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The Use of the Traditional Loop Method and the Introduced Wheel-point Method to Assess Ground Cover and Bare Soil

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THE ANNUAL and biennial herbaceous forage plants from (El Baja) area (13° 36′ and 14° 10′ N ; 31° 45′ and 32° 23′ E), White Nile State, were assessed between 15th and 30th October 2002. The most effective rainfall period occurred between June and July 2002.

The principal objective of the study was to investigate the reliability of vegetation assessment techniques that help attaining suitable management indicators.

Ground cover, consisting of living vegetation and litter, was found to be high (93%), as assessed by the Loop method. This value was low (38%), as assessed by the Wheel-point method. The most dominant forage plants, as assessed by the Loop method were: *Aristida adscensionis, Dactyloctenium aegyptium, Eragrostis tremula* and *Fimberstylis dichotoma.* They were: *Aristida adscensionis, Fimberstylis dichotoma, Eragrostis tremula* and *Indigofera* sp., as determined by the Wheel-point method. Regardless of these variations in results, both methods were found to be useful and they have identified some management indicators. The methods were considered to be ecologically based.

Keywords: Loop method, Wheel-point method, Ground cover, Bare soil.

The annual and biennial herbaceous forage plants and some selected shrubs from (El Baja) area (13° 36′ and 14° 10′ N ; 13° 45′ and 32° 23′ E), White Nile State, were assessed between 15th and 30th October 2002. The most effective rainfall period occurred between June and July 2002.

The principal objective of the study was to investigate the reliability of vegetation assessment techniques that help attaining suitable management indicators.

In the course of this study, two techniques were used to assess ground cover and bare soil. These are the frequently used Loop method or Parker Loop method and an introduced method called the Wheel-point method.

The Loop method

This method as developed by Parker & Harris (1959) is called: The 3-Step method for measuring condition and trend of forest range – USA.

In brief, the methods consist of:

Step 1

Measurement and observation of the essential features of vegetation and soil stability on permanently established transects lines and plots on a section of the range that is suitable for grazing. The previously mentioned essential features include: measurements of site factors by means of ¾-inch diameter ring or loop at 100 points along each transect line. The reading for vegetation in most cases requires only the simple decision of whether or not the loop is occupying by a part of the root crown in grasses and forbs or the perennial crown of shrubs. On the other hand, the readings for litter and bare soils require estimation and decision as to which is dominated within the ring.

Step 2

Summarization in the field of these data and classification of vegetation and soil stability.

Step 3

General and close-up photographs from permanent photo points .

As indicated by Parker & Harris (1959) the method was initially recommended for use primarily on perennial grasslands. The use of the method was extended to include all browse shrubs.

As an administrative tool in USA, the 3-Step method has met with wide acceptance. Therefore since then, the method, or salient features of it, is in use by several agricultural experiment stations and western state game departments in USA.

Interest, and in some instances extensive use, both in research and land administration has been evidenced throughout the world notably in Canada, Argentina, Uruguay, Australia, New Zealand, Iran, Iraq, Syria, Jordan, Egypt and Ghana.

In Sudan, the method was largely used in routine surveying and research (Mohamed, 2001 and Mohamed , 2004).

As indicated by Darag & Suliman (1988), the field methodology of this method is so simple. It consists of randomly located transects, 100 meters long, on the part of the range site considered suitable for grazing. Vegetation measurements are to be determined every one-meter using ¾-inch loop to obtain 100 readings along each transect line. Observations are recorded to what is actually defined within the areas delineated by the ¾-inch loop which are classified into the following:

Observations*	Symbol
- Intercept plant species	(name of species)
- Litter	(L)
- Erosion Basement or Bare Soil	(BS)
- Rock (if found)	(R)

