

CHAPTER 5: INDICATORS OF PRODUCTION CONSTRAINTS

Land degradation also concerns farmers in its effect on production. Most responses from land users to changes in soil quality are tied to some aspect of agricultural production: reduced yields; greater difficulty in maintaining yields; more weeds; stones on the surface making ploughing difficult. The farmers' perspective is, therefore, most often articulated through how production is changing and the way in which plants, soil, water supplies and natural vegetation have deteriorated, making production more problematic. It is therefore essential that these *Guidelines* reflect the concerns of farmers, because this is the way they most often make their assessments of land degradation.

Farmers are the primary source of information. They decide on the appropriate indicators of production and they choose the levels of seriousness of land degradation. They are able to put current production into context in terms of both historical trends and changes in production methods. They have their own ways of observing and describing the evidence of the effect of land degradation on production. PRA techniques (see section 3.4) may yield much valuable data about the extent of land degradation and how it leads to changes in

farming practices over time.

Indicators of production constraints do not give a quantitative measure of the extent of land degradation, as is possible with estimation of soil loss. Instead, these indicators identify problems which may have been caused by land degradation. It is possible that other factors (e.g. drought stress) result in the identified production constraints. However, these other factors may themselves also be partly related to land degradation. Drought, for example, may not just be a lack of rainfall; it can also be caused by a reduced available soil water capacity that has been induced by loss of organic matter. Thus, while the identification of these production constraints is not conclusive evidence of land degradation, further investigation may well conclude that this is the most likely direct or indirect cause of the problems.

Because production constraints involve observations and data from many sources, experience has shown they are the most difficult for which to find systematic evidence. Therefore, the following checklist questions have been devised for field use:

Table 5.1: Field Question Checklist

<i>Questions</i>	<i>Go To Section</i>
What medium- to long-term trends in yields do farmers report?	5.1 Crop Yield
Examine yield records on-farm, local co-operative, district statistics.	5.1 Crop Yield
What measures do farmers report for counteracting and compensating for yield decline? [e.g. fertiliser; change crop; new variety; farm more/less land]	5.1 Crop Yield
Do you notice within-field differences in crop size and/or vigour?	5.1 Crop Yield & 5.2 Crop Growth
What crop-specific evidence is there of differential growth? [e.g. height; number of tillers; size of root]	5.2 Crop Growth
What immediate explanations are there for these differences? Factors seen by you; and factors reported by farmers?	5.1 Crop Yield & 5.2 Crop Growth
Are soil texture, soil colour, soil depth clearly related to within-field yield differences?	5.4 Soil Texture, Colour & Rooting Depth
Do you see markings or colour differences on the leaves of plants? Any differences between young and old leaves?	5.2 Crop Growth & 5.3 Nutrient Deficiencies
Is there any association of these differences with field evidence of land degradation? [e.g. yellow leaves and shallow/sandy soil]	5.3 Nutrient Deficiencies
Are soil texture, soil colour, soil depth clearly related to markings or colour differences on plants?	5.4 Soil Texture, Colour & Rooting Depth
What measures have farmers taken to counteract or compensate for these possible nutrient deficiencies? [e.g. nitrogenous fertiliser]	5.3 Nutrient Deficiencies

5.1 Crop Yield

Crop yield is dependent, in part, on the underlying productivity of the soil. It is also affected by seed quality, climate, pests, crop diseases and management by the farmer. The assessment of trends in crop yield, in association with farmers, may show that crop yields have fallen which, in turn, may indicate that land degradation has taken place.

Whilst falling crop yields can be indicative of land degradation, this is not the only possible explanation of decreasing yields – for example, the yields of perennial crops may fall as they get older. Even if yields are increasing, land degradation may also be occurring, but its effects may be masked by the management practices adopted by the farmer, such as increased amounts of fertiliser. Indeed, this masking of land degradation by greater and greater use of inputs is considered by some to be the most serious consequence of land degradation indicating that future yields will crash when farmers are no longer able to afford the inputs. Some of these issues are considered further in Chapters 7 and 8.

