 at JICA Hamlet: trainees selected six sample spots for conducting crop cutting. The results are: average yield is 8.88t/ha, precision is 4.98%, sampling error is 0.44t.

Sample number (n = 6)	Symbol	Yield(t/ha)	$(X_i - \bar{X})$	$(X_i - \bar{X})^2$
No1	X_1	9.21	0.33	0.11
No2	X_2	8.77	−0.11	0.01
No3	X_3	8.77	−0.11	0.01
No4	X_4	10.59	1.71	2.93
No5	X_5	7.21	−1.67	2.78
No6	X_6	8.72	−0.16	0.03
Total	$\sum X_i$	53.27	$\sum (X_i - \bar{X})^2$	5.87
Sample mean (Estimated Yield)	$\bar{X}$	8.88	$s^2 = \frac{1}{n-1}\sum (X_i - \bar{X})^2$	1.17
			$s = \sqrt{s^2}$	1.08
			$CV_{\bar{X}} = \frac{s}{\bar{X}} \times 100$	12.21

Item	Symbol	Formula	Results
Sample variance	s^2	$\frac{1}{n-1}\sum (X_i - \bar{X})^2$	1.17
Sample standard deviation	s	$\sqrt{s^2}$	1.08
Sample coefficient of variation(%)	CV_X	$\frac{s}{\bar{X}}$	12.21

Sample mean variance	${s_{\bar{X}}}^2$	$\frac{s^2}{n}$	0.20
Standard error (sample error)	$s_{\bar{X}}$	$\sqrt{{s_{\bar{X}}}^2}$	0.44
Sample mean coefficient of variation(%)	$\mathrm{CV}_{\bar{X}}$	$\frac{s_{\bar{X}}}{\bar{X}}$	4.98

(For more information)

Alternative Way for Selecting Sample Spots for Crop Cutting

In case that you don't know the Dot Sampling Method, alternative crop cutting survey design is shown as follows. Please note that you need to prepare list of farmers to select sample spots with probability Proportional to size.

In following case, the target region or the estimation unit is District and there are dozens of villages in a District.

(1) Sampling frame

The sampling method for rice yield survey is "Two Stage Sampling". Villages are used as the Primary Sampling Unit (PSU). Farm households in the sample villages are used as the Secondary Sampling Unit (SSU).

(2) The number of samples and sample allocation

You decide the number of PSUs is 10 villages per District and the number of SSUs is 2 farm households per village.

(3) PSU sampling

Concerning PSU sampling, you use the PPS method or the probability proportional sampling to size of planted area. At first, you need to make a list of villages in a District. And then you select sample villages using the PPS method.

(4) SSU sampling

Concerning SSU sampling, you apply systematic random sampling. At first, you need to make a list of farm households in a sample village. And then you select sample farm households using a random table.

(5) Selecting a sample field of each sample household

You select sample fields at random. At first, you need to make a list of fields of each sample farm household. And then you select a sample field of each sample household using a random table.