* Observations are recorded in a data sheet

As it has been mentioned before, the Loop method was extensively used in rangeland surveying in Sudan to assess a number of management indicators such as species composition, ground cover index, cover percentage. ...etc. In recent study (Mohamed, 2001) had used the Loop method in two contrasting areas west of Ed-Dieum, a forested area and open grazing one. *Eragrostis* spp. and *Echinoclua colona* dominated the forested area in 1998 and 1999, respectively, whereas in the open grazing area *Dactyloctenium aegyptium* is the most dominant plant in both seasons. The results also showed high density (77.6, 58.6), plant composition, (77.6, 96), forage composition (76.8, 94.8), and cover percentage (67.5, 88.4) in both seasons in the forested grazing area. Mohamed (2004) used the Loop method in "El Baja" to assess the vegetation composition around Donkey El harit water point in three selected zones 4, 8 and 12 km apart. The study was carried out for two seasons, 1999 and 2000. He showed that the forage plant composition declined as we go closer to water point and this is a good indicator for grazing intensity effect on vegetation cover.

Notwithstanding, the fact that this method was used by different research officers, however, the adequacy of the method to fulfill the management options or practice, were not discussed thoroughly.

Wheel-point method

In the early 1920's of the last century, numerous methods for surveying, inventorying, and monitoring vegetation in rangeland were developed to meet the diverse conditions and needs confronting researchers and range ecologists. These methods and their applications were available in different texts (Muller-Dombois & Ellenberg, 1974 and Greig-Smith, 1983).

The botanical composition expressed as percentage cover was considered to be one of the most effective means of studying ecological trends and changes in pastures. The basal cover was defined to be the rooted cover at ground level, was a more sensitive indicator of change than canopy cover, *i.e.* the portions that plants raised above the soil surface. Therefore, the basal cover has been considered and become a useful criterion for the evaluation of rangeland vegetation.

For systematic sampling of vegetation a method called the Wheel-point, apparatus was devised by Tidmarsh & Havenga (1955) in South Africa. In that method one spoke of a rimless wheel was used as a point to sample for basal cover. They showed that the variance of the mean obtained from systematic point sampling tended to that of random point sampling as long as the spacing between

points exceeded the size of the individuals or clusters of vegetation (Greig-Smith, 1983). They also concluded that providing the spacing of points did not conform to repetitive pattern in the vegetation, data gathered in this way could be treated as if obtained from a similar number of random points.

The originally devised Wheel-point apparatus having consisted of two wheels was large and heavy. Since it proved difficult to draw the wheels along a straight and uninterrupted line, it was thought that the estimates taken by the two-wheeled apparatus would be biased and a new, single-wheeled, apparatus was devised by Von Broembsen (1965). The new devised apparatus was light enough to be slewed out of the vertical and could be pushed along straight line in this position when shrubs and trees were encountered. Von Broembsen (1965) found that the method provided adequate and simultaneous estimates of the basal areas of the different features of vegetation in an open and semi-open savannah region of South Africa. Tidmarsh & Havenga (1955) had formulated clear definitions of strike or of a miss. These definitions were refined by Von Broembsen (1965).

The simplicity of the wheel-point, its insensitivity to personal bias and skill of operator, and its adaptability to various purposes in the field, are the reasons that made the method been extensively used throughout the world (Donaldson, 1967; Du Toit, 1968; Morris & Muller, 1970; Walker, 1970; Skinner, 1976; Foran *et al.*, 1978; Mentis, 1981; Lodge & Gleeson, 1979; Lodge & Gleeson, 1982; Payne *et al.*, 1982; Friedel & Shaw, 1987 and Zhou & Robson, 1998).

It is apparent from the review that if the Wheel-point method is to be used in an arid open grazing area, would give a satisfactory assessment of vegetation ground cover when compared with the traditional Loop method.

Materials and Methods

In the present study where the emphasis is to investigate the reliability of the prevailing vegetation assessment techniques, it is important to determine the so-called "minimal area" of the community. The "minimal area" is defined as the smallest area on which the species composition of the community in question is adequately represented (Mueller – Dombois & Ellenberg, 1974). According to this definition a site of an open-grazing rangeland within the study area was selected to the west of Donkey El harit (N 13° 48′ 3″ - 31° 52′ 298″). The area of this site is 1 km x 1 km. In which all vegetation measurements by all methods used in this study were carried out.