An historic comparison of yields can provide useful information about changes in production. By accessing records of past crop yields from farm records, local co-operatives, marketing boards or official government statistics, a good idea of medium to long term trends can be gained. Then putting those records alongside statistics on fertiliser use, introduction of new varieties and other production-enhancing factors, a qualitative view may be gained of how far land degradation may have impacted production. Often, however, farmers change their production and livelihood practices in response to land degradation. Any one or more of the following explanations and factors should also be considered:

- change in crop type to one more tolerant of degraded conditions: e.g. maize to millet; sorghum to cassava; or annual crops to perennials;
- extensify production onto more marginal hillslopes and poor soils: note that this

tends to reduce average yields even faster, and cause further land degradation;

- intensify production on smaller areas by applying manures, irrigation or other inputs: note that this may well reduce overall land degradation;
- land users migrate to towns, or diversify sources of income into non-farm activities such as poaching, brewing; charcoal-making; or village industry: each of these, in turn, may have land degradation implications.

These coping and adaptation practices in response to land degradation are only amenable to descriptive and non-quantitative analysis. The field assessor will want quantitative measures of production constraints. In terms of changed yield, these can be obtained rapidly through participatory techniques directly in the field. Figure 5.1 gives one example from Sri Lanka where a smallholder has moulded a lump of earth to indicate to the researcher the expected size of radishes from different parts of the field. Within-field differences in yield are often very significant – the farmer will be well aware of these differences, and the researcher may be able to relate the yield differences to land degradation variables such as soil depth. Root crops, such as carrots, sweet potatoes and beet, are especially amenable to this participatory technique. Farmers are also often happy to draw the size of their individual root crops onto paper. The researcher, then, may purchase an equivalent size of crop from the market, weigh it, and multiply by the number of plants in a fixed area to get accurate yield assessments.



Figure 5.1: Sri Lankan Farmer Demonstrating Crop Yield by Making a Clay Model

Table 5.2: Techniques for Assessing Yield

<i>Field-based Yield Assessment</i>	<i>Relevant situations and warnings</i>
Relative diameter of growing crops in relation to land degradation indicators, such as depth of topsoil, organic carbon content or slope.	This is useful for vegetables, planted on same date but in different parts of the field. Lettuces or cabbages have significantly different diameters according to soil quality – these measures are a good proxy for yield, especially if the farmer can show what size they are expected to reach at harvest.
Relative height of growing crops (as above).	Height is a good proxy of yield for other crops, such as maize. But note that height is very specific to crop variety, and so relative measures can only be used for the same variety.
Number of tillers on individual cereal plants, such as wheat, barley and oats.	For many cereals, the number of tillers is directly related to yield, because each tiller has a seed head. So, a count of tillers is a useful proxy for yield. Again, the farmer can help by indicating size of expected seed head.
Plant population per square metre.	Where germination is poor due to land degradation, plant population in degraded versus less degraded parts is a useful proxy. This has been used with cereals, especially where soil crusting by raindrop impact has affected germination.
Direct farmer assessments of bags of marketable yield per field from growing crop.	From experience farmers will usually be able to estimate the number of bags of crop yield. Comparison of farmers' estimates between fields is especially useful.

Other practical yield assessment techniques that have been used in the field are listed in table 5.2 and should be considered for application in appropriate situations. A word of warning, however – information on yield will depend on human recall. The limitations of memory must be recognised – it provides a personal history and interpretation rather than factual evidence. Yet, it is the farmer-perspective that is vital to obtain, rather than absolute quantitative yield figures.

5.2 Crop Growth Characteristics

Several of the yield assessments use crop growth as a proxy for yield. However, crop growth characteristics by themselves are one of the most common indicators of plant vigour described by farmers. In so far as crop growth is related to land degradation, observations and simple relative measurements are very useful in obtaining a farmer-perspective. Crop growth characteristics depend on the seed itself, the agronomic practices followed by the land user, the soil and the climate. Within fields it may be possible to identify differential crop growth. The question that must be asked is 'what has



caused this difference in growth pattern throughout the field?'



Figure 5.2: Differential Growth of Radishes In-field, Sri Lanka

Note that the plants are denser and more vigorous in the lower part of the field, showing that this part of the field is more fertile.

