

PET-Cereals
West Bank and Gaza Strip

A Pictorial Evaluation Tool for Cereal Harvest Assessment in West Bank and Gaza Strip (WBGS)



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What is PET-Cereals (WBGS)?

This book is called PET-Cereals(WBGS). It shows you HOW TO USE PICTURES to estimate the amount of cereal grain and straw in fields at harvest time. The book contains photographs of wheat and barley crops, arranged according to levels of production that are called *photo-indicators*. By comparing these *photo-indicators* with the crop in a field, you can decide how much grain and straw may be harvested from that field.

When you estimate the production from a standing crop in the field at harvest time, it is called a crop assessment. PET-Cereals(WBGS) will help you to complete a rapid crop assessment for a farm, for a village, for a locality and for a state.

Whatever the situation you are working in:-

Production = Area x Yield per unit area.

Therefore, to estimate the harvest you will need to know:-

1. **The size or area of the crop to be harvested, as well as,**
2. **Average crop yield per unit area of the land to be harvested.**

Area: At the simplest level of assessment, field size and farm size may be measured or told to you by the farmer. At the village or locality level, crop areas can be estimated either i) by collecting data from all of the farmers and adding them together, or, ii) by taking samples from a few farmers and multiplying the sample averages by the number of families farming in the village or locality.

The local authorities, ministries or commissions usually do such exercises. In WBGS, the Ministry of Agriculture could use either method by a) estimating crop areas from all farmers or from a sample of farmers in each locality (as described above); b) adding up the areas, at locality level, for each crop; c) adding together all the locality data for each crop to give an estimate of the harvest at *Governorate* level; and, d) adding all *Governorate* data together to arrive at an estimate of area for each crop at *national* level.

Where such levels of organisation are not available, methods used to calculate crop area are different. Area farmed may be calculated by multiplying estimates of numbers of households or businesses farming by the average area known to have been farmed in the past, adjusted by data obtained during the assessment for the year in question including:-

- **data collected from statements by individual farmers;**
- **data collected by active administrations;**
- **data collected by projects and NGOs;**
- **data extrapolated from household surveys by other agencies;**
- **remote sensed data.**

Area estimates[1] for each crop are then multiplied by estimates of crop yield per unit area to determine production.

Crop yield from a known area of land: To estimate crop yield from a known area, you could harvest the whole area and weigh the crop or, much easier, you could mark out a sample plot of known area in the field, then harvest and weigh the crop within it. For small fields of less than one hectare, with an even crop, an area of one square metre (1 m^2) may be cut, harvested and weighed and the crop yield recorded as the weight of crop harvested per one square metre or crop yield/m^2. This sum may then be multiplied by 1,000 to obtain the estimated yield per *dunam* or by 10,000 to obtain an estimate of the yield per *hectare* (ha).

If the field is large and variable you may have to take more than one sample, add up the values and take the average to get a representative estimate of the production of the whole field. However, taking samples from each field is a time-consuming process. During rapid assessments there is usually NOT ENOUGH time to sample every field. Therefore, PET-Cereals (WBGS) **has been prepared to provide ALL ASSESSORS with a manual containing a) *photo-indicators* of wheat and barley crops in WBGS with different levels of production; and b) instructions on how to use the *photo-indicators* to assess the yields of grain and straw. The photo-indicators, prepared from actual fields in West Bank and Gaza Strip, have been grouped in high, medium and low clusters (these are arbitrary terms). You can choose the photo-indicator that best matches the field you are working in and then read off the probable yield from the relevant data column.**

The actual yields achieved will depend on the season, so all the photo-indicators will need to be consulted for all locations – that is, it is important not to pre-judge what photo-indicator will apply, based on any general impressions about how "good" the season is said to be.

[1] More information to help you estimate area in the field is given in Annex 6.

Using PET-Cereals (WBGS) means:

Looking at the field- Looking at the photo-indicators- Picking the photo-indicator that matches your field- Reading off the yield in kilograms per dunam (kg/dunam) or tonnes per hectare (t/ha).

The crop yield at harvest will differ every year in the same fields. This means that, in order to get a good idea of crop yield at field, farm, village and locality level, you will need to cover vast distances and visit many farms. Proper use of the manual allows you to decide for yourself how much cereal will be harvested from every field seen. You can then compare your estimates with information given by farmers, other agencies and authorities.

Using PET-Cereals (WBGS) will allow you to complete all wheat and barley assessments within the time available and with confidence. The advantages of using the PET approach, versus crop assessments based on agricultural statistics and census data are presented in Annex 5.

The methodology that was used in preparing PET-Cereals (WBGS) is summarised below:-

- **Preliminary discussions identified the crops to be included as wheat and barley for both grain and straw production;**
- **Reconnaissance surveys in each Governorate identified both the scope and range of performance of both crops at all locations within the Governorate;**
- **Stratified sampling was then undertaken in specific locations selected jointly by the FAO/MoA PET team and local MoA office subject matter specialists as being representative of the range of performance noted in reconnaissance surveys;**
- **Within those selected locations, representative fields were selected and sub-sampled to offer 1m^2 plots delivering the most informative photo-indicators;**
- **Photo-indicators of standing crops were prepared at each site;**
- **The 1m^2 plots were harvested and threshed;**
- **Photo-indictors of products after harvest were prepared at each site;**
- **All product samples were weighed to constant weight to determine the exact production obtained from 1m^2;**
- **All weights were recorded and ultimately entered into the PET manual alongside the photo-indicators from the same plots.**

The map provided in Annex 5 illustrates the location of the sample and photo-indicator sites.

BEFORE YOU START

It is important that you spend time reading this introduction. It explains how to use PET-Cereals(WBGS) correctly and how to check your results.

In the gallery of photo-indicators beginning on page 21 of PET-Cereals(WBGS) you will find photographs of crops of wheat and barley with known yields of grain and straw. Due to their equal importance to the rural economy grain and straw are presented in separate sections.

All the photographs in the manual were taken of crops growing in WBGS. Also, all the photos and related data collected were obtained in the presence of senior MoA and FAO-WBGS staff, who were there when fields were selected and grain and straw samples taken and weighed.

The presentation of the photo-indicators of each product follows a similar sequence conforming to all recent PET-Crop manuals used in other countries. Each yield range indicated (high, medium or low) has a double page spread of three rows of photographs divided into five columns showing (1) field from-a-distance; (2) 1m^2 in close-up; (3) the harvest taken from 1m^2; and, (4) the product i.e. grain (or straw) harvested from the 1m^2; (5) yield estimate figures in kilograms per dunam (kg/dunam) and tonnes per hectare (t/ha).

NB The photographs of biomass, grain and straw (columns 3 and 4) placed between the close-up photos and the yield estimates are present to show you how the yield was derived and what the biomass, grain production and straw production from one square metre looks like when compared to an A4 sheet of paper and a sickle placed on the ground next to the products.

	**(1) From-a-distance:** these photographs show you the field from-a-distance, giving you an idea of the ***health*** of the cereal, ***how many*** plants are in the field, how ***uniformly*** they have grown, how ***weedy*** the field has become and how well the harvestable parts have ***developed.***
	**(2) Close-up:** the photographs of a close view of the crop show the ***spikes*** (heads) in an area of **1m^2.** The photographs show the extent of the cover of the space (canopy) and the size and quality of the harvestable parts of the crop, in this case the wheat spikes and straw stems.
	**(3) The harvest:** the photographs of the harvest show those parts of the crop that have been harvested from the typical area of 1m^2 shown in the close-up photograph. In this case, the wheat stems have been cut at ground level showing straw and spikes. Information provided is the number of spikes (and stems) per m^2.
	**(4) The grain**: the photographs show grain threshed from the harvest and air dried to constant weight. Yield is shown in g/m^2 extrapolated to **kg/dunam** and **t/ha.** In the straw section of photos, the grain product is replaced by a photo-indicator of the straw remaining after threshing, with yields shown as **kg/dunam** and **t/ha.** The products of all crops in this manual were air-dry at harvest.

When actually using the manual in the field you should move directly from the close-up (2) to the yield estimate, only harvesting the product of 1m^2 from time-to-time to check your judgement.

STEP 1
Is it a 'high', 'medium' or 'low' crop?

In Step 1, you decide if the general condition of the field is indicative of a 'high', 'medium' or 'low' crop. To do this you should look at the *'From-a-distance'* photographs in the photographic guide **and compare these with the farmer's field in which you have interest. Looking *from-a-distance* will give you an impression of the overall quality of the crop and tell you if the crop is variable or even.**

Turn to the photographic guide **beginning on page 21 and select the cereal you wish to assess. Look at the 'from-a-distance' photographs for high (red band), medium (yellow band) and low (blue band) levels of production for that cereal.**

There are three *photo-indicators* within each of these bands, making nine choices from which to select your crop for grain and for straw. The photographs have been taken from a distance of several metres. If you stand at a similar distance from the field (or you can do this from a slow moving vehicle), you can compare your crop with the *photo-indicators*. By looking at the whole field, you can decide which photograph is most similar to your crop. There are notes next to the 'from-a-distance' photographs; read these carefully because they will tell you what to look for when deciding if your field is in the 'high', 'medium' or 'low' range.