Two methods were involved. These are:

1- The Traditional Loop method

Within the selected site, 10 transects randomly selected, each of 100 meter long were located. The measurements were taken along each transect, using 100 meter tape.

Plant species, litter and bare soil were recorded every one-meter using ¾-inch loop to obtain 100 observations. The data required was:

a- Species composition for the three parameters, *i.e.*, plant species, litter and bare soil.
b- Species composition for the four dominant plant species.
c- Species composition for the four minimum, or less-dominant, plant species.
d- Species composition of the preferable and less preferable plants. The term preferable plants were given to those plants that are readily grazed by all kinds of livestock. On the other hand, less preferable plants are those of low grazing intensity and/or unpalatable. These definitions were based on field observations and feed back from local communities.

The species composition for plants, litter and bare soil was obtained by dividing the total hits of each parameter by 100.

2- The Wheel-point apparatus

The Wheel-point apparatus is rimless wheel with 12 spokes of which only one spoke was used to record the strike or hits of plant species, litter and bare soil.

With 100 revolutions of the wheel over a distance of 350 meters, 100 readings were recorded in each transect.

"Strikes" were recorded in the same data sheet used for the Loop method. Two operators were used, one to push the wheel and the other to record the "strikes" of the three parameters:

a- Plant species mainly grasses and herbs.
b- Litter, including woody sticks, dead plants, and dry leaves and livestock dung.
c- Bare soil.

The data was then used to obtain the following:

a- Species composition for the three parameters.
b- Species composition for the four dominant plants.
c- Species compositions for the four minimum plants.
d-Species composition of the preferable and less preferable plants.

Results and Discussion

Vegetation assessment

Ground cover and bare soil

The ground cover in the study area consists of a variety of annual and perennial species. Significant changes in ground cover and bare soil during a

season are to be expected, due to the succession of the annual species. The term ground cover refers to forage plants and litter.

The work to assess ground cover and bare soil during the year 2002 was undertaken largely on the annual and perennial components of the vegetation.

As determined by the Loop method, the results show that the ground cover is 93%, of which 82.3% is forage plants composition and 10.7% is litter composition, whereas bare soil is only 7% (Table 1).

TABLE 1. Ground cover and bare soil by the Loop and the Wheel- point methods.

Tool	Ground cover %		Bare soil
	Plant composition	Litter	
Loop	82.3	10.7	7
Wheel point	20.7	16.9	62.4

On the other hand , when using the Wheel-point method, the results show that the ground cover composition is 37.6%, of which 20.7% is forage plants composition and 16.9% is litter composition, whereas bare soil is 62.4% (Table 1).

These results indicate that there are great differences between data obtained by the two methods. This is obvious; because when the Loop method was used its sampling point is a loop or a ring ¾ -inch in diameter. Therefore, some personal or operators bias may be expected on what parameter or strike or hit to be reported, in data sheets. On the other hand, by using the Wheel-point method, the sampling point is a sharpened spoke and therefore the probability of strike is low. Another reason for difference in data may be attributed to the fact that the "hit" and "miss" of parameters recorded is clearly defined when the Wheel-point method was used. This may reduce the personal bias or discrepancy of data obtained. A third reason of this difference in results may be attributed to the length of sampling areas or transects. The length of the transect when using the Loop method is 100 meters and sampling points are 1 meter apart. However the data obtained by the Wheel-point methods were from a 100 revolutions which equivalent to 350 meters in which the sampling points are 3.5 meters apart. This may or may not increase or decrease the probability of hits.

The species composition of the individual forage plants as determined by the Loop and the Wheel-point methods are presented in Table 2. The species composition as determined by the Loop method is high and range between 0.2% and 39.1% whereas by the Wheel-point method is low and range between 0.1% and 8.6%.

TABLE 2. Plants species composition by the Loop and the Wheel point methods.