While it may seem that the cause of differential plant growth is self-evident, it is worthwhile taking some time to map the incidence of the differential growth, and then to plot the possible causation factors. The mapping of the growth is most easily achieved by dividing the field into a grid and recording the relative vigour of the plants in each square. In determining the reasons for differential growth, it is important to eliminate as many explanations as possible. A checklist of questions to help identify the reasons for

differential crop growth might include the following:

Crop factors

- Are all the crops in the field the same variety? Very often land users will elect to plant a mix of high yielding (for sale) and lesser yielding (for home consumption and taste preference) varieties that will, nevertheless, produce some yield even if the growing season is particularly dry or wet, or particularly hot or cold.
- Were all the plants in the field sown or introduced at the same time?
- Are the row distances constant throughout the field, or are crops planted more densely in some parts of the field than others?
- Do plants in one part of the field show signs of pest infestation/consumption that are not on plants elsewhere in the field?
- Have animals been grazing along the field boundaries, resulting in reduced crop density and vigour?
- Has one part of the field had a different treatment applied to it?

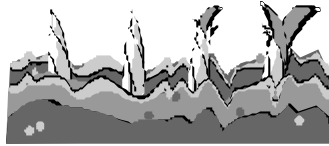


Figure 5.3: Differential Maize Growth, Mexico

A gypsiferous soil amendment was applied to the part of the field to the right and to the fore of the photograph, showing more vigorous maize growth.

Land degradation factors

- Are parts of the field more exposed to wind than the rest?
- Are parts of the field more sloping than others?
- Have conservation or tillage practices introduced in-field differences in soil depth or accumulations of fertile sediment?

- Are there accumulations of soil behind barriers, such as boundary walls and hedges? Has farming practice caused 'plough erosion': i.e. the progressive removal of soil downslope by hand or with the plough?
- Are any parts of the field inherently more fertile than others (e.g. old stream beds)?

Knowledge of the common characteristics of locally planted varieties is extremely useful in determining how a crop that is uniformly productive on a particular plot compares to the same crop planted elsewhere in the locality. Comparisons with fields of the same crop planted nearby may suggest that different management practices have been followed.

5.3 Nutrient Deficiencies

Nutrient deficiencies are one of the commonest ways in which land degradation affects production. Hence, it is essential for the field assessor to be aware of the evidence of such deficiencies in growing plants. In most cases, by the time nutrient deficiencies are evidenced by abnormalities in the visual presentation of a plant, it is already too late to correct the deficiency in time to affect current yields. Nevertheless, if future productivity is to be maintained or increased, it is important to identify, as far as is possible, the cause of the abnormalities. As will be discussed below this is not a straightforward task.



Different crops require different levels of nutrition. This means that some species may be more susceptible to particular deficiencies than others. Land degradation can, therefore, affect some crops and leave others untouched. So, as with yields and crop growth characteristics, the effect of deficiencies of nutrients, resulting from land degradation, is both crop-specific and soil-specific. This is why local people may respond to nutrient deficiencies by applying fertilisers and manure

or changing to a less demanding crop. These responses are themselves also good evidence of nutrient deficiencies, which can be gained from local people and their explanations as to why they have changed practice.



Figure 5.4: Evidence of Nutrient Deficiencies in Millet Crop

Note the yellowing of lower leaves.

Nutrient deficiencies are caused by more than just removal in the processes of soil degradation. The principal cause (up to 100 kg N or more, in intensive cropping) comes from removal in harvested crops and insufficient replenishment through manures or fertiliser. Excess removal through harvesting, although unrelated to soil erosion, is still a factor of land degradation. Thus, in determining the cause of nutrient deficiencies, the field assessor must make careful judgement, tying field evidence with other aspects of farming practice and local knowledge.

Many commentators argue that visual symptoms are not sufficient indicators on which to base conclusions about nutrient deficiencies or toxicities. The main reasons why visual symptoms alone are insufficient for determining the existence of nutrient deficiencies and their link to land degradation are:

- 1) Different plants respond in different ways to nutrient deficiencies. For example, root crops demand over twice the levels of phosphorus than cereals or beans.
- 2) Deficiencies (or toxicities or other degradation factors) of different nutrients may exhibit the same visual symptom. For example, yellowing of bean leaves can be lack of nitrogen, waterlogging, or even salinity. In maize, the accumulation of

purple, red and yellow pigments in the leaves may indicate N deficiency, an insufficient supply of P, low soil temperature or insect damage to the roots.

- 3) Disease, insect and herbicide damage may induce visual symptoms similar to those caused by micronutrient deficiencies. For example, in alfalfa it is easy to confuse leaf-hopper damage with evidence of Boron deficiency.



Notwithstanding these valid objections to the use of visual observations, their judicious use can provide valuable insights into the constraints in particular cropping systems.

