


PET - Cereals

A Pictorial Evaluation Tool for Crop Harvest Assessment in Ethiopia




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A Pictorial Evaluation Tool for Crop Harvest Assessment For Ethiopia

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CAZS | Centre for Arid Zone Studies

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Designed by C.M. Stirling

What is PET-Cereals ?

PET-Cereals is a pictorial manual designed to help you achieve more accurate estimates of crop yield at harvest time. It does this by allowing you to compare your crop with a photographic key showing a range of yields commonly found in farmers' fields. You will be able to judge the yield of your crop by comparing your field with the photographs and so estimate yield in a more consistent and accurate manner.

Crop assessment is essential in any analysis of rural situations where communities are wholly or partially dependent on agriculture. Accurate assessment of production at all levels from farm to region depends on an accurate knowledge of the **area** harvested and the **yield per unit area**. Estimates of cropped area are obtainable and verifiable from Peasant Associations, Bureau of Agriculture records and Central Statistical Authority surveys. Obtaining reliable estimates of yield per unit area, however, is more difficult.

Crop yields vary dramatically from place-to-place and from year-to-year and any meaningful assessment will require wide-ranging and detailed field visits at the time of harvest. Often these data are collected by non-specialists who rely heavily on interviews with key informants from rural communities, either farmers or administrators, whose estimates are usually conservative. In these circumstances, PET-Cereals provides you with a means of cross-checking informant opinion of crop yields in order to improve the level of objectivity and accuracy in annual assessment procedures.

Getting started

Whether you're already familiar with or new to crop assessment, it is important that you spend time reading this introduction. This explains not only how to use PET-Cereals but also how to cross-check your data – an important procedure that will ensure that you are using the manual correctly and accurately.

PET-Cereals consists of a set of photographs for each crop, representing three broad levels of production corresponding to 'good', 'medium' and 'poor' and coded red, yellow and blue, respectively. The main section of the manual describes the five most common cereals grown in Ethiopia[1]: wheat, barley, teff, maize and sorghum. Each cereal has three pages of photographs showing:

(i) the approach:	the field viewed from a distance to illustrate the height, variability and general health of the crop stand.
(ii) the close-up:	a close view of one square metre of the crop clearly showing plant density and size and condition of harvested parts.
(iii) the range of yield:	two different formats are used to show yield. For wheat, barley and teff a series of close-up views are shown[2], whilst for maize and sorghum, photographs show the size and number of cobs or heads from one square metre. The corresponding yield is printed in units of tonnes per hectare (t/ha). Details of how to convert to different units of yield, including quintals per hectare (qt/ha), are given in appendix I.

In the 'close-up' and the 'range of yield' pages, a notepad (21 cm x 12 cm) is placed within the crop or alongside the harvested parts to provide you with a true perspective of size and quantity.

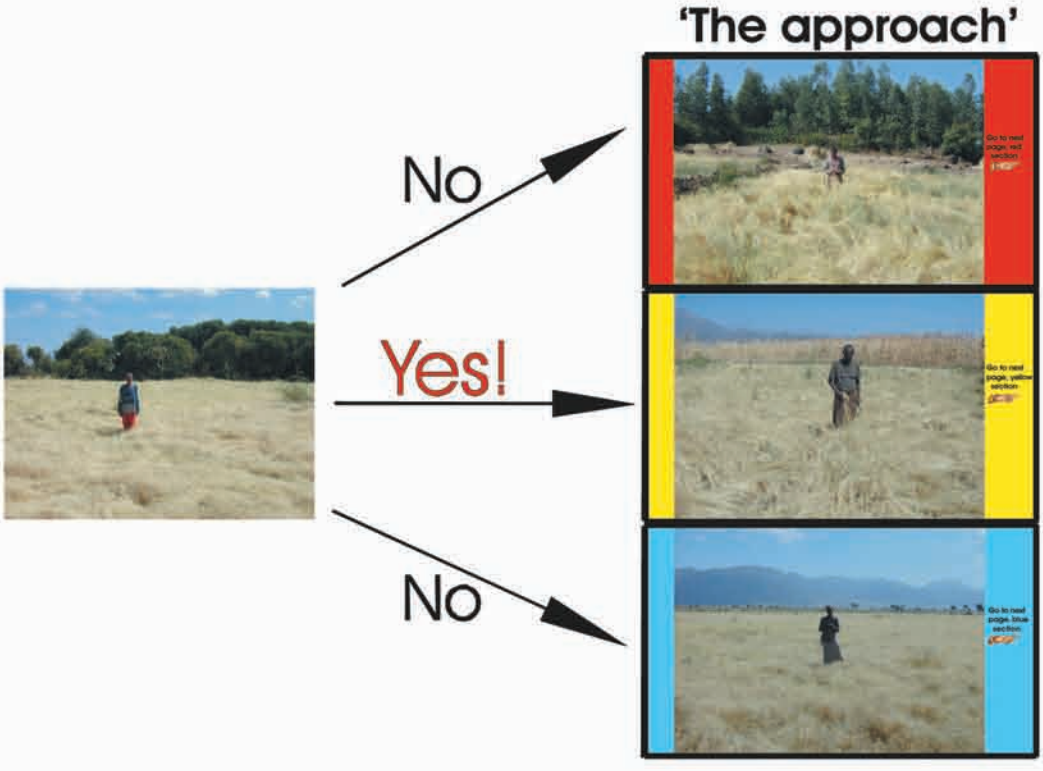
[1] See appendix III for further information on finger millet.
[2] See appendix II for additional photographs of threshed grain produced from one square metre.

STEP 1:
Determining the production level

The first step in estimating crop yield is to determine which of the three production levels (coded red, yellow or blue) best describes your crop. To do this, use only the 'approach' and 'close-up' pages. View the field from several different positions, from both a distance and within the stand to get a true picture of the variability and general health of the crop.