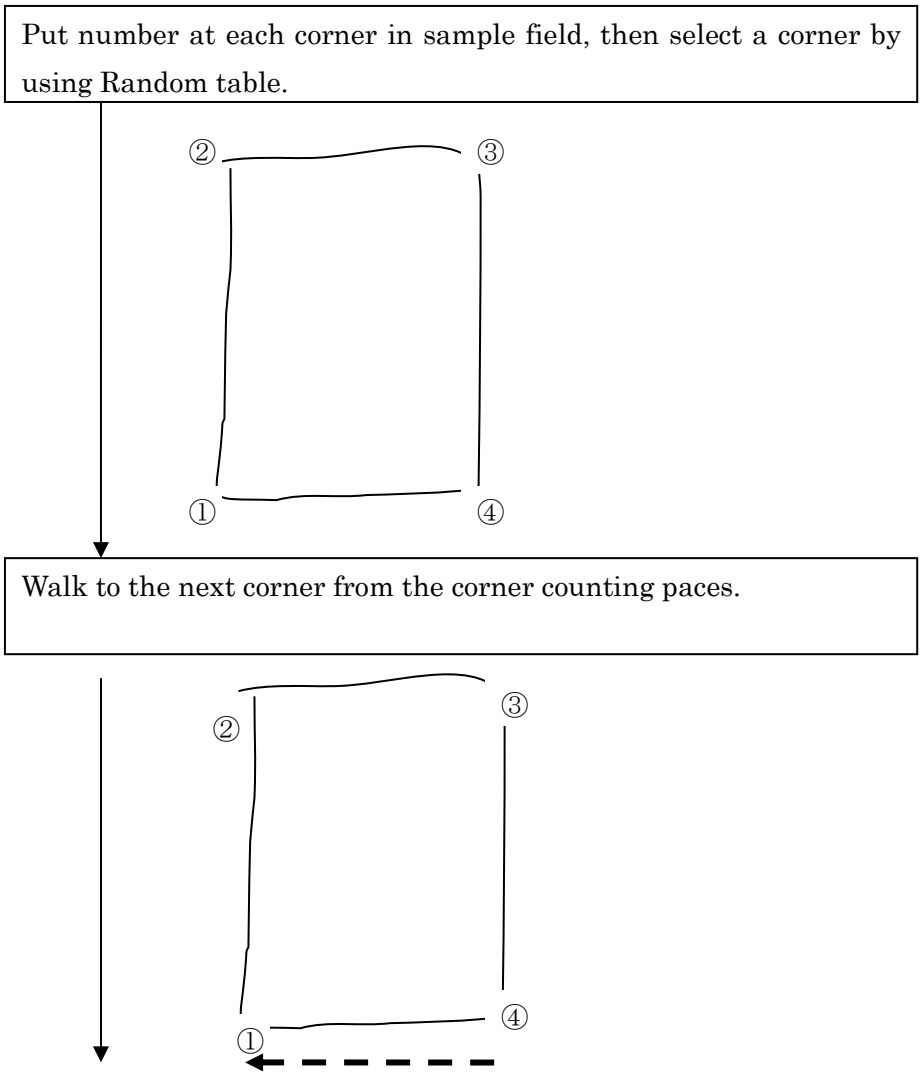
(6) Selecting sample spots in each sample field

You select two sample spots at random in each sample field. At first, you select a starting point to so select a sample spot. And then you select a

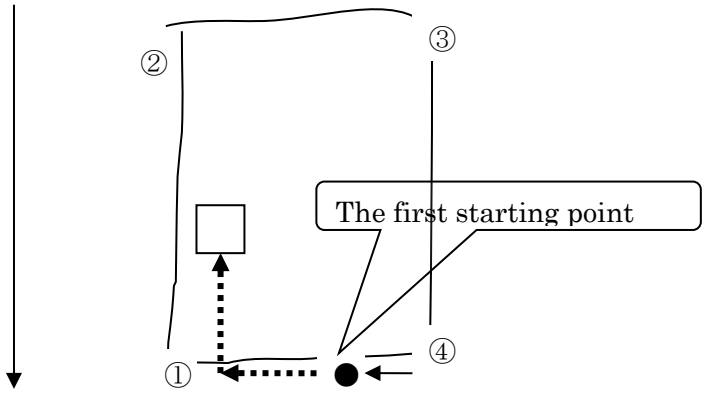
sample spot using, say, 30 paces method in the sample field. The second starting point is decided at the opposite point on the field.

(For more information)

The followings are the selecting 2 samples spots by using 30 paces method in the sample field written by Mr.Issei Jinguji.



Decide the first starting point to walk 30 paces based on the paces by using Random table. The second starting point is decided at the opposite point on the dyke.



Source: Mr.Issei Jinguji, Rice Crop Cutting Survey, December 2007

Chapter 6 Production Survey

In this chapter, you learn the concept of a production survey and make a report on the results of the survey.

6.1 Let's compile the results of a rice production survey

Let's remember the formula below, which you have already learnt in Chapter 3 Package of Crop Production Survey.

Production survey = Yield survey + Area survey

You have already conducted a rice planted area survey and a rice yield survey in Chapter 4 and chapter 5.

The time has come at last for you to estimate the value of rice production in Tsukuba Hamlet. You multiply **average yield** of rice in Tsukuba Hamlet and total **planted area** of rice in Tsukuba Hamlet together.

Total production of rice in Tsukuba Hamlet
=
Average yield of rice in Tsukuba Hamlet
×
Total planted area of rice in Tsukuba Hamlet

Let's conduct a production survey.