Indicative Conditions for Nutrient Deficiencies: Certain soil types, or soil uses, may be more likely to display nutrient deficiencies than others. The combination of particular soil conditions with visual indicators of nutrient deficiencies makes the conclusions drawn from the latter more robust. In the following table some of the conditions that can lead to nutrient deficiencies and toxicities are noted. These are not the only situations in which deficiencies or toxicities may occur. Land management practices also have a significant impact on the potential for nutrient deficiencies/ abnormalities.

Table 5.3: Nutrient Deficiencies and Toxicities – Generalised Symptoms and Circumstances

<i>Essential Nutrient</i>	<i>Deficiency/Toxicity Symptoms</i>	<i>Typical Conditions</i>
Nitrogen (N)	Leaves (first older ones) turn yellow/brown, plants are spindly, lack vigour and may be dwarfed.	Sandy soils under high rainfall conditions and soils low in organic matter, where leaching occurs.
Phosphorus (P)	Not easily detected from appearance. Where deficiency is severe plant will be stunted, the leaves will take on a purplish tint and the stem will be reddish in colour.	Acid soils rich in iron and aluminium oxides (i.e. red tropical soils)
Potassium (K)	Yellow/brown spots appear on older leaves and/or necrosis of edges.	More frequent on light soils (as K is concentrated in the clay fraction of soils).
Sulphur (S)	Leaves are stunted, with uniform chlorosis.	
Calcium (Ca)	Roots are usually affected first – growth is impaired and rotting often occurs. In vegetative growth, deficiency may show in distorted leaves, brown scorching or spotting on foliage or bitter fruit (e.g. apple) or blossom-end rot (e.g. tomato).	Acid soils, or alkali or saline soils containing high proportions of sodium.
Magnesium (Mg)	Interveinal chlorosis, first on older leaves.	Acid, sandy soils in areas with moderate to high rainfall. Often occurs in conjunction with Ca deficiency.
Iron (Fe)	Chlorosis of younger leaves.	Calcareous soils, poorly drained and with high pH. (In neutral and alkaline soils P may prevent the absorption of Fe.)
Manganese (Mn)	Chlorosis of younger leaves.	Badly drained soils, over-liming or deep ploughing of calcareous soils can lead to Mn deficiency, as can the presence of high levels of Mg. The combination of high pH values (> 6.5) and high levels of organic matter can immobilise soil Mn.
Zinc (Zn)	Symptoms vary with plant type – in cereals young plants display purpling, whereas in broad-leaved plants symptoms include interveinal chlorosis, reduced leaf size and sparse foliage.	Soils with high pH. Available Zn is reduced by the application of lime or phosphates.
Copper (Cu)	Chlorosis of the tips of the youngest leaves and die-back of growing points.	Peat soils, or leached sandy or acid soils.
Boron (B)	In crops, other than cereals, the apical growing point on the main stem dies and lateral buds fail to develop shoots.	Sandy soils, dry conditions and liming can result in B deficiency.
Molybdenum (Mo)	Marginal scorching and cupping of leaves. Wilting is common in Brassicas.	Acid soils or soils with high pH. Mo deficiency can lead to N-deficiency as nitrate requires adequate supplies of Mo for metabolism. Mo availability can inhibit the uptake of Cu.
Chlorine (Cl)	Wilting of leaves.	Well-drained, sandy soils.
Sulphur Toxicity		Build up of sulphates as a result of irrigation
Manganese Toxicity	Brown spots and uneven chlorophyll in older leaves.	Soils with pH of < 5.0 (for susceptible species)
Copper Toxicity	Chlorosis of leaves and restricted root growth.	Soils with low pH
Boron Toxicity	Progressive necrosis of the leaves, starting from the tips and/or margins.	Soils with low pH
Aluminium Toxicity	Plants die after early growth.	Acid mineral soils, aggravated by low P status
Chlorine Toxicity	Burning of leaf tips, bronzing and premature yellowing of leaves.	Associated with irrigation using water containing chloride

Identification of Nutrient Deficiencies:

Observation of abnormalities in plants is a complicated and skilled task. Since nutrient deficiencies may be manifested in different ways depending on the crop in which they occur, particular criteria will be crop-specific. As an example, the visual indicators of nutrient deficiencies in several tropical crops are set out in the following table.