The following pictures summarise the process of placing your crop in the 'high' (red), 'medium' (yellow) or 'low' (blue) range.

Which photograph is the best fit from-a-distance?

Photo-indicator

Is this a match?

Probably

So place initially in the RED range

Farmer's crop

No

Not likely to be in the YELLOW range

No

Definitely not in the BLUE range

In the above example, the crop is clearly better than the blue *photo-indicator* and the yellow *photo-indicator*. The Farmer's crop of wheat is **therefore best described by the red *photo-indicator*. The selection should be confirmed by working through STEP 2.**

STEP 2
Confirming your choice

Confirm your choice in Step 2 by looking more closely at the field. If the field is small, walk up to the field and look closely at a small area that you think represents the field – then compare it with the 'Close-Up' photographs in the photographic guide**. For larger fields, you will need to take a close look at several places, either by a) walking around the edge or b) walking through the middle of the field.**

When confirming your choice using the 'Close-Up' photo-indicators, you should concentrate your gaze on one square metre of crop which you can judge by standing with your feet one metre apart and projecting your gaze forward to make a square or (preferably) use a 1m^2 quadrat to define your area, by placing the *quadrat* where it will be clearly visible, as shown in the next group of photographs. In some cases, the *close-up* view may not be exactly the same as the photographs so you will need to decide what is the best match. The plant density i.e. the number of ears (spikes/heads) is noted on the photo-indicator.

Overall, you should see more detail than when you were looking from a distance.

- **You may see more soil through the canopy, more gaps, more weeds and the plants may look less strong and healthy than they looked from-a-distance.**
- **Or, the plants may look stronger and the parts that will be harvested, such as the ears (spikes/heads) and the straw may also look larger or stronger (thicker) than when you looked at the crop from-a-distance.**
- **The number of spikes may not necessarily be the same as the number of spikes in the photo-indicator for the same weight of crop - so you may need to adjust your thinking to counterbalance number with average spike size.**

NB; your brain is better than any computer in its flexible reading of situations. So do not be afraid if your intuitive response is to adjust your decision and change your mind from your initial selection based on the from-a-distance observation.

The RED band was identified in Step 1 (from-a-distance). The close-up shows that the **closest fit** is the **high red photo-indicator** with more spikes forming a more complete canopy over the 1m^2 than the *'low'* and *'medium'* red crops.

Photo-indicator

Is this a match?

Yes

Close-up 1m²

High Red - The individual spikes are a similar size and density in the farmer's field to that in the photo-indicator

No

NOT Medium Red - The individual spikes are bigger in the farmer's field than in the photo-indicator

No

NOT Low Red - There are more spikes in the farmer's field per m^2 than in the photo-indicator

In **Step 1,** you observed **from-a-distance** that the crop was probably in the red band of production.

In **STEP 2,** you confirmed from the **close-up** photo-indicators that your crop is at the top of the red range.

STEP 3
Estimating the value

In STEP 3, you assign a value in kg/dunam or t/ha to your crop, using the final column in the sequence, which shows the value of the 'harvest' from 1m^2 and final yield estimates per dunam and hectare.

The photographs on the right hand page (columns 3 and 4) show how the yields of grain and straw for the *photo-indicator crops* were derived;

- **The first photo (column 3) shows the amount of biomass harvested from 1m^2 of wheat and barley. The weight of biomass comes from straw and grain, so reflects the number, length and thickness of the stems and the dimensions of ears (spikes/ heads), which are determined by seed-set and grain-fill.**
- **The second photo (column 4) shows *either* the amount of grain threshed from the ears (spikes/ heads) or the straw left after threshing biomass from the one square metre that was sampled.**
- **The final box next (column 5) gives the yield of the *photo-indicator* crop in units of grams per square metre (g/m^2), kilograms per dunam (kg/dunam) and tonnes per hectare (t/ha).**
- **Record the yield from Column 5 for the level that** you chose from the 'Close-Up' **photo-indicators in Step 2 (that is, is the closest fit to** your farmer's **field) and then move on to the next field.**
- **As noted earlier, it is unlikely that your crop will look *exactly* like the one in the photograph so pick the one that is closest to it or choose a yield in-between the values of the two closest *photo-indicators.***
- **In the example above the closest fit is high red at 600 g/m^2, 600 kg/dunam or 6.0 t/ha.**

NB **Only harvest and weigh your sample of 1m^2 when you decide to crosscheck your results (see STEP 5)**

STEP 4
Accounting for field variability

Often you see parts of the field where the crop has been damaged by too much or too little water, poor soil, pests or diseases, too many weeds or poor germination. Therefore, the crop will be different for different parts of the field and the yield per square metre will vary from place-to-place.

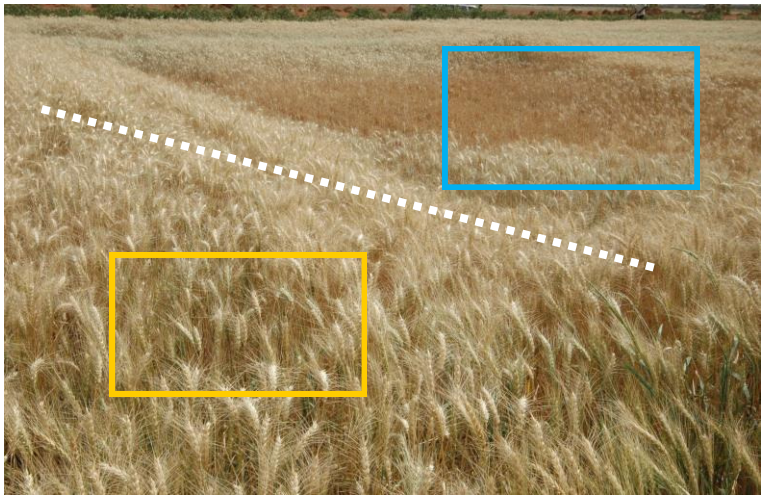
When the field is variable, you will need to decide which parts of the field are 'high', 'medium' or 'low' and estimate the overall yield, taking into account the level of variation. Look closely at the two photographs of wheat below taken from-a-distance. Decide how many estimates you should take to place a value on the average yield.

The wheat field on the left is very even, so only *one* PET estimate of yield will suffice.
The wheat field on the right is variable, so for a rapid assessment within optimal levels of accuracy (OLA), *two* PET estimates are needed from which a weighted average will be calculated.

Estimating the yield of a variable field of wheat

1. Stand where you can see the whole field.

2. Divide the field into two different parts. Within each part the crop should look similar. In this case, two estimates are required.



3. Determine whether each part is 'red', 'yellow' or 'blue'.

Approximately one third of the field looks most like a **blue** crop (PET photograph at **medium blue** level).

Two thirds of the field looks most like a **yellow** crop (PET photograph at **medium yellow** level).

This part of the field is similar to the 100 kg/dunam *photo-indicator.*

4. Estimate crop yield for each part of the field by following the instructions for STEP 3 of PET-Cereals WBGS.

This part of the field is similar to the 280 kg/dunam *photo-indicator.*

100 kg/dunam =Estimated yield= **280 kg/dunam**

5. Calculate the crop yield of the variable wheat field.

The wheat field is producing at two levels, one 'medium blue' and one 'medium yellow'. In this example, the 'blue' part is about one third of the field. The 'yellow' part is about two thirds of the field.

Therefore, the weighted average per dunam (Y) in the variable wheat field:

a) **Y in kg/dunam = (Estimated medium blue yield in kg/dunam) x 33% + (Estimated medium yellow yield in kg/dunam) x 67%**

b) **Crop yield from the 'medium blue' part = 100 kg/dunam x 0.33 = 33 kg/dunam**

c) **Crop yield from the 'medium yellow' part = 280 kg/dunam x 0.67 =188 kg/dunam**

To calculate the total crop yield for the field you therefore simply add together the crop yield of each part of the field (b + c):-

Y in kg/dunam = 33 kg + 188 kg = 221 kg/dunam

Similarly, total crop yield Y in tonnes/hectare = 0.33 t + 1.88 t = 2.21 t/ha

STEP 5
Deciding when to crosscheck your results

To make sure that your estimates of crop yield *based on the photographs* are accurate and that mistakes are not being made, it is important that you regularly crosscheck your results, by following the crop cutting procedure described later in STEP 6.

Crop cutting is the method used to crosscheck your *photo-indicator* estimates of crop yield with a physical sample. This involves harvesting small areas of the farmer's **crop, weighing the harvested parts when they are dry and extrapolating to production per dunam or hectare. Comparing these results with your figures (from Step 4) allows you to check if your previous estimates of crop yield using** PET-Cereals (WBGS) **photo-indicators are too high or too low.**

If you find that your estimates are often too high, you can make changes to improve the accuracy of your results. The same is true if you find that your estimates are often too low. It is very important that you regularly crosscheck your results and it is recommended that you do this in the following situations:

- **When using** PET-Cereals (WBGS) **for the first time.**
- **When estimating the yield for a new crop.**
- **When estimating crop yield in a new region.**
- **Finally, at regular intervals even if you are always working on the same crop in the same region, because mistakes can be made through complacency.**

STEP 6
How to crosscheck your results

To crosscheck your results you will need to take a crop cutting from a known area of a field and then measure the weight of the harvested parts. This will give you the value of crop yield per unit area. In each situation where crosschecking your data is recommended, crop cuttings should be taken from a minimum of three separate fields. The number of samples you take in each field will depend on the variability of the crop.