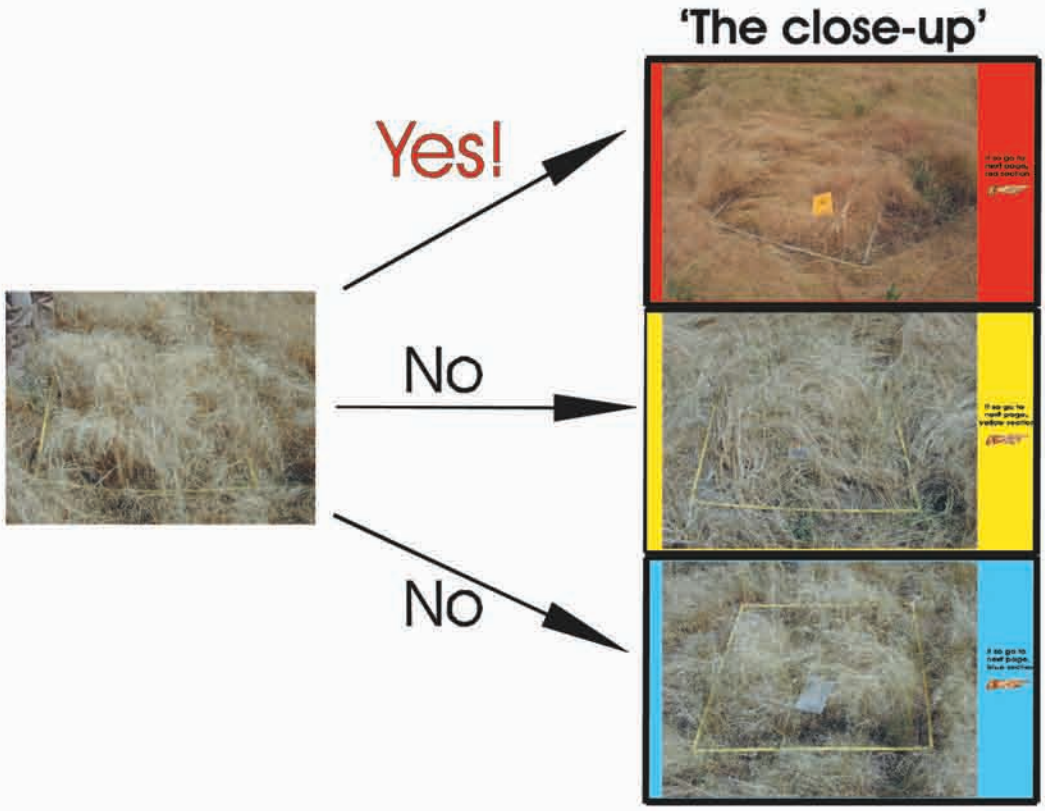
The first page has three photographs showing the field viewed from a distance (i.e. 'the approach') giving impressions of the overall condition of the crop stand for three levels of production. The corresponding close view of one square metre of crop for each level of production is shown on the second page (i.e. 'the close-up'). By comparing your crop viewed at a distance and close-up with the relevant set of photographs, you will be able to choose which of the three levels of production best describes your crop.

In this example, the crop of teff is best described by the 'yellow' production level.



To check your choice of production level, take a closer look at the crop by walking through it taking care to keep damage to a minimum. Compare your impression of the crop with the 'close-up' photographs on the second page of PET-Cereals. In some cases, you may find that on closer inspection the crop is less dense or less healthy than it appeared from a distance or vice versa.

In this example, on closer inspection the teff crop looks denser and the grain heads are better filled than those shown for the 'yellow' production level. In fact, the 'red' production level provides a better match.



Photographs are annotated to offer guidance in terms of the key indicators representing a particular level of production. The 'close-up' page for wheat, barley and teff has a further set of photographs and text explaining how to evaluate grain size and the condition of the grain head and where appropriate how to relate this to a production level.

STEP 2:
Estimating crop yield

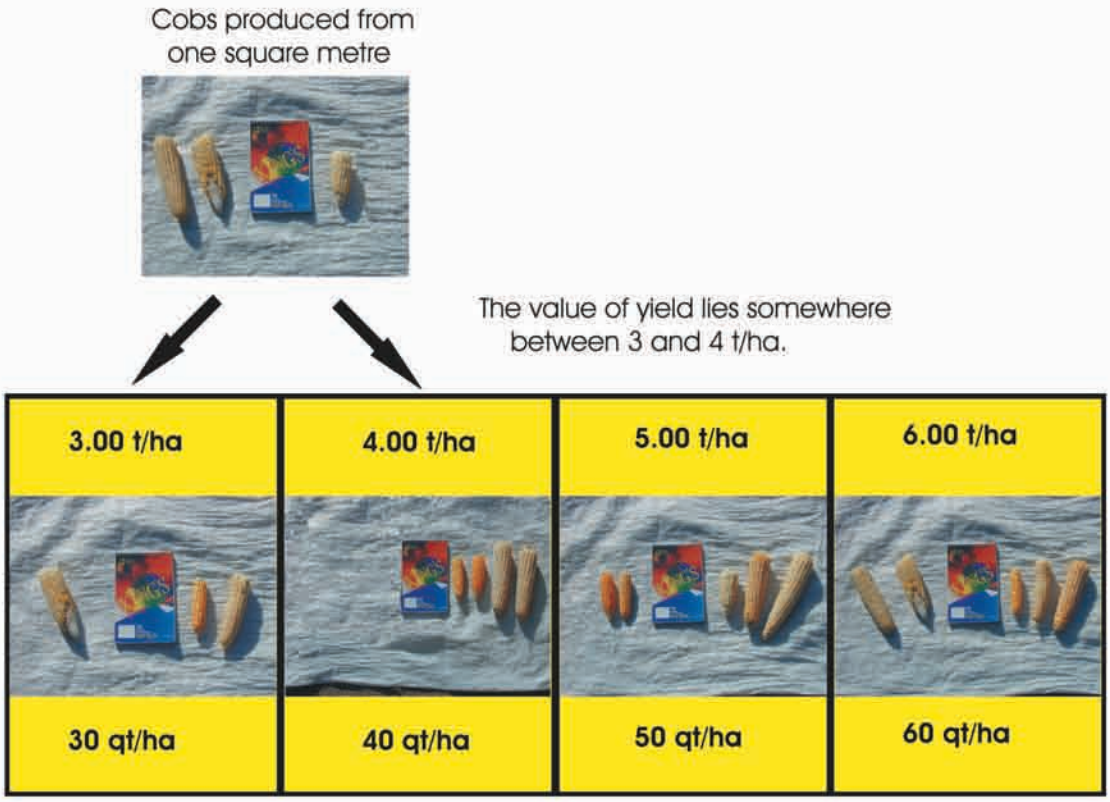
The second step in estimating crop yield is to decide which photograph(s) of the harvested parts best represents your crop. Look closely at the crop stand and compare the yield components with those shown on the 'range of yield' page. In some cases, the yield of your crop may not fit exactly with the photographs shown by PET-Cereals. If this is the case, you will have to estimate the yield by deciding where the value lies relative to the nearest yield value(s) shown.