The formula of a production survey

$$\hat{Y} = \bar{X} \times \hat{T}$$

where $\hat{Y}$: Total Rice production in Tsukuba Hamlet
$\bar{X}$: Estimated Average Yield of Rice from the Yield Survey
$\hat{T}$: Estimated Rice Planted Area from the Planted Area Survey

Precision of estimated total rice production

$$CV_{Production} = \sqrt{CV_{yield}^2 + CV_{Planted\ Area}^2}$$

	Yield (t/ha)	Planted area (ha)	Production (t)
Estimation			
C.V. (%)			
Survey Method	Crop Cutting, Selection of sample spots with Probability Proportional to Size using the Dot Sampling Method	Attribute survey with the Dot Sampling Method	Production = Yield × Area

A table below shows the results of the rice production survey in Tsukuba Hamlet conducted in 2017: production of rice in the target region and the precision are estimated 109t and 10.2% respectively.

	Yield (t/ha)	Planted area (ha)	Production (t)
Estimation	8.88	12.25	109
C.V. (%)	4.98	8.9	10.2
Survey Method	Crop Cutting, Selection of sample spots with Probability Proportional to Size using the Dot Sampling Method	Attribute survey with the Dot Sampling Method	Production = Yield × Area

In the lecture, it took two days for you to conduct a rice production survey: one day for a rice planted area survey and one day for a rice yield survey in

Tsukuba Hamlet. Isn’t it amazing to conduct a production survey in such a short time? In traditional ways, you need considerable days to conduct a production survey, because you need to make a list of farmers to select sample farmers, fields and spots for crop cutting. Now you can enjoy conducting area survey in dramatically short time with the Dot Sampling Method.

6.2 Let's make a rice crop production report

The last stage of a survey is for you to make a report of the results of the survey. In the lecture, you write a brief report on the rice production in Tsukuba Hamlet for a press release and hold a press conference.

An example of report form is shown below.

(Example of Report Form)

Rice Production in Tsukuba Hamlet 2018

JICA Training: Planning and Designing of Crop Production Surveys

Press conference: 9:45am on 29 August, 2018

Reporter: Ms. Gozaimasu Ohayou

Results:

Production

Planted Area

Yield per ha

Comments:

Statistical Methodology:

Survey Procedure

Estimating Procedure

Reliability

(For more information)
The followings are USDA Report on crop production.

Crop Production

ISSN: 1936-3737

Released July 12, 2018, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Winter Wheat Production Down Less Than 1 Percent from June
Durum Wheat Production Up 36 Percent from 2017
Other Spring Wheat Production Up 48 Percent from 2017
Orange Production Down 1 Percent from June

Winter wheat production is forecast at 1.19 billion bushels, down less than 1 percent from the June 1 forecast and down 6 percent from 2017. As of July 1, the United States yield is forecast at 48.0 bushels per acre, down 0.4 bushel from last month and down 2.2 bushels from last year's average yield of 50.2 bushels per acre. The area expected to be harvested for grain totals 24.8 million acres, unchanged from the *Acreage* report released on June 29, 2018, but down 2 percent from last year.

Hard Red Winter production, at 657 million bushels, is up 1 percent from last month. Soft Red Winter, at 303 million bushels, is down 4 percent from the June forecast. White Winter, at 232 million bushels, is up less than 1 percent from last month. Of the White Winter production, 21.1 million bushels are Hard White and 211 million bushels are Soft White.

Durum wheat production is forecast at 74.9 million bushels, up 36 percent from 2017. The United States yield is forecast at 40.7 bushels per acre, up 15.0 bushels from last year. Area expected to be harvested for grain or seed totals 1.84 million acres, unchanged from the *Acreage* report released on June 29, 2018, but 14 percent below 2017.

Other spring wheat production is forecast at 614 million bushels, up 48 percent from last year. Area harvested for grain or seed is expected to total 12.9 million acres, unchanged from the *Acreage* report released on June 29, 2018, but 27 percent above 2017. The United States yield is forecast at a record high 47.6 bushels per acre, up 6.6 bushels from last

Rice Production in 2017 totaled 178 million cwt, down 20 percent from the 2016 total. Planted area for 2017 was estimated at 2.46 million acres, down 22 percent from 2016. Area harvested, at 2.37 million acres, was down 23 percent from the previous crop year. The average yield for all United States rice was estimated at 7,507 pounds per acre, up 270 pounds from the 2016 average yield of 7,237 pounds per acre.