Table 5.4: Examples of Deficiencies in Several Tropical Crops

	<i>Maize</i>	<i>Beans</i>	<i>Cabbage</i>
General	High N requirement and sensitive to low phosphate supply. Relatively sensitive to water stress.	Tolerant to a wide range of conditions, but only high yielding with high N.	Demanding of N, P and K. Moderately sensitive to water stress.
Nitrogen	Reduced vigour; leaves a pale green or yellowish colour.	Plants are small, leaves are pale green and older leaves turn yellow. Few flowers are produced.	Young leaves pale green, older leaves are orange, red or purple. Severe deficiency renders the crop useless.
Phosphorus	Stunted growth, delayed ripening and purplish leaf colour, especially during early growth.	Stems are dwarfed and thin, leaves lack lustre. Early defoliation occurs, starting at base of shoot.	Leaves are dull green with purplish tinge, margins die.
Potassium	Small whitish-yellow spots on leaves. Poor root system, plants are weak and may be blown down.	Chlorosis of leaves, with necrotic brown patches at margins between veins.	Leaves are bluish-green. Leaf margins may show scorching and tips of older leaves may die.
Sulphur	Somewhat similar to N-deficiency. Plants short and spindly. Younger leaves pale beige to straw in colour.	Stunted growth, yellowing leaves. Delayed flowering and development of beans. Reduced nodulation on roots.	Smaller plants, with yellowing leaves.
Calcium	Poor germination and stunted growth.	Growth is stunted and growing point may die. In severe cases plants turn black and die.	Leaves rolled up at margins, necrosis of rims and death of growing point.
Magnesium	Whitish or yellow striping between the leaf veins, followed by necrosis.	Older leaves show interveinal reddish-brown mottling.	Interveinal chlorosis and puckering of older leaves.
Iron	Alternate rows of green and white on leaves	At early stage, patternless paling in leaf colour; later stage, yellowing of leaf similar to N-deficiency.	Whitish streaks on leaves. Veins unaffected at first, but larger veins eventually turn yellow.
Manganese	Yellow and green striping along the length of the leaf.	Chlorosis, initially of young leaves, followed by necrotic spots in interveinal areas. Leaves will fall off and plants eventually die.	Leaves are of smaller size and exhibit yellow mottling between veins.
Zinc	Chlorotic fading of the leaves, with broad whitish areas.	Leaves and flower buds are shed	
Copper	Leaves become chlorotic and the tips wither.		Leaves chlorotic, heads fail to form, growth stunted.
Boron	New leaves show transparent stripes. Growing points die and ears may not develop.	Leaves turn yellow and then brown. No flowers or pods are produced.	Leaves are distorted, brittle, mottled along margins and wilted.
Molybdenum	Not common by itself, but indicators include scorched patches on leaves.	Leaves are smaller, pale in colour with interveinal mottling developing into brown scorched areas.	Older leaves become mottled, scorched and cupped. Margins are irregular and heart formation is poor.
Chlorine	Plants short with poorly-developed stubby roots	Cl essential for the symbiotic fixation of N in legumes. No nodulation and stunted growth	Stunted roots with excessive branching and poor wilted top growth
Copper Toxicity	Reduced growth, chlorosis and stunted root development.		

Measuring Nutrient Levels

In most cases, plant analysis is carried out in laboratories. However, it is possible to test the levels of various nutrients in the field. There are two simple ways to do this, i.e.

1. *Using manufactured strips:* Some manufacturers produce strips that react with plant sap. The sap can be squeezed from the petiole onto the strip, which will change colour depending on the level of the nutrient being measured. (These strips may require refrigeration before use, and so may not be suitable for use in remote fields.)
2. *Using filter paper and colour reagents:* Sap tests for particular nutrients can be performed using colour-developing reagents. Sap extracted from leaves is smeared onto filter paper to which the reagent is applied. The resulting colour is then compared to a standard colour chart to determine the level of the nutrient being measured. Different reagents are used depending on the nutrient being measured.

Nutrient depletion can be a cause of further land degradation since nutrient-poor soil produces less biomass, both above and below ground, which gives poorer protection to the soil from erosion. (Above ground the plant canopy protects the soil surface from the impact of raindrops, whilst below ground the roots bind the soil, and when dead add humus, promoting aggregation.)

5.4 Soil Variables Related to Production: Texture, Colour and Depth

Three of the most frequently observed soil indicators that farmers relate to production constraints are soil texture, colour and rooting depth. These are easily observable, and it is clear in the minds of most land users how they relate to changes in plant growth. The methods of using them as indicators of soil loss have already been covered in Chapter 4. Here, they are related to observations on production, and their use as support measures for assessing the effects of land degradation on production.