Remembering the production level you chose after Step 1, turn to the third page (i.e. 'range of yield') and concentrate on the set of photographs representing this production level. Two different formats are used to guide you in your evaluation. For grain crops (i.e. wheat, barley and teff), yield is depicted by a series of 'close-up' photographs of one square metre, showing stand health, density and grain-head size. For stover crops (i.e. maize and sorghum), yield can be estimated by comparing your crop with a series of photographs showing the size and number of maize cobs or sorghum heads produced per one square metre of crop.

Next to each photograph, the yield is printed in units of tonnes per hectare (t/ha)[3]. If the photographs shown by PET-Cereals do not exactly match your crop, you will need to estimate yield by judging where the true value lies relative to the closest matching photograph(s). The example on the next page shows how to estimate the yield of a crop of maize that does not conform exactly to the yield levels shown by PET-Cereals.

[3] See appendix I for details of calculations.

Estimating yield of a maize crop where the value of yield lies between the intervals shown by PET-Cereals.



Firstly, you need to decide which photograph(s) is closest to your crop. In the example above, your crop has produced the same number of cobs from one square metre as the 3 t/ha crop but the size differs. By comparing the size of the cobs using the notepad for perspective, you would estimate that yield lies somewhere between the 3 and 4 t/ha crops and so arrive at a value of 3.5 t/ha. In fact, the actual measured yield was 3.4 t/ha so the estimate using PET-Cereals would be perfectly acceptable.

Estimated yield = 3.5 t/ha or 35 qt/ha

STEP 3:
Accounting for field variability

Once you are familiar with the procedure for estimating crop yield using PET-Cereals you can further refine your estimates by taking into account the variability of the field. In many situations, you will find sections of the field where the crop has been damaged because of water logging, water stress, poor soil, pests or diseases. This section explains how to deal with such variability.

Where the field is not uniform you will need to determine the proportion of the field that corresponds to a particular production level. You are advised to divide the field into two, and at most three, different levels of production.

In the example shown, an uneven field of wheat is divided into two sections accounting for 2/3^{rds} and 1/3rd of the total field area. The two sections are compared with the relevant 'approach' and close-up' pages of PET-Cereals and the larger section is categorised as falling within the 'yellow' range of production and the smaller section within the 'blue' range (following the procedure outlined in Step 1). The value of yield for each section is estimated using the procedure described in Step 2, resulting in estimates of 3 t/ha and 0.5 t/ha (see example).

To calculate proportional and total yield per hectare for wheat:

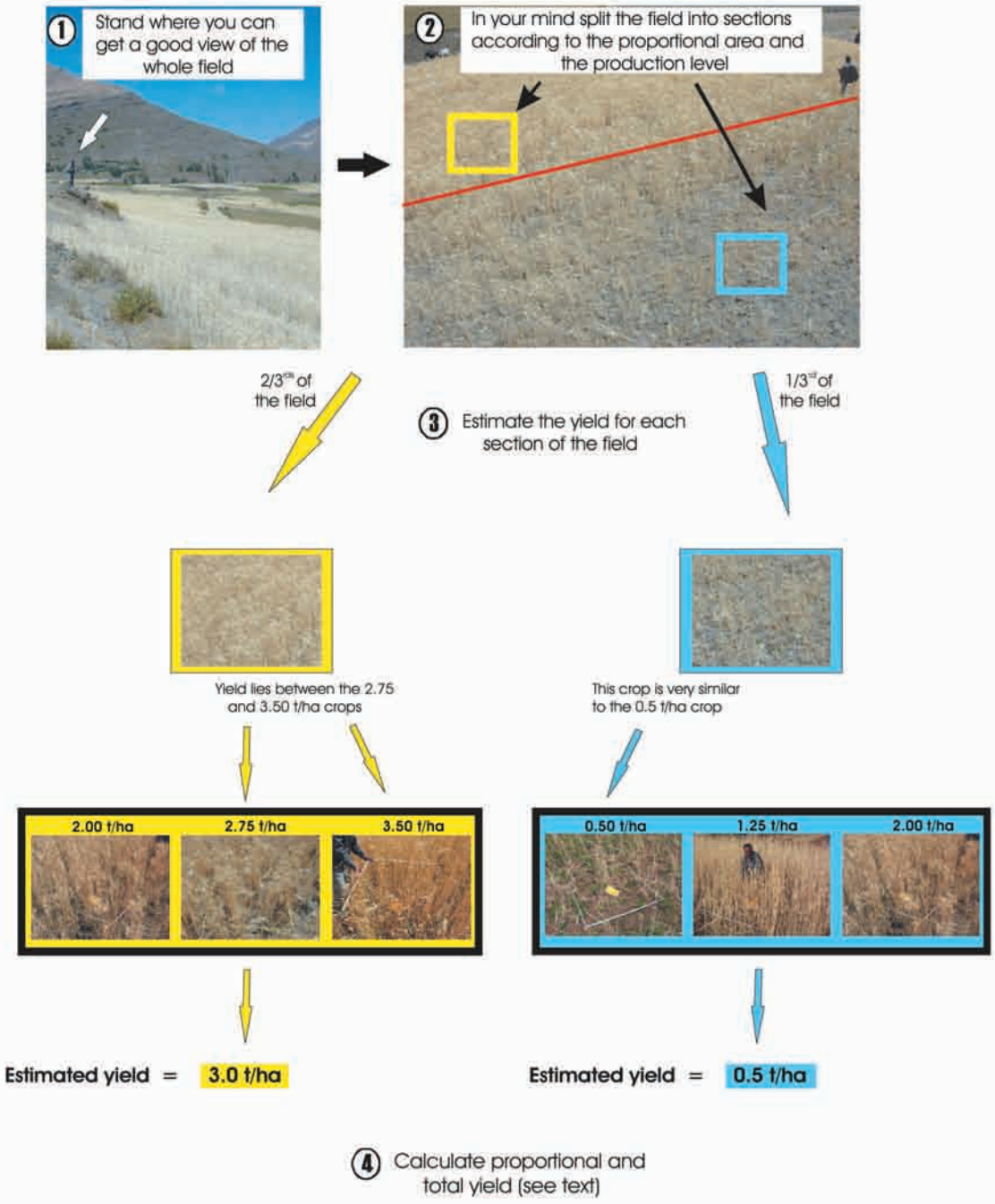
Referring to the example overleaf, the wheat field is best described by two levels of production; 2/3^{rds} of the field produced a yield of 3 t/ha and 1/3rd produced a yield of 0.5 t/ha.