1. Choosing the field

Try to choose a field where the crop does not change too much[2]. If this is not possible and the fields are very variable, then divide a field into different parts, as explained in STEP 4.

2. Estimating crop yield

Estimate the crop yield following the instructions given in STEPS 1 to 4 of PET-Cereals (WBGS); **and record your answer before you begin**.

3. Select the areas of the field for crop cuttings

For all short stover/ straw crops such as wheat or barley, take a long stick, mark the end clearly and ask the farmer to turn their back to the field and throw the stick over their head into the crop. Where the stick lands in the crop is where you will position your square frame or quadrat for the crop cutting. Push the marked end of the stick upright into the ground.

4. Placing the quadrat in the crop

The quadrat is used to mark an area of crop from which the crop cutting is to be taken. To do this accurately, it is important that only those plants whose stems emerge from the soil within the quadrat are included in the measurements. The quadrat should be placed with the stick in the centre.

5. Harvesting

Take extra care to harvest only the stems that emerge from the soil inside the quadrat. When crosschecking grain and straw yields, make sure that the stems are cut (or broken off) close to the ground but without pulling up (or roots and soil will come up too). The harvested spikes should be counted and weighed.

[2] Choosing a variable field to crosscheck yourself IS NOT RECOMMENDED because you are crosschecking your own judgement - so make it as easy as possible!

6. Cleaning and threshing harvested parts

For wheat and barley, the ears (spikes or head) should be removed from the stems and threshed. Try to minimise any loss of grain when you are threshing. If possible, ask the farmer to thresh and winnow the harvested parts in their usual manner for small plots.

7. Weighing

Before each weighing, the spring balance scale (supplied with the PET manual and quadrat) should be set to zero when a clean, empty bag is attached to the hook. Do this in a sheltered position away from wind. The cleaned or threshed harvested parts should then be placed in the same bag and the weight recorded.

8. Repeating the measurements

The field may be variable (in two or more distinct portions) so unless the field is uniform, it is recommended that **at least two quadrat samples** be taken from each field. A single sample should be taken from each significantly variable portion and the weighted average of these portions calculated (based on their respective areas), in order to assess crop production from that field (in the same way as STEP 4). NB for small fields of less than 1 ha, no more than 2 samples are recommended.[3]

9. Large field adjustments

For large fields, you should walk in a W shape across the field (see example in Figure 1 below) and sample up to 10 points spaced at regular intervals. The weights of these samples should be added together and divided by the number of samples taken, to give a representative average production per m^2 of grain or straw for the field.

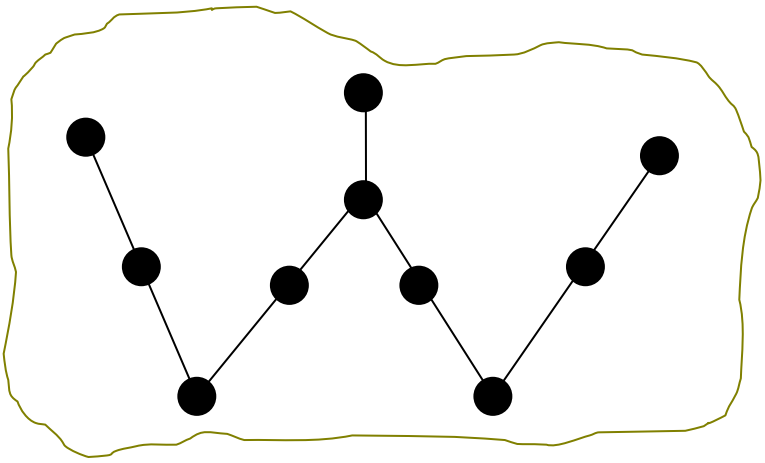


Figure 1. Sampling up to 10 points at regularly spaced intervals

[3] Stratified sampling

10. Drying grain and straw from a smallholder field (one sample)

Grain and straw samples should be dry (harvestable) for accurate estimations of yield. The dryness of the samples after threshing can be tested in the following ways:-

- **Harvestable wheat and barley grains will be hard to bite into and will break when bitten. A soft bite i.e. the teeth sink into the grain, means more drying is required.**
- **Harvestable wheat straw will snap, rather than bend; a bendy straw means that more drying is required. NB *barley straw is more flexible than wheat straw*.**

All samples should be weighed (= W_{f1}) and then stored separately in clearly marked cotton bags or thick paper envelopes. A label fixed firmly to the bag or stuck on the envelope should provide information on the date, assessor, region, district, village, sample number, farmer (name), crop, field, quadrat number, fresh weight, and when (time) the sample was taken. The bags should be stored in a safe place in the sun or placed very securely on the roof rack of the vehicle if you are travelling, which allows the contents of the bag to dry while driving.

Upon arrival, assisted drying may be necessary. If this is the case:-

- **Re-weigh the sample = W_{f2}, record the weight.[4]**
- **Place the whole sample in a microwave oven at medium-low intensity for a 2-minute interval.**
- **Allow to cool, then weigh the sample again = W_{f3}.**
- **Repeat as many times as is necessary until the weight is the same i.e. *constant* = W_{fc} on two consecutive occasions, i.e. the weight remains the same after drying.**
- **Confirm acceptable levels of dryness by biting the grain and snapping the straw.**
- **Record the final weight as the *constant weight=* W_{fc}, which will used in the checking the PET assessment (the choice of photo-indicator level).**

NB. If for a very large field, the samples need drying then, after weighing all the samples and calculating the average weight, the (approximately) 10 samples from the 'W' shape sampling procedure should be thoroughly mixed and a single sample extracted and bagged for drying and weighing, as described above.

11. NB. Recording the results

All weights for each quadrat should be clearly written on a results sheet and on the sample bag or envelope.

An example of the results sheet and the calculations needed to convert your values for crop yield per one square metre (from the quadrat) to crop yield for a dunam or hectare are given in Annex 1 and 2 of PET-Cereals (WBGS).

[4] If the sample is too big for the oven, a) take a sub-sample; b) weigh the sub-sample = ws; c) follow the same procedure drying and weighing the subsample to constant weight= wc. The air dry weight of the field sample is, therefore < W_{f2} x wc/W_{f2} >

PET-Cereals (WBGS)

Photo-indicators

Crops in order of appearance

Wheat Straw (3 double pages)

- **Higher-yield range** **380 kg/dunam and above**
- **Medium-yield range** **230 - 335 kg/dunam**
- **Lower-yield range** **150 kg/dunam and below**

Wheat Grain (3 double pages)

- **Higher-yield range** **400 kg/dunam and above**
- **Medium-yield range** **175 - 375 kg/dunam**
- **Lower-yield range** **130 kg/dunam and below**

Barley Straw (3 double pages)

- **Higher-yield range** **355 kg/dunam and above**
- **Medium-yield range** **230 - 325 kg/dunam**
- **Lower-yield range** **180 kg/dunam and below**

Barley Grain (3 double pages)

- **Higher-yield range** **305 kg/dunam and above**
- **Medium-yield range** **185 - 285 kg/dunam**
- **Lower-yield range** **135 kg/dunam and below**

Wheat Straw - High

From-a-distance | Close-up

- ***Ambar,*** durum wheat variety
- **Dense; closed canopy of long awns**
- **Weed free with volunteer ACSAD 3 plants**
- **Even crop**
- **Good seed set**
- **Biomass 4g/stem**
- **Long straw @ 1.6g/stem**
- **Grain average weight 1.4g/spike**
- **Loss from threshing 25%**

- ***Dariel,*** bread wheat variety
- **Very dense sowing**
- **Even crop**
- **Weed free**
- **Small spikes and grains; short awns**
- **Long straw @ 0.9g/stem**
- **Grain average weight 0.7g/spike**
- **Loss from threshing 18%**

- ***Ambar***, durum wheat variety
- **Dense; canopy closed by long awns**
- **Very clean crop; weed free**
- **Even crop**
- **Good seed set; well filled grains**
- **Biomass 4.3g/stem**
- **Long straw @ 1.4g/stem**
- **Grain average weight 1.7g/spike**
- **Loss from threshing 29%**

Wheat Straw - High

Biomass from 1m^2	Straw from 1m^2	Yield
		Dry Matter 700g/m^2 700.0 kg/dunam 7.00 t/ha
		Dry Matter 535g/m^2 535.0 kg/dunam 5.35 t/ha
		Dry Matter 475g/m^2 475.0 kg/dunam 4.75 t/ha

Wheat Straw - Medium

From-a-distance

Close-up

- ***Ambar,*** durum wheat variety
- **Open canopy - long awns**
- **Even crop**
- **Weed free**
- **Biomass 4.5g/stem**
- **Straw @ 1.5g/stem**
- **Grain average weight 1.7g/spike**
- **Loss from threshing 30%**

- ***Dariel***, bread wheat variety
- **Open canopy - long awns**
- **Even crop**
- **Weed free**
- **Biomass 4.0g/stem**
- **Straw @ 0.9g/stem**
- **Grain average weight 1.3g/spike**
- **Loss from threshing 47%**