Species	Tool	
	Loop	Wheel point
Dactyloctenium aegyptium	16.4	0.8
Cenchrus spp.	3.6	1
Chrozophora brocchiana	0.2	0.1
Euphorbia spp.	0.6	0.2
Cucumis sativa	0.2	0.3
Aristida adscenionis.	39.1	8.6
Eragrostis tremula	12.0	2.6
Fimberstylis dichotoma	5.2	4.7
Indigofera spp.	1.1	2.2
Heliotropium spp.	3.6	Not recorded
Farsetia longisiliqua	0.3	0.1
Aerva javanica	Not recorded	0.1

Forage plants composition

Forage plants contained two categories. These are: the preferable forage plants that are readily preferred or grazed by all kinds of livestock. The second category is the less preferable forage plants and these are plants with less grazing intensity and/or unpalatable forage plants.

The results show that the preferable forage plants are 20.4% as determined by the Loop method compared to 2.2% as determined by the Wheel-point method (Table 3). The values were considered to be low. This is because of the extensive grazing or utilization by livestock and/or trampling.

TABLE 3. Preferable and less preferable plants by the Loop and the Wheel-point methods.

Tool	Parameter		Total
	Preferable	Less preferable	
Loop	20.4	61.9	82.3
Wheel point	2.2	18.5	20.7

On the other hand, the less preferable forage plants constitute about 61.9% and 18.5% as determined by the Loop and Wheel point methods, respectively (Table 3).

Due to these results a recommendation for range improvement through reseeding of the preferable forage plants could be inferred in the study area.

Forage plants dominance

The dominant plant species of a rangeland site or vegetation has been defined as the species which exerts the greatest influence on other species of the community and is least influenced by them (Greig-Smith, 1983).

When using the Loop method, the results indicate that the dominant forage species are: *Aristida adscenionis, Dactyloctenium aegyptium, Eragrostis tremula* and *Fimberstylis dichotoma*, with composition of 39.1, 16.4, 12 and 5.2%, respectively (Table 4). However when determined by the Wheel-point method, the dominant forage plants are *Aristida adscenionis, Fimberstylis dichotoma, Eragrostis tremula* and *indigofera* spp., with composition of 8.6 , 4.7, 2.6 and 2.2% , respectively (Table 4). Three of these aforesaid dominant species were recorded by the two methods but they differ in their species composition. These are *Aristida adscensionis, Eragrostis termula* and *Fimberstylis dichotoma.*

TABLE 4. The dominant plant species by the Loop and the Wheel point method.

Species	Loop	Wheel
	%	
Aristida adscenionis	39.1	8.6
Dactyloctenium aegyptium	16.4	--
Eragrostis tremula	12.0	2.6
Fimberstylis dichotoma	5.2	7.4
Indigofera sp.	--	2.2

The minimum or the less-dominant forage plants as assessed by the Loop method are *Chrozophora brocchiana, Cucumis sativus, Farsetia longisiliqua* and *Euphorbia* spp. with species composition of 0.2, 0.2, 0.5 and 0.6% ,respectively (Table 5). When the Wheel –point method was used the minimum forage plants are *Chrozobhora brocchiana, Farsetia longisiliqua, Aerva javanica* and *Cucumis sativus* with species composition of 0.2, 0.3, 0.4 and 0.9 %, respectively (Table 5).This variation in plant dominancy may be attributed to several factors such as rainfall, level of utilization and effects of over grazing, soil depletion by wind and water erosion, deliberate fires and trampling by all kinds of livestock.

TABLE 5. The minimum plant species by the Loop and the Wheel point method.

Species	Loop	Wheel
	%	
Chrozophora brocchiana	0.2	0.2
Cucumis sativa	0.2	0.9
Farsetia longisiliqua	0.3	0.3
Euphorbia spp.	0.6	--
Aerva javanica	--	0.4

The method cost

In the present study, one single operator is involved in the assessment when using the Loop method, whereas using the Wheel-point method two operators are used, one to push the wheel and to score the strikes by the sampling spoke, and the other to record them in data sheets.

Method cost is defined to be the time as expressed by man-minutes. It has been found that the Loop method takes about 15 – 20 man-minutes to record data in a single transect (150 – 200 man-minutes in 10 transects). As for the Wheel point method and regardless of the distance (350m.) it takes only 9 – 12 man-minutes for a single transect (90 – 120 man-minutes for 10 transects).