The proportional yield is:

3 x 2/3 = 2 t/ha
0.5 x 1/3 = 0.17 t/ha

Total field yield = 2 + 0.17 = 2.17 t/ha

Example of how to estimate the yield of a variable field of wheat using PET-Cereals.



STEP 4:
Cross-checking your data

To ensure that your estimates of crop yield are accurate it is vital that you regularly cross-check your data by following the crop cutting procedure outlined below. It is recommended that you cross-check your data at regular intervals and whenever you are using PET-Cereals in a new situation, for example a new crop or different variety of crop.

Crop cutting is the method used to cross-check your PET-Cereals estimates of crop yield against measured values of yield. This procedure will determine whether there is a tendency to over- or under-estimate yield and so, allow you to make the necessary adjustments to improve the accuracy of data collection. It is vitally important that you regularly cross-check your data and it is recommended that you do this in the following situations:

- When using PET-Cereals for the first time.
- When assessing a new crop.
- When assessing crops in a new region.
- When assessing a different variety of the same crop (e.g. two-row versus four-row barley, dispersed versus compact heads of sorghum).
- Finally, at regular intervals during crop assessment to ensure that no systematic errors are introduced.

Crop cutting is recommended when assessing a different variety of the same crop e.g. dispersed (left) vs compact (right) sorghum heads.

STEP 5:
Procedure for cross-checking data

Cross-checking your PET-Cereals estimates of crop yield involves taking crop cuttings from a known area of a crop and measuring the weight of the harvested parts to obtain the value of yield per unit area. In each situation where cross-checking your data is recommended, crop cuttings must be taken for a minimum of three separate fields. The procedure involved in crop cutting is described below.

1. Defining the field area

In your mind, define the field or section of a field that is to be assessed using PET-Cereals. Try to select an area with a fairly uniform production and avoid areas of high variability. If necessary, divide a highly variable field into different sections and production levels (see Step 3).

2. Estimating crop yield using PET-Cereals

Carry out your PET-Cereals assessment as detailed in Steps 1 to 3 of this manual.

2. Randomly selecting the field areas for crop cuttings

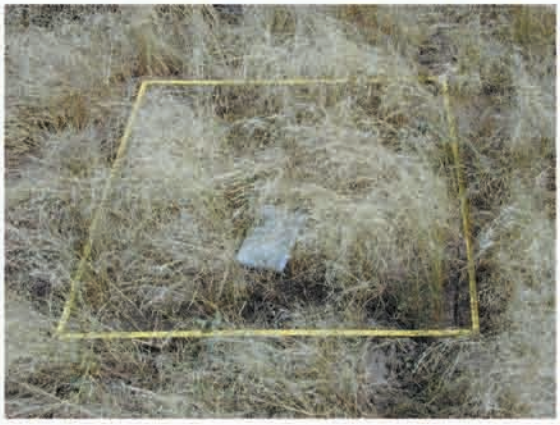
Take a long stick, mark one end and ask the farmer or a passer-by to turn their back to the field/area that has been defined (see 1 above) and throw the stick over their head into the crop. Where the stick lands in the crop will define the position for the first quadrat[4] and crop cutting. Stand the stick on its end making sure that the same marked end of the stick is used each time to mark the centre of the quadrat.

[4] A quadrat is the formal term for a very simple instrument that is used to define a known area of crop. It can be made up of four rulers or sticks (one metre in length), each defining one side of a square.

3. Placing the quadrat in the crop

The aim of the quadrat is to define a known area of crop from which plant and head counts and crop cuttings can be taken. To do this accurately, it is important that only those plants whose stems emerge from the soil within the boundary of the quadrat are included in the measurements.

For grain crops (i.e. wheat, barley and teff) it is easiest to place the quadrat on the ground. Plants should be separated into those that emerge within and outside the boundary of the quadrat.



For tall dense crops such as maize and sorghum, it is best to hold the quadrat at waist height within the stand. This makes it easier to define the area for plant and head counts.

4. Counting the number of heads/plants within the quadrat

Counting the number of heads and plants will help to develop your eye for assessing stand quality and density. These data will tell you something about the relationship between plant population and yield and how the importance of this relationship varies with different crops. Head counts are recommended for wheat and barley, whilst both plant and cob/head counts are required for maize and sorghum. Whilst counting, pay close attention to the size and fullness of grain head and cobs. Counts are not recommended for teff because of the complexity of its growth habit.

For wheat and barley, assistance will be required. Once counts are completed, you need to collect all data to add up the total for the quadrat.

5. Harvesting

For wheat, barley and teff, remove all the plants within the quadrat by cutting with a sickle or knife. For maize and sorghum it is only necessary to remove the harvested parts (i.e. cobs and heads). Take extra care to remove only those plants or cobs/heads of plants whose stem emerges from the soil within the boundary of the quadrat.

After crop cutting in wheat, barley and teff, your quadrat should look like this.

6. Threshing

The crop cuttings taken from the quadrat should be threshed until the grain is clean. Try to minimise any loss of grain during this procedure.

7. Weighing

Before each weighing, the spring balance scale should be calibrated to zero with a clean plastic bag. Do this in a sheltered position away from gusting winds.

The threshed grain should then be placed in the clean bag and the weight of the grain recorded.

8. Replication

It is recommended that a minimum of **three random quadrats** are taken per field. If the field is highly variable, in your head divide the field into separate sections with different levels of production. Take one random quadrat from each section of the field and calculate the average field yield by following the procedure outlined in Step 3. Data for counts and yield should be recorded separately for each quadrat.