- ***Dibyah,*** landrace, durum wheat variety
- **Open canopy**
- **Weed free**
- **Bare ground apparent**
- **Small spikes**
- **Biomass 2.4g/stem**
- **Straw @ 1.0g/stem**
- **Grain average weight 0.9g/spike**
- **Loss from threshing 26%**

Wheat Straw - Medium

Biomass from 1m^2	Straw from 1m^2	Yield
		Dry Matter 335g/m^2 335.0 kg/dunam 3.35 t/ha
		Dry Matter 260g/m^2 260.0 kg/dunam 2.6 t/ha
		Dry Matter 225g/m^2 225.0 kg/dunam 2.25 t/ha

Wheat Straw - Low

From-a-distance | Close-up

- ***Dibyah,*** land race, durum wheat
- **Poor germination**
- **Weak plants**
- **No canopy**
- **Small spikes**
- **Biomass 2.7g/stem**
- **Short straw @ 1.3g/stem**
- **Grain average weight 0.8g/spike**
- **Loss from threshing 25%**

- Bread wheat variety
- **No canopy - rows thinly populated**
- **Bare ground dominant**
- **Biomass 1.1g/stem**
- **Short straw @ 0.5g/stem**
- **Grain average weight 0.5g/spike**
- **Loss from threshing 10%**

- Bread wheat variety
- **Poor development**
- **Very weak plants**
- **No canopy**
- **Bareground very dominant**
- **Very small spikes/ grain**
- **Very short straw @ 0.3g/stem**
- **Grain average weight <0.3g/spike**
- **Loss from threshing 27%**

Wheat Straw - Low

Biomass from 1m^2	Straw from 1m^2	Yield
 330 g/m^2	 150 g/m^2	Dry Matter 150g/m^2 150.0 kg/dunam 1.50 t/ha
 200 g/m^2	 90 g/m^2	Dry Matter 90g/m^2 90.0 kg/dunam 0.90 t/ha
 132 g/m^2	 52 g/m^2	Dry Matter 52g/m^2 52.0 kg/dunam 0.52 t/ha

Wheat Grain - High

From-a-distance | Close-up

- ***Ambar***, durum wheat variety
- **Dense; closed canopy of long awns**
- **Weed free with volunteer ACSAD 3 plants**
- **Even crop**
- **Good seed set**
- **Grain average weight 1.4g/spike**
- **Biomass 4g/stem**
- **Long straw @ 700g/m^2**
- **Loss from threshing 25%**

- **Ambar**, durum wheat variety
- **Dense; canopy closed by long awns**
- **Very clean crop; weed free**
- **Even crop**
- **Good seed set; well filled grains**
- **Grain average weight 1.7g/spike**
- **Biomass 4.3g/stem**
- **Long straw @ 475g/m^2**
- **Loss from threshing 29%**

- ***Dariel,*** bread wheat variety
- **Very dense sowing**
- **Even crop**
- **Weed free**
- **Small spikes and grains; short awns**
- **Grain average weight 0.7g/spike**
- **Long straw @ 535g/m^2**
- **Loss from threshing 18%**

Wheat Grain - High

Biomass from 1m^2	Grain from 1m^2	Yield
		Dry Matter 600g/m^2 600.0 kg/dunam 6.00 t/ha
		Dry Matter 550g/m^2 550.0 kg/dunam 5.50 t/ha
		Dry Matter 400g/m^2 400.0 kg/dunam 4.00 t/ha

Wheat Grain - Medium

From-a-distance | Close-up

- ***Dariel,*** bread wheat variety
- **Rows obvious; no canopy - short awns**
- **Dense sowing in rows**
- **Even crop**
- **Weed free**
- **Small spikes**
- **Grain average weight 0.8g/spike**
- **Biomass 2.4g/stem**
- **Short straw @ 308g/m^2**
- **Loss from threshing 35%**

- ***Ambar,*** durum wheat variety
- **Dense canopy due to long awns**
- **Even crop**
- **Weed free**
- **Medium spikes**
- **Grain average weight 1.2g/spike**
- **Biomass 3.1g/stem**
- **Short straw @ 325g/m^2**
- **Loss from threshing 20%**

- ***Dariel***, bread wheat variety
- **Not dense; no canopy**
- **Uneven crop**
- **Weedy patches**
- **Small spikes**
- **Grain average weight 0.9g/spike**
- **Biomass 3g/stem**
- **Short straw @ 265g/m^2**
- **Loss from threshing 27%**

Wheat Grain - Medium

Biomass from 1m^2	Grain from 1m^2	Yield
		Dry Matter 370g/m^2 370.0 kg/dunam 3.70 t/ha
		Dry Matter 280g/m^2 280.0 kg/dunam 2.8 t/ha
		Dry Matter 175g/m^2 175.0 kg/dunam 1.75 t/ha

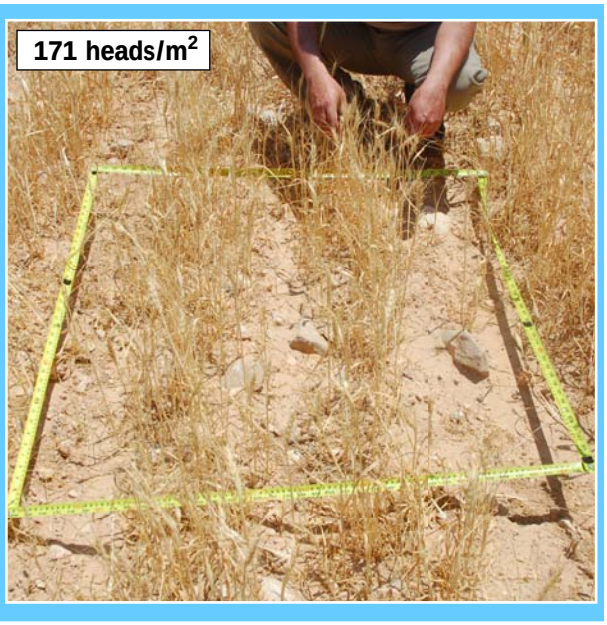
Wheat Grain - Low

From-a-distance | Close-up

- ***Ambar,*** durum wheat variety
- **Late sown; variable germination**
- **Open canopy from long awns**
- **Bare ground noted**
- **Weed free**
- **Small spikes**
- **Grain average weight 0.7g/spike**
- **Biomass 2.4g/stem**
- **Short straw @ 150g/m^2**
- **Loss from threshing 34%**

- ***Dibyah*** land race, durum wheat
- **Poor germination**
- **Weak plants**
- **Bare ground**
- **No canopy**
- **Small spikes**
- **Grain average weight 0.8g/spike**
- **Biomass 2.7g/stem**
- **Short straw @ 150g/m^2**
- **Loss from threshing 25%**

- Bread wheat variety
- **Poor development**
- **Very weak plants**
- **No canopy**
- **Bare ground very dominant**
- **Very small spikes/ grain**
- **Grain average weight <0.3g/spike**
- **Very short straw @ 52g/m^2**
- **Loss from threshing 27%**



Wheat Grain - Low

Biomass from 1m^2	Grain from 1m^2	Yield
		Dry Matter 130g/m^2 130.0 kg/dunam 1.30 t/ha
		Dry Matter 100g/m^2 100.0 kg/dunam 1.00 t/ha
		Dry Matter 45g/m^2 45.0 kg/dunam 0.45 t/ha

Barley Straw - High

From-a-distance | Close-up

- *Baladi* variety 2 row
- Very heavy sowing rate
- Open canopy - short awns
- Even crop
- Weed free
- Small spikes
- Biomass 2.1g/stem
- Long straw @ 0.9 g/stem
- Grain average weight 0.8g/spike
- Loss from threshing 15%

- *Baladi* variety 2 row
- Medium sown
- Bad lodging - no awns
- Bare ground hidden
- Thick, long straw @ 1.9g/stem
- Biomass 3.5g/stem
- Grain average weight 0.9g/spike
- Loss from threshing 18%

- *Baladi* variety 6 row
- Medium sown
- Open canopy - long awns
- Even crop
- Biomass 3.5g/stem
- Short straw @ 1.3 g/stem
- Grain average weight 1.1g/spike
- Loss from threshing 29%

Barley Straw - High

Biomass from 1m^2	Straw from 1m^2	Yield
		Dry Matter 625g/m^2 625.0 kg/dunam 6.25 t/ha
		Dry Matter 420g/m^2 420.0 kg/dunam 4.20 t/ha
		Dry Matter 355g/m^2 355.0 kg/dunam 3.55 t/ha

Barley Straw - Medium

From-a-distance | Close-up

- *Baladi* barley and *Abarabi* wheat
- Open canopy - long awns
- Even crop
- Some weeds
- Biomass 2.1g/stem
- Straw @ 1.3g/stem
- Grain average weight 0.4g/spike
- Loss from threshing 23%

- *Baladi* variety
- Medium sown
- Open canopy - long awns
- Even crop
- Some weeds
- Biomass 3.0g/stem
- Short straw @ 0.9g/stem
- Grain average weight 1.2g/spike
- Loss from threshing 32%