As described earlier in Chapter 4, soil texture,

colour and depth are intrinsically a function of the parent material of the soil and rate of weathering. The three variables directly link to production through the biophysical processes of plant growth in supplying nutrients and water and providing a medium conducive to plant growth. By assessing one or more of these variables simply in the field, the field assessor has an excellent check on how and why production has changed consequent on the processes of land degradation.



Figure 5.4: Mexican Farmer showing difference in colour between fertile and infertile soils

Of particular importance in gaining a farmer-perspective is the fact that these three variables of soil – colour, texture and depth – are routinely used by farmers to assess the productive potential of their fields. Where farmers bring up lighter coloured subsoil with the plough or hoe, they will always recognise that yields will be less because of the thin topsoil and lack of rooting volume. Texture, also, especially the dark clays and organic matter, is a common indicator. Farmers will relate how putting in manure or growing cover crops changes the 'feel' of the soil. They will also note the occurrence of coarse particles and stones as indicating poor productive potential. Soil depth is closely related to soil colour, but thin soils will be noted as particularly limiting for some crops, especially root crops and cereals that are demanding of water, such as maize.

These observations by farmers present useful opportunities to the field assessor. Soil variables enable a check to be made on other indicators of production change such as yield statistics – this is an example of triangulation (see Section 1.3). Local soil types can be colour-calibrated in order to assess loss of K and P from fields. Accumulations of finer material behind barriers can be field assessed for their organic matter content, which is then related to observations of plant growth.

These *Guidelines* recommend, then, that along with observations on growing crops and nutrient deficiencies, the following soil variables are noted to provide not only an explanation of production constraints induced by land degradation but also corroborative evidence (see Chapter 4 for more detail):

Soil texture: feel between the fingers – to look especially at relation between finer textures and organic matter with spots of better production. Baseline measure should be taken from natural forest or grass pasture.

Soil colour: Munsell soil colour chart – look especially for lighter colour patches within fields, and overall lightness of fields compared with a baseline of natural forest or grass.

Soil depth: using a sharp stick to probe to impenetrable subsoil, or digging a pit – look especially for the coincidence of shallow depths and smaller crops and poor germination.

Box 5.1: Extended Spade Diagnosis

This is an evaluation technique developed in the 1930s to assess the effects of management practices on soil structure. It simply involves removing a spade-size sod, examining the exposed root structures and undertaking field tests for shear strength and aggregate stability. (For more details see Herweg et al, 1999.)

Source: Karl Herweg, CDE, personal correspondence.

5.5 Facing Problems with Production Indicators?

Production constraints imposed by land degradation are many and varied. This chapter has highlighted how their identification can

lead the field assessor to significant insights into the complex relationship between the land user and their maintaining the quality of the land. Interpretation, however, can often be difficult. For example, without further examination and experiment, nutrient deficiencies can be elusive to detect. Impacts on production are also problematic because there are so many other factors that can also affect yields. It would be easy to become mired in the problems of accurate detection and lose sight of the ultimate purpose of these field observations.

First, degradation-induced production constraints are the main way that land users express how land degradation processes affect them. So, searching for these indicators is an immediate way for the field assessor to be targeting the real concerns of local people and entering into a useful dialogue. Secondly, the understanding of production constraints is an ideal way of bringing together the biophysical indicators that assess site-specific processes and impacts that affect the land user. Therefore, throughout this chapter a link has been drawn between evidence of land degradation and production problems. For example, accumulations of sediment give evidence of a production opportunity in useful planting sites for demanding crops while at the same time indicating soil loss from the slopes above and possibly inadequate soil depth to get a yield. In the next chapter (6), ways of combining indicators to get added understanding are explained. Thirdly, the ultimate purpose of all these field observations is to help advance the cause of land rehabilitation and conservation. Chapter 7 commences addressing this objective by ensuring that the field assessor understands all the 'actors' involved, and how some lose through land degradation while others gain. Then in Chapter 8, these *Guidelines* directly target simple means of assessing the benefits of conservation from the farmers' perspective. So, it is not useful simply to say that because detection of production constraints is difficult, then the assessor can go no further. Indicators of production constraints are only one part of the big picture, and it is perfectly possible to move onto 'Combining Indicators' in Chapter 6 without the full picture.