Remember: whenever using PET-Cereals in a new situation, crop cuttings should be performed for a minimum of three fields.

9. Drying

If the grain is not dry when harvested and threshed, it should be stored in a clearly marked cloth bag stating the woreda, crop, field and quadrat number. The grain should be positioned in a safe place in the sun if stationary, or on the roof rack of the vehicle if mobile, so that the contents of the bag can be dried to a constant weight (i.e. to a point where two consecutive

measurements of the sample weight, separated in time by several hours, are the same).

10. Recording the data

All weights for each quadrat should be clearly recorded on a data sheet. Examples of the data sheet and the calculations required to scale up yield from one square metre to yield per hectare are given in appendices.

Wheat

STEP 1: Determining the production level

Wheat: the approach

What to look for:

- Plant density
- Plant health
- Grain size
- Spikelet number
- Weeds

Wheat: the close-up

Look closely at:

- Number of heads m^{-2}:
- Grain size and spikelet number

Are most of the heads well-developed like this one?

This head has 16 spikelets

If so go to next page, red section

Do most grain heads fall within the size range shown below?

If so go to next page, yellow section

Do most grain heads fall within the size range shown below?

If so go to next page, blue section

Wheat

STEP 2: Estimating the yield

3.50 t/ha ⟷ **5.50 t/ha**

2.00 t/ha ⟷ **3.50 t/ha**

0.50 t/ha ⟷ **2.00 t/ha**

Barley

STEP 1: Determining the production level

Barley: the approach

What to look for:

- Plant density
- Plant health
- Grain size
- Weeds
- Number of rows of grain
- Spikelet number

Barley: the close-up

Look closely at the type of barley

Two-row barley

Head appears flat because there are no lateral (or side) kernels.

Kernels are arranged symmetrically with no twisting

Six-row barley

Head appears rounded and packed because of the presence of lateral (or side) kernels.

Kernels are twisted giving a rounded appearance to the head

Look closely at the size of grain head

Counting kernels

Viewing the grain head from one direction - kernels are arranged in a symmetrical, alternating pattern along the head.

This two-row barley has 14 kernels. →

As with two-row barley, for six-row barley kernels are counted looking at the head from one direction only.

← This six-row barley has 15 kernels.

Look closely at the level of grain fill

Low yields

- Low number of kernels
- Poorly filled kernels

In this example the grain of the 22-kernel head is less well filled than the 15-kernel head.