- *Baladi* variety 2 and 6 row
- Medium sown
- Open canopy
- Small spikes
- Biomass 2.3g/stem
- Short straw @ 1.1g/stem
- Grain average weight 0.7g/spike
- Loss from threshing 24%

Barley Straw - Medium

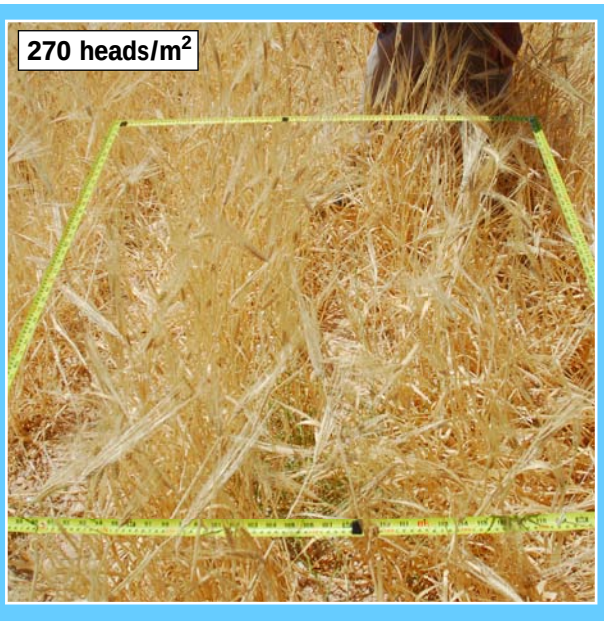
Biomass from 1m^2	Straw from 1m^2	Yield
 550 g/m^2	 325 g/m^2	Dry Matter 325g/m^2 325.0 kg/dunam 3.25 t/ha
 900 g/m^2	 280 g/m^2	Dry Matter 280g/m^2 280.0 kg/dunam 2.8 t/ha
 475 g/m^2	 230 g/m^2	Dry Matter 230g/m^2 230.0 kg/dunam 2.30 t/ha

Barley Straw - Low

From-a-distance | Close-up

- ***Baladi*** variety 6 row
- **Medium sown**
- **Open canopy**
- **Dirty field, with oats**
- **Biomass 2.1g/stem**
- **Short straw @ 0.8g/stem**
- **Grain average weight 0.8g/spike**
- **Loss from threshing 23%**

- ***Baladi*** variety
- **Medium sown**
- **Open canopy - long awns**
- **Biomass 1.6g/stem**
- **Short straw @ 0.5g/stem**
- **Grain average weight 0.7g/spike**
- **Loss from threshing 21%**



- ***Baladi*** variety
- **Medium sown**
- **Open canopy**
- **Bare ground dominant**
- **Biomass 1.6g/stem**
- **Short straw @ 0.8g/stem**
- **Grain average weight 0.6g/spike**
- **Loss from threshing 14%**

Barley Straw - Low

Biomass from 1m^2	Straw from 1m^2	Yield
		Dry Matter 180g/m^2 180.0 kg/dunam 1.80 t/ha
		Dry Matter 145g/m^2 145.0 kg/dunam 1.45 t/ha
		Dry Matter 125g/m^2 125.0 kg/dunam 1.25 t/ha

Barley Grain - High

From-a-distance | Close-up

- *Baladi* variety 2 row
- Very heavy sowing rate
- Open canopy - short awns
- Even crop
- Weed free
- Small spikes
- Grain average weight 0.8g/spike
- Biomass 2.1g/stem
- Long straw @ 625g/m^2
- Loss from threshing 15%

- *Baladi* variety
- Medium sown
- Open canopy - long awns
- Even crop
- Some weeds
- Grain average weight 1.2g/spike
- Biomass 3.0g/stem
- Short straw @ 296g/m^2
- Loss from threshing 32%

- *Baladi* variety 6 row
- Medium sown
- Open canopy - long awns
- Even crop
- Grain average weight 1.1g/spike
- Biomass 3.5g/stem
- Short straw @ 346g/m^2
- Loss from threshing 29%

Barley Grain - High

Biomass from 1m^2	Grain from 1m^2	Yield
 1375 g/m^2	 550 g/m^2	Dry Matter 550g/m^2 550.0 kg/dunam 5.5 t/ha
 900 g/m^2	 340 g/m^2	Dry Matter 340g/m^2 340.0 kg/dunam 3.4 t/ha
 930 g/m^2	 305 g/m^2	Dry Matter 305g/m^2 305.0 kg/dunam 3.05 t/ha

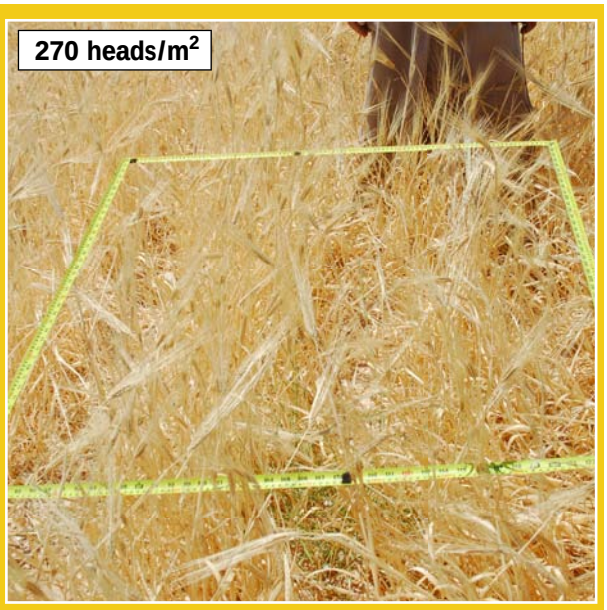
Barley Grain - Medium

From-a-distance | Close-up

- ***Baladi*** variety 2 and 6 row
- **Medium sown**
- **No canopy - lodging**
- **Small spikes**
- **Grain average weight 0.9g/spike**
- **Biomass 1.3g/stem**
- **Thin straw @ 130g/m^2**
- **Loss from threshing 27%**

- ***Baladi*** variety 2 row
- **Medium sown**
- **Bad lodging - no awns**
- **Bare ground hidden**
- **Poor spikes**
- **Grain average weight 0.9g/spike**
- **Biomass 3.5g/stem**
- **Thick, long straw @ 430g/m^2**
- **Loss from threshing 18%**

- ***Baladi*** variety
- **Medium sown**
- **Open canopy - long awns**
- **Grain average weight 0.7g/spike**
- **Biomass 1.6g/stem**
- **Short straw @ 135g/m^2**
- **Loss from threshing 22%**



Barley Grain - Medium

Biomass from 1m^2	Grain from 1m^2	Yield
 426 g/m^2	 285 g/m^2	Dry Matter 285g/m^2 285.0 kg/dunam 2.85 t/ha
 750 g/m^2	 200 g/m^2	Dry Matter 200g/m^2 200.0 kg/dunam 2.0 t/ha
 420 g/m^2	 185 g/m^2	Dry Matter 185g/m^2 185.0 kg/dunam 1.85 t/ha

Barley Grain - Low

From-a-distance | Close-up

- ***Baladi*** variety 2 and 6 row
- **Medium sown**
- **Open canopy**
- **Small spikes**
- **Grain average weight 0.7g/spike**
- **Biomass 2.3g/stem**
- **Short straw @ 230g/m^2**
- **Loss from threshing 24%**

- ***Baladi*** variety, a mixture of 2 and 6 row
- **Poor germination**
- **Poor development**
- **Small spikes**
- **Grain average weight 0.6g/spike**
- **Biomass 1.9g/stem**
- **Very short straw @ 125g/m^2**
- **Loss from threshing 17%**

- ***Baladi*** variety 2 and 6 row
- **Poor germination**
- **Poor development**
- **Very small spikes**
- **Grain average weight 0.3g/spike**
- **Biomass 1.9g/stem**
- **Short straw @ 210g/m^2**
- **Loss from threshing 28%**

Barley Grain - Low

Biomass from 1m^2	Grain from 1m^2	Yield
 475 g/m^2	 135 g/m^2	Dry Matter 135g/m^2 135.0 kg/dunam 1.35 t/ha
 240 g/m^2	 75 g/m^2	Dry Matter 75g/m^2 75.0 kg/dunam 0.75 t/ha
 360 g/m^2	 50 g/m^2	Dry Matter 50g/m^2 50.0 kg/dunam 0.50 t/ha

ANNEX 1

Converting grams per m^2 to kg per dunam and to tonnes per hectare

To convert the weight of your grain sample (in grams) harvested from one square metre (m^2) to yield in kilograms per dunam, you only have to change the units, as shown in the example below.

e.g. 175 g/m^2 = 175 kg/dunam

To convert the weight from kg per dunam to tonnes per hectare, divide by 100 and change the units.

e.g. 175 kg/dunam = 1.75 t/ha

Calculations explained:

- **To scale up from one square metre to one dunam, multiple by 1,000 (1000 m^2 = 1 dunam).**
- **To scale up from one dunam to one hectare multiple by 10 (10 dunam = 1 hectare).**
- **To convert your sample weight from grams to kilograms divide by 1,000 (1000 g = 1 kg).**
- **To convert your sample weight from kilograms to tonnes divide by 1,000 (1000 kg = 1 tonne).**

Example: if the grain harvested from one square metre weighs 175 g, then to scale up to kg/dunam and then to t/ha - use the equations below.

$$175\text{ g} \times \frac{1000\ (\text{change } 1m^2 \text{ to dunams})}{1000\ (\text{change grams to kilograms})} = 175\text{ kg/dunam}$$

$$175\text{ kg} \times \frac{10\ (\text{change dunam to hectares})}{1000\ (\text{change kilograms to tonnes})} = 1.75\text{ t/ha}$$

ANNEX 2

PET-Cereals (WBGS)

Self-Checking Sheet

Region: **Assessor's Name:** **Date:**

CROP name Sample number	GPS Coord.	Yield estimate kg/dunam and t/ha	Count Data (mean value from 1m^2)		Measured Yield (g/m^2)				Comments
			Ears, Heads, Spikes	Number of Plants	Quadrat 1	Quadrat 2	Quadrat 3	Mean Yield	

ANNEX 3

Some definitions of terms used in PET

What does estimate mean?