Adequacy and significance of methods

The Loop method was originally developed by Parker & Harris (1959). It develops practical, accurate and technically sound and yield concrete measurements on the trend or rate of change in range condition. Nowadays, the method had been used by many Sudanese range ecologists such as Mohamed (2001) and Mohamed (2004). In this study the method was used in straightforward measurements that yield useful information as regards the ground cover and bare soil composition. The method has been able to measure vegetation and soil stability on selected transects in the study area. In its straightforward procedure, it could be recommended that the method allows for inventory, and then if repeated at yearly or multiyearly intervals trends in range condition can be inferred. According to the statements given by Hacker (1973) and Wilson (1982) the method may be considered to be ecologically based one.

The Wheel-point method was originally developed by Tidmarsh & Havenga (1955). It provides preliminary information in rangelands surveys. In its later developments the method has been used to assess range condition and trend. In the present study the method was used for the first time in Sudanese rangeland. It was used in a very simple, but nevertheless precise way, to assess ground cover, consisting of living vegetation, litter and bare soil. The results obtained, although they are descriptive, can be used to indicate range condition class and soil stability as influenced by grazing and/or trampling of all kinds of livestock. In this straightforward application, the method was found to be useful in acquiring the desired data. As stated earlier, the method is not time–consuming (90 – 120 man-minutes). In the present study, the method was operated by two operators, however, with means of data logging to store the data, it should be possible to increase the precision and reduce personal bias in collecting raw data. The method can also be indicated as an ecologically based one.

It has been shown before in the results, the Loop method provides higher ground cover estimates than the Wheel–point method in this grassland community of the study area. This is agreed with findings of Mohamed (2001) and Mohamed (2004). However, it has been found that the method acquired higher results when compared with other methods such as the line–intercept and

variable radius plot methods in shrubland community (Cook & Box, 1961 and Kinsinger *et al.*, 1960).

To give an example of how the Loop and Wheel–point method can indicate range condition Darag & Suliman (1988) range condition classification can be cited. They classified range condition into four classes usually expressed as excellent, good, fair and poor. These classes were often assigned the following ratings:
0 – 25% desirable forage species composition – poor
26 – 50% desirable forage species composition – fair
51 – 75% desirable forage species composition – good
76 – 100% desirable forage species composition – Excellent

Taking that classification as a guideline the range site of the study area can be considered to be in a poor condition. This is obvious since the preferable forage plants composition was 20.4% and 2.2% as determined by Loop and Wheel–point methods, respectively. This finding is true since the study area has been extensively utilized by all kinds of livestock and most of these preferable plants had disappeared due to grazing and / or trampling.

On the other hand, some features of forage plants can be recognized from data collected by both the Loop and Wheel–point methods. These were:

Presence of increaser plants

Increaser plants were considered to be the plant species of the original or pristine vegetation that increase in relative amount under over-use (Darag & Suliman, 1988). These are usually undesirable plants. In the present study they were represented by *Fimberstylis dichotoma* to a greater extent.

Presence of decreaser plants

Decreaser plants are defined to be the plant species of the original or pristine range vegetation that decreases in relative amount with continuous over-use. In this study, these were represented by the preferable forage plants such as *Dactyloctenium aegyptium, Cenchrus* spp, *Indigofera* spp. – when dry -, *Cucumis sativus* and *Chorozophora brocchiana.* In conclusion, data obtained by the Loop and Wheel–point method, although they are different in data content and time covered, but they were considered to be useful and provide reliable information that might help range managers and ecologists in taking proper management decisions, such as reseeding. Both methods were significant in surveying, inventory and monitoring of rangelands.

General conclusions about methods of vegetation measurements

To take any decisions about the optimum strategy for rangeland management depend on satisfactory methods of making inventories of the rangeland resource and of monitoring the consequences of the utilization practices imposed. Numerous techniques and methodologies have been developed for field evaluation of vegetation, litter and soil conditions. These methods are either ecologically based or productivity based. As an example, the Loop and the

Wheel – point methods are ecologically based methods, whereas methods such as quadrate method, Double sampling and the Dry Weight Rank method are productivity based techniques.