High yields

- High number of kernels
- Well-filled kernels

From 200 heads m^{-2} upwards

Go to next page, red section

Between 150 to 250 heads m^{-2}

Go to next page, yellow section

Between 0 to 200 heads m^{-2}

Go to next page,blue section

Barley

STEP 2: Estimating the yield

2.00 t/ha ⟵ ⟶ **3.25 t/ha**

1.25 t/ha ⟵ ⟶ **2.00 t/ha**

0.50 t/ha ⟵ ⟶ **1.25 t/ha**

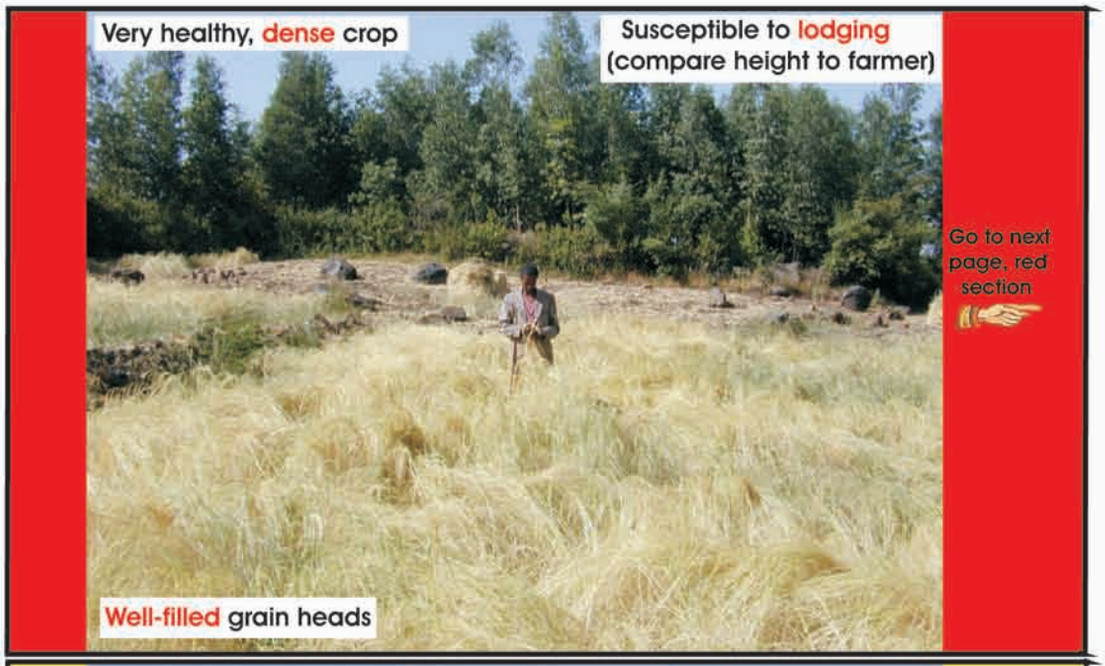
Teff

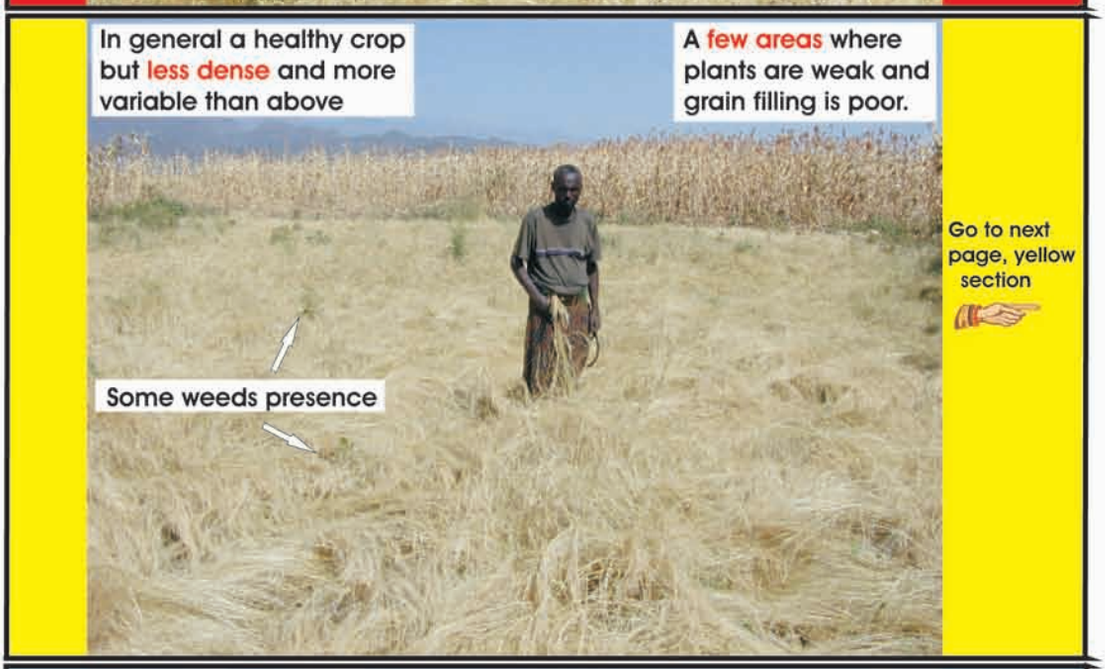
STEP 1: Determining the production level

Teff: the approach

What to look for:

- Plant health
- Plant density
- Fullness of grain
- Weeds
- Pest/disease damage





Teff: the close-up

Look closely at the grain heads - are they....

Healthy & well-filled like this?

If so go to next page, red section

Healthy & well-filled like this?

If so go to next page, yellow section

Poorly filled like this?

Example of shoot fly damage to grain

If so go to next page, blue section

Poorly filled like these?

Example of stress damage to grain

If so go to next page, blue section

Example of shoot fly damage to grain

Teff

STEP 2: Estimating the yield

1.50 t/ha ⟷ **2.50 t/ha**

0.75 t/ha ⟷ **1.00 t/ha**

0.25 t/ha ⟷ **0.50 t/ha**

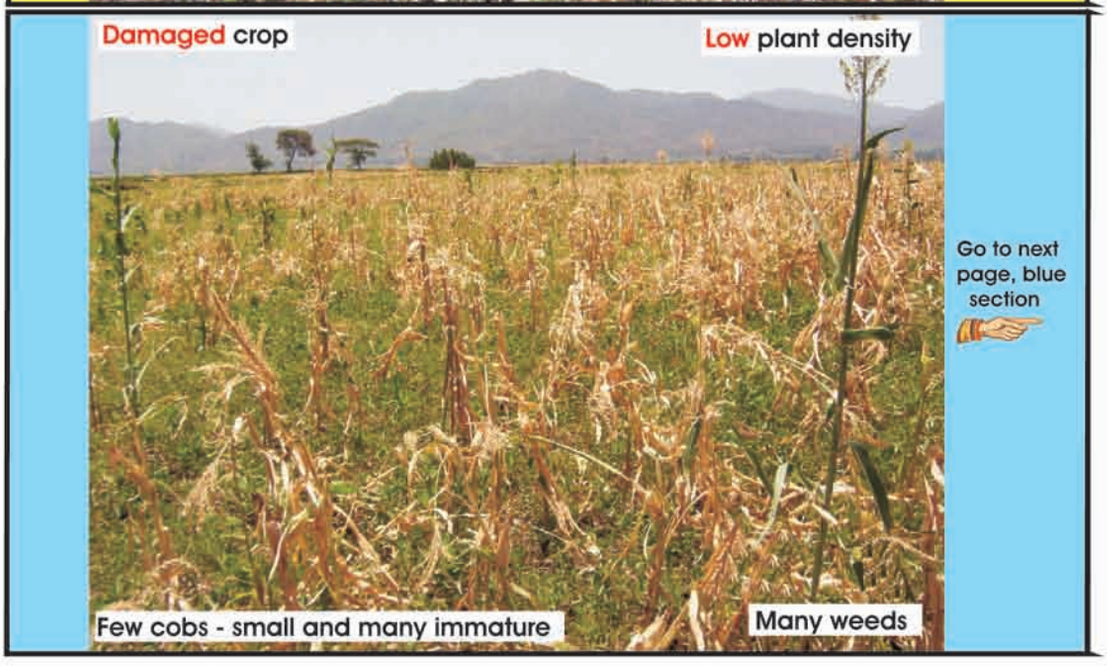
Maize

STEP 1: Determining the production level

Maize: the approach

What to look for:

- Plant health
- Plant density
- Cob size
- Cobs number
- Weeds



Maize: the close-up

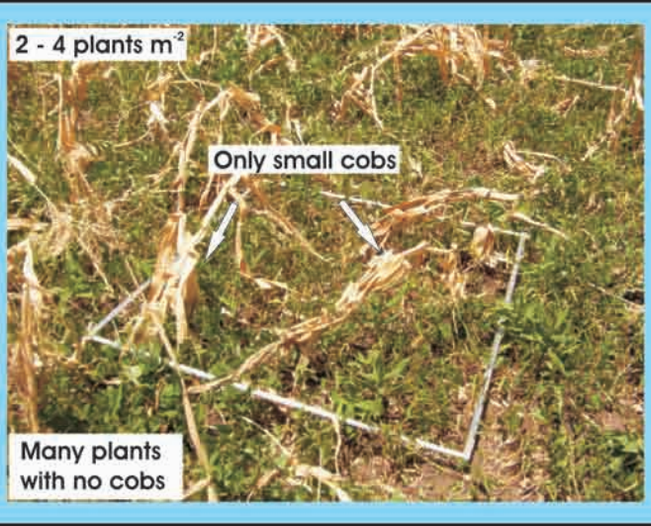
6.0 t/ha ⟷ 9.0 t/ha

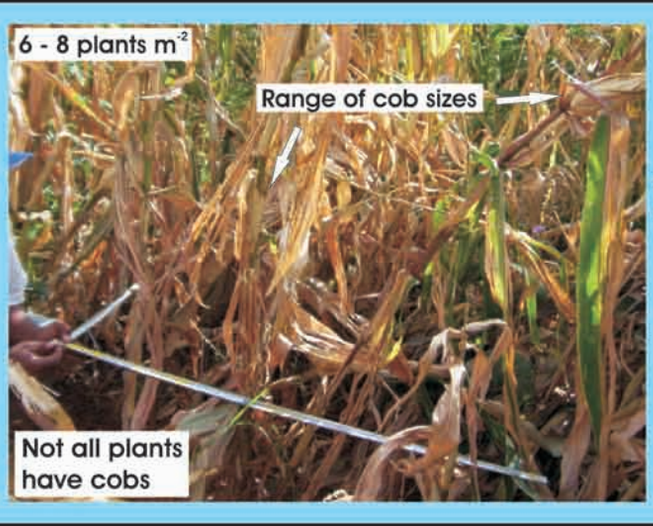
Go to next page, red section

3.0 t/ha ⟷ 6.0 t/ha

Go to next page, yellow section

0.5 t/ha ⟷ 3.0 t/ha





Go to next page, blue section

Maize

STEP 2: Estimating the yield

Each image shows the number and size of cobs harvested from one square metre.

6.00 t/ha	7.00 t/ha	8.00 t/ha	9.00 t/ha
			

3.00 t/ha	4.00 t/ha	5.00 t/ha	6.00 t/ha
			

0.10 t/ha	1.00 t/ha	2.00 t/ha	3.00 t/ha
			

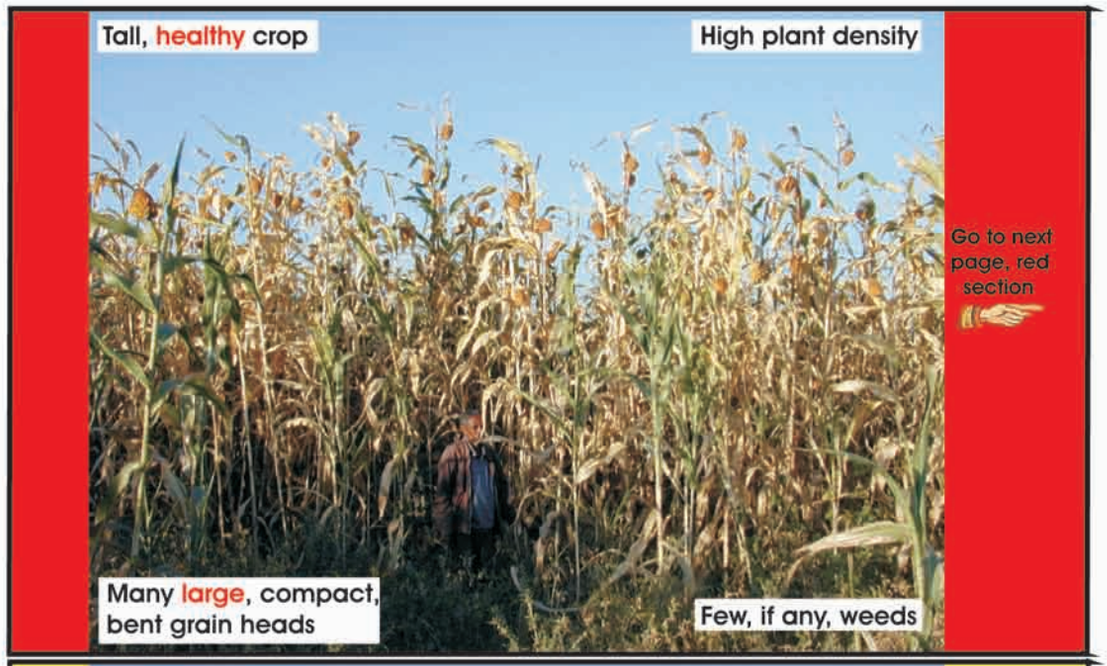
Sorghum

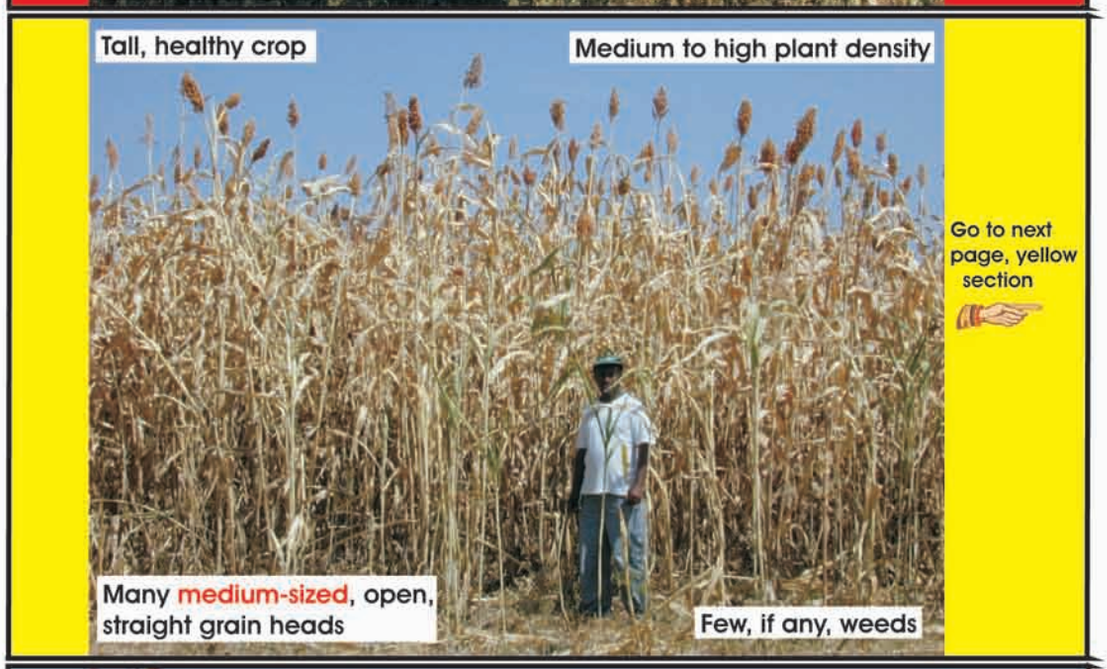
STEP 1: Determining the production level