An estimate is an approximate or rough calculation. Good estimates, based on a sound knowledge of a situation, will help you reach a good decision within the resources that are available. For example, if you are asked how much crop is harvested from a farmer's field, you could measure the whole crop to get a true value of yield or you could estimate the yield with the help of PET-Cereals (WBGS). In most situations, it is not practical to measure the harvested crop and so a good estimate is important.

What is a crop assessment?

When you estimate the amount of crop in a village, a district or a region at harvest time, you are doing what is called a crop assessment. A crop assessment involves a collection of on-farm estimates of each crop provided by each farmer after harvest; or an assessment made by multiplying the weight of samples of crop yield taken per unit area by the number of units in your area of interest.

What is crop yield (or yield per unit area)?

The yield of a crop is the weight of that part of the crop that can be eaten, or used in any way, and is harvested by the farmer (for example, wheat grain). The yield per unit area is the weight of the harvested parts produced from a known area of land (usually a dunam, which is 1/10th of a hectare). For example, you can say that the farmer's field produced **100 kilograms per dunam or 1000 kilograms per hectare (1000 kg/ha) or one tonne per hectare (1 t/ha).**

If you are measuring the weight of your crop from one square metre (1m^2) you would weigh your crop in grams (g). If you weigh your crop from one square metre, and it weighs 100 grams (100g), you can say your yield is 100 grams per square metre (100 g/m^2). This may then be converted to a more usable/ quotable yield in kg per dunam or tonnes per ha.

***Remember*:** **One tonne (t) is the same as 1000 kilograms (kg).**
One kilogram (kg) is the same as 1000 grams (g).

What is plant density (or crop density)?

By plant (or crop) density, we mean the number of plants in a known area of land. In PET-Cereals (WBGS) plant density often refers to the number of plants inside the square frame (or quadrat), whose sides measure one metre in length (that is, the number of plants per 1m^2). If you have a crop with many plants inside the square metre then the plant density is high. You can also say that it is a very dense crop. If you have few

plants inside your square metre then the plant density is low. You can also say it is not a dense crop, or it is a thin crop. Some fields have mixed stands, some areas may have a high density and others may have a low density. You will have to estimate the proportions of each high area and each low area to arrive at the average plant density of the field.

What is one square metre?

A square metre is a measurement of area and is often used as a unit of area in which to count the number of plants or weigh the harvest. You will be working with a square frame (a quadrat) and each of the four sides will be one metre. The area inside your square frame when you put it on the ground is one square metre (1m x 1m = $1m^2$).

If you have an area which you can cover with the equivalent of 4 quadrats, your land will measure four square metres ($4m^2$) this will be equivalent to a square with sides 2m long (2m x 2m= $4m^2$)

If you have a bigger area which you can cover with 100 quadrats, then your field is 100 square metres (100 m^2 =10m x 10m).

What is one dunam?

A dunam is a unit of measure used in WBGS covering $1,000m^2$. Yields are usually quoted by local agriculturalists and farmers in kilograms per dunam.

What is one hectare?

One hectare (ha) is another measurement of area 10,000 times larger than $1m^2$. It is equivalent to an area 100m x 100m ($10,000m^2$). It is the most used international measure of land area; and used most often for the value of crop yields. One hectare is ten dunams.

What is a tonne per hectare?

A tonne per hectare is a measure of the weight of crop harvested (one tonne) from an area of one hectare. If you have one tonne per hectare (1 t/ha) it means that a field which measures one hectare produced 1 tonne or 1000 kilograms of crop. If a field which measures one hectare produced 2000 kilograms, you would say that the crop quantity was two tonnes per hectare (2 t/ha).

When you weigh your crop from one square metre, you will obtain the yield in grams per square metre (g/m^2). Normally you do not give the yield from a field in g/m^2, because the area is so small, instead you would convert your measures to tonnes per hectare (t/ha). NB. Annex 1 explains how to do this.

What does crosscheck mean?

When you crosscheck your data, it means that you compare your estimate of crop yield with a measured value of crop yield to make sure that your estimates are good and accurate.

What is a quadrat?

A quadrat is a square frame, which can be made of most materials such as wood, plastic or wire. A quadrat is used to mark an area of land from where you will take your crop cuttings or counts. The quadrat you will use will usually measure one metre (1m) each side, and therefore the size of the land inside the quadrat will measure one square metre ($1m^2$).

What is a spring balance scale?

The spring balance is a simple weighing instrument, which you can see in the photograph in the PET manual. It is used to measure the weight of small quantities of crop. You need to have something to hold the crop, in this case a clean plastic bag. The plastic bag has a weight, so in order to measure the weight of the crop you first need to set the spring balance to zero with the empty plastic bag attached. This is known as calibrating the spring balance, setting to zero, or *taring* the balance.

What does drying to a constant weight (cw) mean?

When the sampled crop is not fully dry, you must dry it in the sun to obtain an estimate of the weight of the mature crop. It may take a long time to bring down the *water content* to the usual level at harvest time, which is usually lower than 15%, leaving dry matter (DM) greater than 85%. After drying for several hours, weigh the crop on the spring balance and dry again. You will know the harvested parts are fully dry when the measurement you take is the same as the one before. When two consecutive measurements are the same, the sample is said to be dried to a constant weight and is, for purposes of crop assessment, 'completely' dry. Speeding-up the natural process using a microwave oven needs care not to cook the sample.

Therefore, if using a microwave oven:-

Use only medium intensity in 2-minute bursts.

Cool and weigh after each burst until the weight stays the same.

Bite the grain, if soft, continue to dry in 2- minute bursts until the grain is too hard to bite, or it snaps when bitten.

ANNEX 4

Post-Harvest Yield Assessment

On many occasions, assessment teams arrive after harvest. Rather than relying totally on the hearsay regarding crop performance, assessors may wish to conduct a) forensic assessment on the field; or b) estimate the crop in-store to obtain a rough estimate of production.

a) **Forensic assessing.** This technique is applicable to stover crops such as maize, sorghum or pearl millet. In the case below, the photographs used to demonstrate the technique come from Sudan.

i) Use the PET quadrat to estimate number of heads or cobs in a square metre as described in Step 2 and Step 6 and as shown below.

ii) Sample the heap of heads or cobs already harvested by subdividing the heap, taking, at random, a complete segment of the heap of heads or cobs, counting the number of collected harvested parts, threshing, weighing the threshed grain, dividing the weight of threshed grain by the number of harvested parts to find average weight of grain/ head or cob.

iii) Sub sampling 1

Sub-sample 1 with segment removed.

iv) Multiply the average weight of grain/ head or cob from (ii) by the average number of heads or cobs per square metre (i) to get grain weight in g/m^2, which may then be converted as shown in Annex 1.

b) Estimate of threshed production of crop in–store in a heap. **This technique may be used for any cereal crop where/ when the grains have been threshed but not bagged. Once again, the photos used to demonstrate the method come from Sudan.**

i) Measure the size of the field that has been harvested in square metres (e.g. length x width)

ii) Measure the radius of the heap in metres using the PET quadrat.

iii) Calculate volume in cubic metres of threshed grain in heap using the most suitable formula e.g. 2/3 pi r^3 = volume of hemi-sphere (where r= single radius of sphere cubed = r x r x r); or 2/3 pi x r_1 x r_2 x r_3 = volume of a hemi-spheroid (where r_1 x r_2 x r_3 =three radii of spheroid).

iv) Multiply volume of grain in litres[5] by an approximate value of density of grain c. 0.73 kg/litre (may be checked by weighing litre of grain from the heap using the PET balance) to obtain the weight of grain (in kg) in the heap.

v) Divide weight of grain in kg by the area of the field in square metres= kg/ m^2; multiply by 1000 to get kg/dunam; multiply again by 10 to get kg/ha; then divide by 1000 to get a yield estimate in t/ha.

[5] 1 cubic metre is 1000 litres; 1000 m^2 = 1 dunam; 10 dunam = 1 hectare.

ANNEX 5

Crop Yield Assessment using the PET Approach

1.0 Preamble- General Background to Crop Assessments.

1.1 Any crop assessment aims to produce a pattern of figures describing the harvest of the main staples of a specified location for a particular season. Production estimates are derived by multiplying area harvested by an estimated yield per unit area. Both parameters are measurable at harvest time when the assessments should occur.