Some range ecologists prefer to use ecologically based techniques (*e.g.* in USA), while others combine both methods (*e.g.* in South Africa). In Australian rangelands, ecologically based methods are been used in some areas and productivity based methods in others. Selection of the appropriate methodology depends on a number of rangeland conditions and on the objectives of the investigations, as well as on the time and funds available for the work.

In the present study, different procedures and methods were used combining ecologically based and productivity based methods to assess and monitor an arid rangeland ecosystem.

In the subsequent paragraphs that follow, the usefulness and difficulties associated with each method used in this study will be highlighted.

Methods to assess ground cover and bare soil

The Loop method

The Loop method or the 3-step method or Parker frequency method, was originally developed by Parker (1950) and Parker & Harris (1959) for measuring condition and trends of forest ranges. In the present study, the method was used in a very simple, but nevertheless precise way, to assess changes in ground cover and bare soil.

In this straightforward application, the method was found useful and reasonably sensitive in picking up changes in magnitude of ground cover and bare soil and it is not time-consuming and it allows for an inventory and then if repeated at yearly and multi-yearly intervals, trends in range condition can be inferred as indicated by Risser (1984).

However, when compared with the Wheel point method, the method tends to over-estimate values of forage plant composition and this is because of the ¾ - inch ring diameter. If this was reduced unbiased results could be obtained (Greig-Smith, 1983 and Sankari, 1992).

For grassland, the Loop-frequency method, while more rapid, and gave less accurate results for comparable sampling intensity than either point-quadrates or line intercept method. However, in the present study the Loop method tended to over estimate results when compared with the Wheel-point method.

Regardless of all these drawbacks, the Loop-method is simple, straightforward and it suits Sudanese natural rangelands and it could be used in inventory and monitoring studies.

The Wheel-point method

Originally the Wheel-point method was developed in South Africa by Tidmarsh & Havenga (1955) to obtain preliminary information in rangelands survey. In its later developments the method has been used to assess range condition and trend.

In this study, the method was applied in a very simple, but nevertheless precise way, to estimate changes in ground cover and bare soil.

In its straightforward application, the Wheel-point method was found to be useful in acquiring the desired data and it is not laborious and time-consuming. In this study, the wheel apparatus was operated by two observers (the researcher and one assistant). If those operators were used with some means of data logging to store the data in the field, it should be possible to increase the precision and reduce personal bias in collecting the raw data. On the other hand, using more than one spoke may increase the probability of hits. In a forested rangeland area the method may be useful in assessing the understorey (herbaceous), medium storey (shrubs) and overstorey (trees). More studies for application of the Wheel-point method should be carried out in the different rangeland ecosystems of the Sudan. The method was considered to be an ecologically based.

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استعمال طريقة العروة التقليدية وطريقة العجلة لرصد التغطية الأرضية و الأرض الجرداء

بشير بله زهران
كلية الزراعة والموارد الطبيعية – جامعة بخت الرضا – السودان.

لقد أثبتت الدراسة أن نسبة التغطية الأرضية، ممثلة في النباتات الرعوية الحية وبقايا النباتات كانت عالية (٩٣٪) عند استعمال طريقة العروة ، بينما كانت قليلة (٣٨٪) عند استعمال طريقة العجلة. لقد كانت أكثر النباتات سيادة عند استعمال طريقة العروة نباتات القو، أبو أصابع، البنو و أم فسسيات. بينما تمثلت حين استعمال طريقة العجلة بالقو، أم فسيسيات، البنو والشراية . ولقد كان الاختلاف واضحا في نسبة تردد تلك النباتات وذلك حسب الطريقة المتبعة.

وعلى الرغم من هذه الاختلافات الواضحة في استعمال هاتين الطريقتين إلا أنهما قد أثبتتا فائدتهما في رصد تغيرات الغطاء النباتي مما أدى إلى تحديد بعض المؤشرات لإدارة المرعى مثل حالة المرعى وظهور النباتات المتزايدة والمتناقصة، هذا ولقد خلصت الدراسة إلى اعتبار هاتين الطريقتين من الطرق البينية (طرق نوعية).