Sorghum: the approach

What to look for:

- Plant health
- Plant density
- Head size
- Head number
- Weeds





Sorghum: the close-up

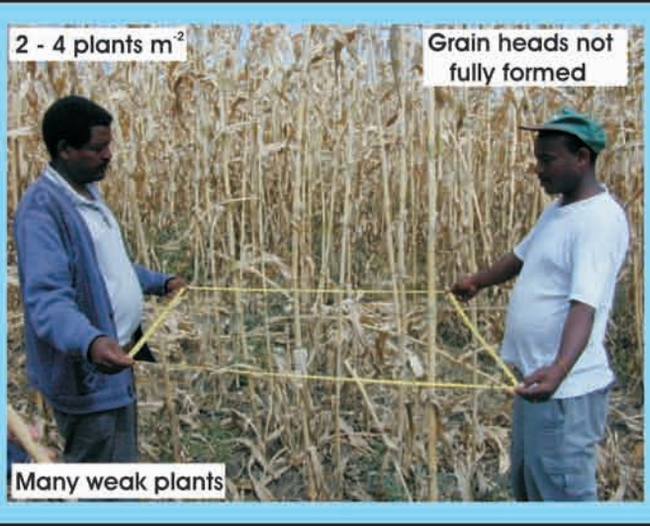
6.0 t/ha ⟷ 9.0 t/ha

Go to next page, red section

3.0 t/ha ⟷ 6.0 t/ha

Go to next page, yellow section

1.0 t/ha ⟷ 3.0 t/ha



Go to next page, blue section

Sorghum

STEP 2: Estimating the yield

Each image shows the number and size of heads harvested from one square metre.

6.00 t/ha	7.00 t/ha	8.00 t/ha	9.00 t/ha
			

3.00 t/ha	4.00 t/ha	5.00 t/ha	6.00 t/ha
			

0.10 t/ha	1.00 t/ha	2.00 t/ha	3.00 t/ha
			

APPENDIX I

To convert the weight of your grain sample harvested from one square metre (m^2) to yield in tonnes per hectare (t/ha) divide the weight in grams by 100.

Calculation explained:

- To scale up from one square metre to one hectare multiple your sample weight by 10,000.

- To convert your sample weight from grams (g) to tonnes (t) divide by 1000,000 :

1000 g = 1 kg
1000 kg = 1 t

- Example: if the grain harvested from one square metre weighs 250 g, then to convert to tonnes per hectare:

$$250\,g/m^2 \times \frac{10000\,(to\,convert\,to\,hectares)}{1000 \times 1000\,(to\,convert\,to\,tonnes)} = 2.5\,t/ha$$

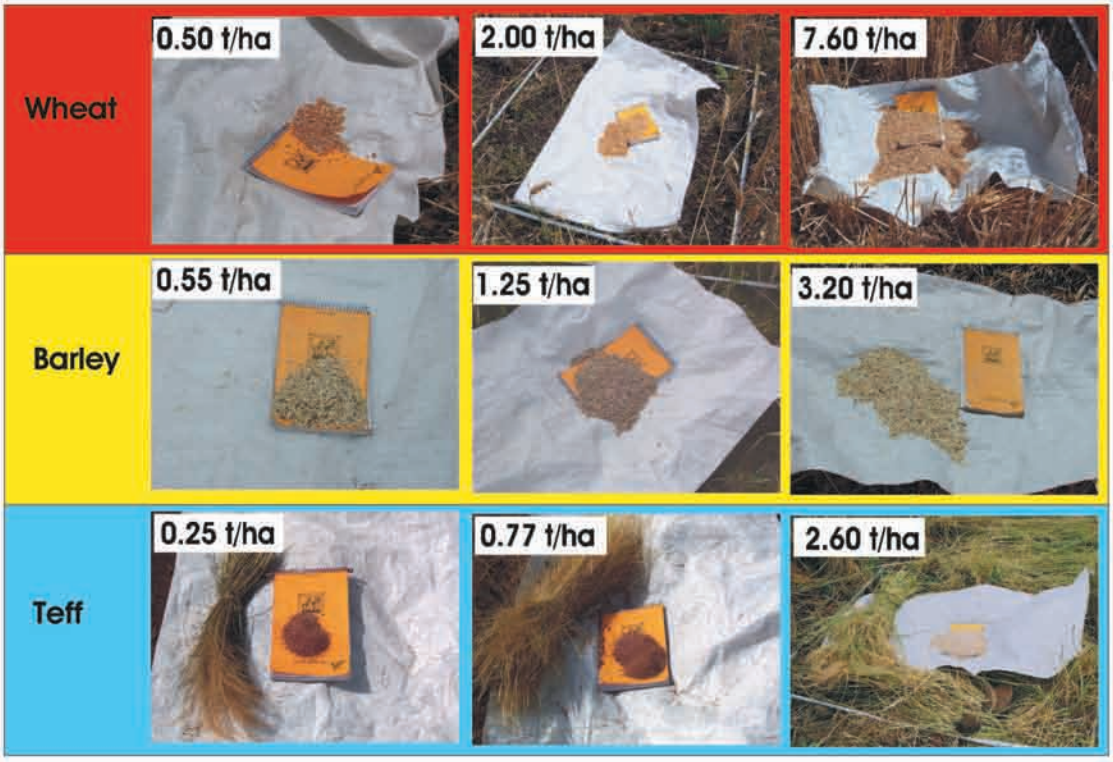
or quick calculation:

$$\frac{250\,g/m^2}{100} = 2.5\,t/ha$$

For quintals per hectare simply divide the sample weight (g) from one square metre by 10.

APPENDIX II

Photographs showing the threshed grain produced from one square metre and corresponding yield per hectare (t/ha).



APPENDIX III

Photographic key for yield of finger millet.

Approach	Close-up	Grain yield m^{-2}	Yield
			**0.85 t/ha**
			**0.5 t/ha**

APPENDIX IV

PET-Cereals **Crop Data Sheet**

Region: **Woreda:** **Assessors Name:** **Date:**

CROP	Yield estimate PET-Cereals (t/ha) or (qt/ha)	Count Data (from one square metre)		Measured Yield (grams per square metre)				**Comments**
		Heads/Cobs	Plant number	Q 1	Q 2	Q 3	Mn Yield	