1.2 To be convincing, the estimated levels of production recorded must be plausible. Plausibility is a very important consideration in acceptability, without which crop assessments become worthless exercises. Therefore, data presented should be rational, justifiable and defendable in debate; and, should come from a source as close as possible to the farming community.

1.3 In countries/ states where active administrations exist, the best *entry-points* for any crop assessment mission teams are the largest administrative units that are a) in day-to-day contact with their farming community, and b) may be visited within *the time and budget allocated* to assessments. These *entry-points* are usually district or regional level Ministry of Agriculture offices but may also be, depending on circumstances, irrigation schemes, area development projects, private estates or zones under temporary administrations. During the course of an assessment mission, such *entry-points* will be visited in sequence to provide the background quantitative information required to create the area per crop framework upon which the results are built.

1.4 With these points in mind, the *golden* rules regarding quantitative data are;

- **Assessment mission teams must never leave an *entry-point* without the area[6] data** for the season's crops of interest.
- **If time is short and data are not compiled, teams should concentrate on the compilation of the data for the main staples.**
- **Do not accept that data will be sent/faxed/e-mailed later. The road to incomplete files is paved with such broken promises.**

[6] Sometimes yield estimates will also be available. These yields will need auditing using PET as described.

2.0 PET- Crops Yield Assessing.

2.1 The PET manual as presented above describes a rapid, objective way of estimating yield in every field you see in passing. The PET Approach summarised below explains how to use the manual to best effect in transects, i.e. in journeys when the item of interest is noted regularly and in a similar manner.

2.2 The PET protocol to estimate crop performance through identifying yields at harvest time comprises the application of increasing intensities of observation, best described diagrammatically as an inverted pyramid as shown in Figure 1. The observations begin from the vehicle, then during walking slowly past the fields, and finally, are made within fields during discussions with farmers.

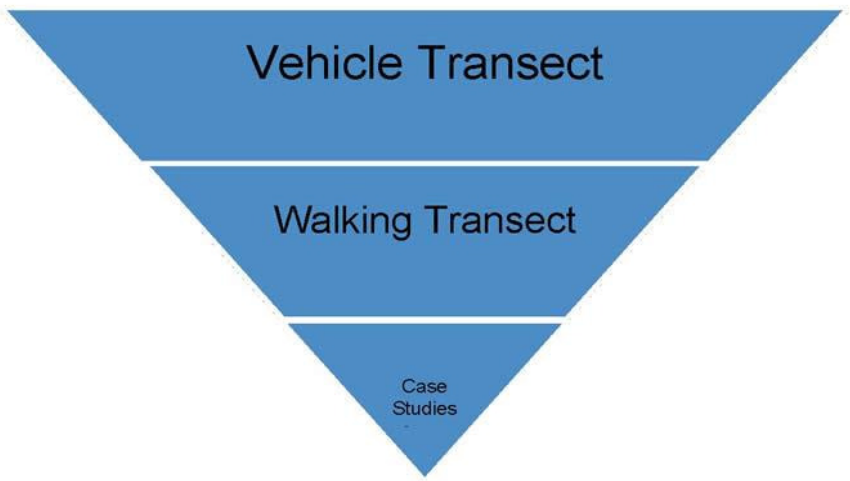


Figure 1: Observation Levels-decreasing in number; increasing in detail

2.3 During vehicle transects, observers identify the approximate yield of all fields seen through the windshield of a vehicle travelling at a slow, steady speed. At such a distance and using the from-a-distance photo-indicators on the appropriate page in the PET manual for the crop in question, the number of fields with harvestable crops passed on the journey that fit into the 3 broad categories, BLUE (low), YELLOW (medium) or RED (high) are recorded in a log book and added-up at the end of each journey. At the same time, all the fields of the same cereal with no harvestable crop (yield = zero) are also noted and added up in the same fashion.

2.4 The three colour categories are present to ease rapid approximation of yields during transects. The colour bands only provide a *convenient initial grouping.* Indeed the range of yields should be regarded as contiguous - NOT as three, pre-set, isolated discontinuous

clusters into which all high, medium and low crops must fall. They should not prevent assessments of levels between each band (i.e. red-yellow; or yellow-blue) if necessary.

2.5 In some years, it is possible, although unlikely, that there will be no crops in the red band. In such a year, the highest crop may be found in the yellow band. Other years, there may be no crops in the blue band, the lowest crops being found in the yellow band, again equally unlikely, but possible; and, if and when they occur, such instances will be recorded fully within the system described.

2.6 So every small field, or regularly recorded sections of large fields passed during the journey (transect) may be classified as **blue, yellow** or **red** (or combinations as noted in 2.5) or **zero** on prepared sheets by noting single ticks in columns of boxes under the corresponding heading. The number of ticks in each column must be added-up at the end of the transect to enable weighted average yields of each crop under assessment to be prepared.

2.7 On arrival at a) an area of specific interest as determined by the results of the initial observations or b) at predefined regular intervals, observers leave the vehicle and switch to walking transects, which enable the fields to be observed more closely and allow crops to be categorised and recorded at **low, medium or high** levels **within the three colour bands** or at levels **between, below or above** the colour category already determined during the driving transect.

2.8 All fields passed during the walking transect are closely observed and scored using the scale provided by the photo-indicators from **Low Blue** to **High Red** in the manual. In this way, more accurate assessments of yield are made by translating colour code to yields in kg/ dunam or t/ha, connecting to the **close-up** photographs and photographs of the harvested products of each field passed.

2.9 After including the number of **zeros**, weighted averages are prepared for each transect walk for each crop by

- multiplying frequency of appearance (number of ticks) by the yield chosen;
- adding the totals together;
- dividing by the total number of ticks.

2.10 The resulting overall weighted yield estimate for the crop may then be obtained by

- multiplying the frequency of appearance of the colours by the weighted averages;
- adding the totals together;
- dividing the **grand total** by the all the ticks, including the zeros.

2.11 The sequence of actions is completed by conducting detailed case-studies of a small number of available farmers involving:

a) semi-structured interviews in his/her field using a common pre-tested/proven checklist, and

b) taking representative samples of the field, threshing, winnowing and weighing the product to crosscheck your use[7] of the photo-indicator.

2.12 At the end of each day, each team summarises the returns for the vehicular and walking transects and weighted averages calculated for each crop using the yields of the photo-indicators (Low Blue to High Red and zero) for fields recorded for each crop using the transects. Samples taken are re-bagged, stored safely ready for drying to constant weight (only if necessary) to determine dry-matter content which is then used to confirm your choice of indicator, and, the day's data cross-referenced with the previous day's data **to check for inconsistency[8].**

2.13 In the PET Methodology, emphasis is placed on the facts that:-

- **PET is a tool for rapid assessment using PET Cereals (WBGS) applying optimal levels of accuracy (OLA);**
- **As such speed of application must be matched by speed of analysis and speed of reporting or the value is lost;**
- **The PET manual provides the formula to be applied to assess yields, but it is the rigour, consistency and stamina of the teams using the manual that make the approach successful;**
- **PET provides estimates of yields per dunam or per hectare at harvest time; *it does not provide forecasts for immature crops*, therefore the timing of assessment missions applying PET needs careful planning.**
- **PET estimates of crops just prior to harvesting need to be adjusted for moisture content by drying to a constant weight;**
    - **If the sample is taken when grain is harvest-dry (grain snaps when bitten) the sample should be weighed, the weight carefully recorded; and the grain returned to the farmer;**
    - **If the grains were still wet, as detected by a soft bite, the grains should be weighed fresh, a purchase price for the sample negotiated and the grains placed in a strong manila envelope, labelled with all details, and taken back to base for drying to constant weight. (Procedures to follow are included in the PET- Cereals manual).**

[7] The assessor should adjust their choice of photo-indicator to correct their bias.