Statistical Methodology

Survey procedures: The estimates in this report are based primarily on surveys conducted the first two weeks of December. The December Agricultural Survey (DAS) is a probability survey that includes a sample of approximately 81,800 farm operators selected from a list of producers that ensures all operations in the United States have a chance to be selected. Data from operators was collected by mail, internet, telephone, or personal interview to obtain information on crop acreage, yield and production for the 2017 crop year.

Estimating procedures: National and State level objective yield and farm operator reported data (DAS) were reviewed for reasonableness and consistency with historical estimates. The survey data were also reviewed considering weather patterns and crop progress compared with previous years. Each Regional Field Office submits an estimate and written analysis for their State to the Agricultural Statistics Board (ASB). The ASB uses the survey data, administrative data, and the State analysis to prepare the estimates published in this report.

Revision policy: Estimates contained in this report may be revised the following year, if new information is available that would justify a change. Estimates will also be reviewed after data for the 5-year Census of Agriculture are available. No revisions will be made after that date.

Reliability: The surveys used to make the acreage, yield, and production estimates contained in this report are subject to sampling and non-sampling type errors that are common to all surveys. Reliability of the objective yield and farmer survey must be treated separately because the survey designs for the two surveys are different. The objective yield indications (corn, cotton, and soybeans) are subject to sampling variability because all acres of a given commodity are not included in the sample.

Chapter 7 Presentations on your Output from the Lecture

7.1 Let's review the lecture

7.1.1 Crop Production Survey

You multiply average yield of rice in Tsukuba Hamlet and total planted area of rice in Tsukuba Hamlet together in order to estimate the amount of rice production in Tsukuba Hamlet. You need to plan and design yield survey and area survey together.

7.1.2 Planted Area Survey

You have learnt a planted area survey using the Dot Sampling Method. The dot Sampling method has characteristics such that 1) its survey object is not a person but a land, 2) it doesn't require population composition, 3) it is easier to be conducted, 4) non-sampling errors hardly occur, as it is not a variable survey but an attribute survey.

There are four steps for an area survey using the Dot Sampling Method. 1) to put sample dots on Google Earth, 2) to examine attributions of sample dots on Google Earth to classify sample dots into two categories, one is sample dots which you need to conduct a field survey to examine their attribution and another is sample dots which you don't need to conduct a field survey, 3) conducting a field survey to visit sample dots to check whether rice is planted or not at a spot of each sample dot, and 4) to estimate area.

7.1.3 Yield Survey

Purpose of a rice yield survey is to estimate average yield of rice in Tsukuba Hamlet.

Crop cutting method is an objective survey method to estimate average yield.

You can use the Dot Sampling Method to select samples for crop cutting. With the Dot Sampling Method, you can dramatically streamline the process of selecting samples.

Major advantages of applying the Dot Sampling Method to yield survey is that you can select sample spots for crop cutting even when you don't have a list of farmers or you don't know rice planted area of each village. With the Dot Sampling Method, a spot which a sample dot falls on is exactly a crop cutting spot, as you can select a sample rice field with perfect probability proportional to size.

7.2 Let's make a presentation

On 29 August 2018, the last day of the lecture "Planning and Designing of Crop Production Survey", each of you make a presentation as an output of the training.

The purpose of the presentation is:

1) to make sure what you have learnt through the training,

and

2) to tell your colleagues what you learnt during the training.

The followings are examples of forms for summarizing what you have learnt through the training.

Summary of the designing and Planning of Crop Production Survey

Name _____ Country _____

	Planted Area Survey
purpose	
Activities	
Output	
Impression, Suggestion	

Name Country

	Yeild Survey
purpose	
Activities	
Output	
Impression, Suggestion	

Name Country

	Crop Production Survey
purpose	
Activities	
Output	
Impression, Suggestion	

Name Country

	Others
purpose	
Activities	
Output	
Impression, Suggestion	

Before & After Analysis

Name _____ Country _____

	Before Training	After Training
Planted Area Survey Dot Sampling Method		
Yield Survey Crop Cutting		
Crop Production Survey Yield x Planted Area		
Presentation, Others		

(Reference)

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