[8] Other tasks that should be completed at the end of each day include summarising the semi-structured interviews, and filing data retrieved from entry point sources,

- **PET yield data should also be crosschecked against a) theoretical estimates from previous surveys; b) direct data from well-positioned and involved key informants including regional/district MoA extension workers, elders, tractor drivers, tractor owner/managers, threshing-machine operators and grain traders; c) combine drivers (NB- *the best source of useful information*)**
- **Combining the yield estimates from PET with the best-fit area estimates provides a rapid and direct estimate of production with which to identify food-security, strategy options at an early stage in the marketing year in prospect.**

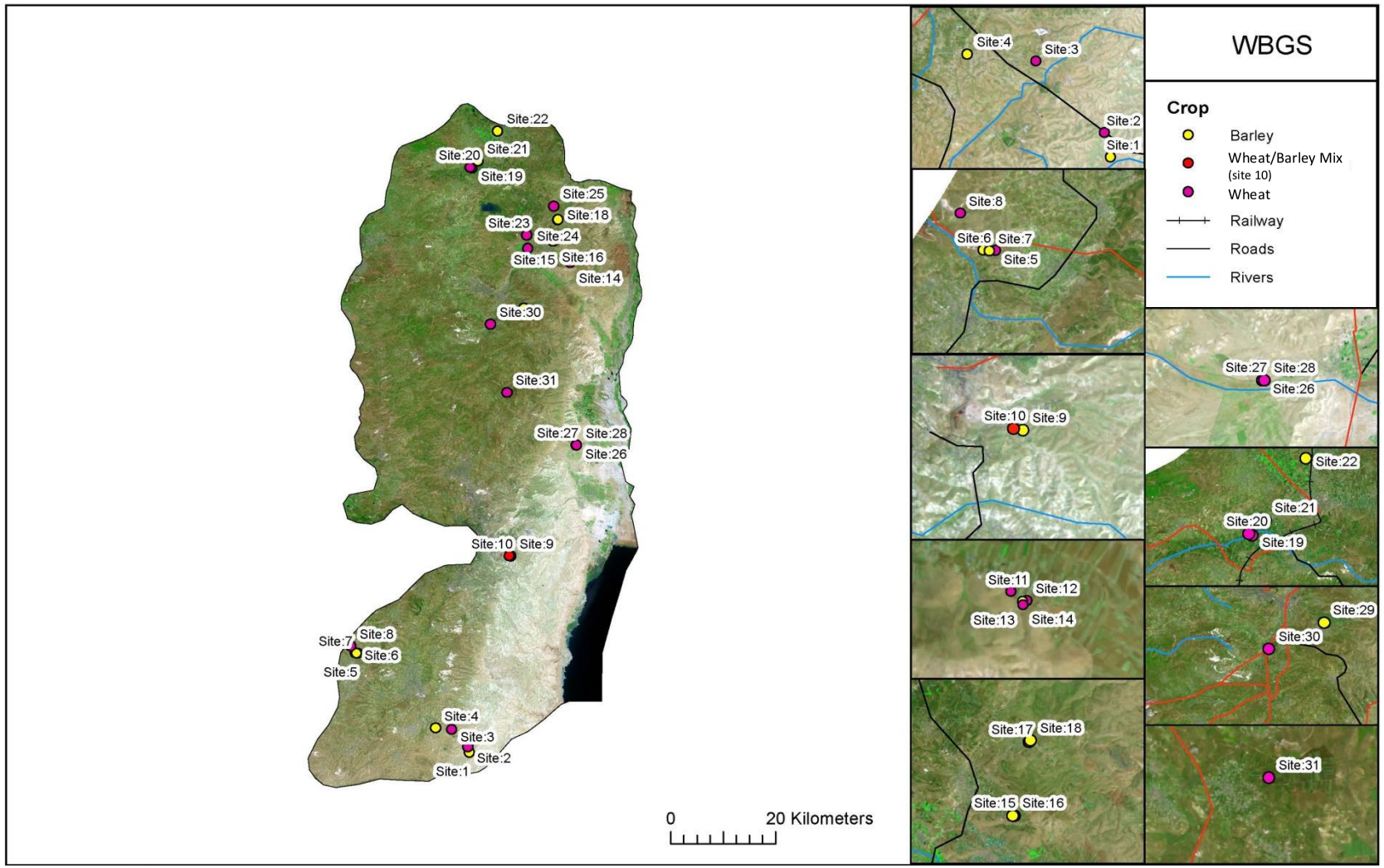
The features of the PET approach to crop assessing, versus more standard statistical approaches based on agricultural and census data, are summarised below:

IMPORTANT ASPECTS	PET APPROACH WITH PET MANUAL	STANDARD STATISTICAL APPROACH
The *purposes* of the two are entirely different, though both are based on *objective approaches* to assessment[9].	Used for Rapid Appraisals only, when results are required immediately.	Used for national archives and experimental comparisons, when results are not expected immediately.
	Used when only approximate estimates are needed to determine trends for immediate decision making, including but not limited to identifying areas of surplus and areas of deficit.	Used to detect the fine differences required for: a)retrospective understanding of events and, b) making choices between similarly performing varieties / farming techniques.
	Provides an Optimal Level of Accuracy (OLA) that is determined by time and funds available.	Highest level of accuracy expected, which is determined by the statistical techniques adopted.
PET is easily explained to non-specialists.	Can be planned, organised and implemented by non-specialists following short training.	Planning, organising implementing and controlling requires highly trained specialists. *Continued....*

[9] As opposed to crop production and food security assessments based on post- harvest interviews which the author notes (having conducted assessments of various types in more than 70 countries) are too easily influenced by vested interests a) particularly in countries with long histories of institutionalised food aid; and, b) where crop assessments are known to be used to generate taxable income levels.

IMPORTANT ASPECTS	PET APPROACH WITH PET MANUAL	STANDARD STATISTICAL APPROACH
The PET approach does not demand a high level of mathematical/statistical expertise.	Analysis can be done through simple mathematical calculations no more complicated than weighted averages.	Analysis requires high degree of statistical training.
PET is an accessible approach.	Every single field can be scored in seconds and quantified in a matter of a few minutes. Due to the relatively small area of WBGS fields, this allows assessments to include a very large number of fields.	System accurately describes yield from a few sampled fields only- disregards all the others.
The PET approach provides flexibility.	Allows for cross checking and correction / adjustments. All fields seen may be scored into main categories. Scoring is then refined and quantified during walking transects, to fine-tune selected levels of performance in specific representative areas.	Inflexible, no adjustments allowed. Without the full rigour of a supervised, statistically valid approach of sampling randomly selected plots within fields, the method can lead to misleading errors, as so few fields are involved.
Farmers can participate in the PET approach.	Farmers can join in PET and select their choice with the assessors.	No participation possible except at labouring level.
PET teams can be easily checked by their supervisors	PET is non-destructive. Sample sites are observed and compared to photo-indicators as standing crops. Crop cutting is used only for fine tuning observational skills only. Therefore sites can be revisited and checked.	All samples are cut. Exact sites cannot be revisited or checked.

The map below indicates the locations from which samples and photo-indicators were taken in preparing PET-Cereals (WBGS).



Source: Aberystwyth University, UK

ANNEX 6

Crop Area Estimates

1.1 The timing of assessment missions means that, in most cases, harvesting is underway. Therefore, harvested area data will always be incomplete. Consequently, final planted area data may provide the best crop area statistics with which to estimate production.

1.2 It is easier for visiting assessment teams to estimate yield, as noted in Annex 5, than to estimate area. Regarding area, assessment missions may only ensure that the figures provided to them by the *entry-point* administrations are plausible and that they are within the historically- accepted, land available for cultivation. To achieve this, assessment missions with access to *entry-point* data should-

- **Watch out for double counting due to administrative boundary changes, which may change the status of villages or even whole districts.**
- **Be aware of changes in numbers of farming households.**
- **Be sure to check the units used i) at the point of data collection from administrators and ii) when transcribed into the records.**
- **If local units are used, check that the conversion factors are consistent and plausible.**
- **Remember that at most *entry-points*, most data are summated by hand and entered/ copied by hand.**
- **Mistakes invariably occur, so check the calculations.**

1.3 Mission teams should request final planted area data at each *entry-point* for each crop. This means that each crop has a separately recorded area. Complications arise when;

- **Two crops are planted in series in the same season, i.e. the second one is planted after the harvest of first one. This doubles the occupancy of the area under production whether the two crops are the same or different (Relay cropping).**
- **Two or more crops are grown together in same field during the same season. When planted and harvested at different times, this doubles the occupancy of the field and, therefore, doubles the harvested area (Intercropping). Plant densities are likely to be lower in an intercropped field than when each crop is a planted separately in monoculture, so yields/ unit area are likely to be lower.**

1.4 In both the circumstances noted above the actual *production* area is twice the *geographical* area. Where data allows, the extent of the increase for the individual crop

areas should be noted in the text and identified in tables. A different approach is necessary when-

- **Two crops are sown together and the mixed products are harvested together. In such cases (for instance-wheat and barley), the area is not doubled and only the area of the dominant crop should be recorded (Mixed cropping).**

1.5 Total planted area data received should be:

- **Collected at each *entry-point* in their original form. An electronic copy on a memory stick is preferred, or a photocopy or carbon copy; but if neither are available the data should be transcribed from original on to assessment mission sheets.**
- **Crosschecked for year-to-year and place-to-place for consistency in transformation from local measures to international units.**
- **Compared with the known total agricultural/cultivated area of each *entry-point*.**
- **Crosschecked against any known changes to numbers of households farming in each *entry-point*.**
- **Crosschecked against any known boundary changes to eliminate double counting.**
- Compared with last year's main season harvested area in each ***entry-point*.**
- **Crosschecked with any changes to the planted area of any preceding minor season in each *entry-point*.**
- **Compared with any known changes to area of industrial crops, tree crops, pasture land, forestry areas or fallowing practices.**

1.6 Individual staple–food crop planted areas should be:

- **Compared with the** last 5 years' annual national, regional and ***entry-point*** **estimates.**
- **Intercropped areas noted in each *entry-point*.**

1.7 The final database will be achieved through combining information received and adjustments made following the team's field audits, particularly with regard to yield. Remember, by virtue of the facilities placed at their disposal, assessment missions are invariably in a far better position to estimate *actual yields* than the local MoA officers or any other assessing groups. When sure of the overall accuracy, enter the data into a hierarchically-linked, excel spreadsheet using figures rounded-up to an appropriate level.

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