The Effectiveness of Community Based Rangelands Rehabilitation Projects in Sahelian Sudan: the case of Giriegikh Scheme in North Kordofan

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ABSTRACT

The objective of this study was to assess rangeland rehabilitation community based projects in Sahelian Sudan with specific focus on Giriegikh scheme in north Kordofan in order to verify the important role of such projects into environmental conservation and rural community development. Fieldwork surveys were conducted during 2005 and 2006 into human population and flora community including protected and non- protected rangelands. Results depict that annual xerophytes contribute by 65.2% into vegetative cover. Protected rangelands rank first into flora biodiversity and similarity. Highest values of relative density, abundance and frequency for perennial grasses are 49%, 46% and 70% flora/m^2 respectively while they were 83%, 69% and 61% flora/m^2 respectively for annual grasses. *Oldenlandia virgata* and *Eragrosis tremula* are the densest annual grasses while *A. mutabtis* are most abundant grasses. Perennials relative frequency accounted highest in individually owned protected rangelands dominantly by *Cenchrus biflorus* and *Aristida pallida* and lowest in open rangelands inside the scheme. Average qualitative density in protected rangelands is 8 plant/m^2 and 11.2% plant/m^2in non-protected rangelands. Trees density measurements ranked *Leptadenia pyrotenica* first in all types of rangelands. From 1997 through to 2006 there is improvement into tree relative density (0.3% to 8% flora/m^2), abundance (5.4% to 12.3% flora/m^2), coverage (14.3% to 28.5% flora/m2) and frequency (0.1% to 9.3% flora/m^2). People shifted from old direct sun drying forage conservation technique to shadow drying technique. In some protected rangelands fodder production is fivefold that in non protected rangelands. The population of Goats declined by 33.1% in 2006; The number of sedentary nomads increased from 11,4% to 20.7%. In addition, 73.8% of the population has stopped tree logging, reduced daily consumption of wood and charcoal by 1.7 kg and 50% of them use mud as building material instead of complete dependence on trees. The authors suggest the promotion of rangelands in Sahelian Sudan.

Keywords: Sahelian Sudan; Giriegikh; biodiversity; development

Abbreviations and acronyms:

"PR" Protected Rangelands; "NPR" Non-Protected Rangelands; "POPR' Publically Owned Protected Rangelands; "IOPR" Individually Owned Protected Rangelands;" ORIS" Open Rangelands Inside the Scheme, "OROS" Open Rangelands Outside the Scheme; "UNSO" United Nations Sahel Organization; "DECARP" Desertification Combat and Rehabilitation Programs; "GPS" global positioning system.

INTRODUCTION

About one third of the Earth's land surface lies in the arid and semi-arid regions which is supporting 600 million people and produces much of the world's grain and a substantial amount of animal produce (Sanders,1986). The Sahel, basically a climatic term, is situated south of the Sahara with 300 to 500 km width (Eduspace, 2011) and 4,000 km east-west extension (Michael, 1999) between the two isohyets of 100 and 600 mm annual rainfall with a fluctuation coefficient value of about 30% (UNESCO and UNEP, 1974). The World Food Organization (FAO,2003) identified Sahelian zone (250 and 500 mm), Sudano-Sahelian zone (500-900 mm) and Sudanian zone (900-1100 mm), while UNESCO and UNEP (1974), divided the Sahel into Saharo-Sahelian (100-200 mm), Sahelian (200-400 mm) and Sudano-Sahelian (400-600 mm).

The ability of the environment to sustain a certain species is defined as that species' "carrying capacity" (ehow.2011). In the Sahelian area, natural rangelands are dominated by annual grasses. During the long dry season, the herbaceous components are in the state of straws with low nutritive value and cannot ensure the maintenance requirement of herbivores (Sanon et al., 2005). Being less dependent on the short rainy season, the ligneous family represents the only source of green forage at this period when leaves, fruits, young branches can constitute 50% to 90% of the diet of cattle and small ruminants respectively (Sanon et al., 2005). Also, in the Sahelian zone straw is used to retain the sand in pits and wells, and its disappearance has required breeders to abandon some rangelands which are no longer usable because of this, and to concentrate themselves on productive rangelands - with predictably disastrous results (Pierre, 2011).

The Sahel region has been spurred on by recurring drought and the threat of long-term land degradation (Nicholson 1978, Rain 1999, Seaquist et al. 2009, Mertz 2010), where the central problem concerns the management of grazing lands under marginal and fluctuating climatic conditions in a particular social, economic and cultural context (UNESCO, UNEP, 1974). The factors considered responsible for rangelands deterioration in the Sahel region include climatic change, overgrazing and population pressure as well as rain fed traditional agricultural practices. Much of the Sahel is now suffering of desertification causing land degradation with a reduced productive capacity (Sanders, 1986). The disappearance of annual grasses has had repercussions at different levels of the ecosystem such as considerable decrease in productivity (Pierre, 2011). The landscape and flora in some parts of the Sudanian zone today show a Sahelian character (Wittig, et al., 2007). Climatic variability has an impact on the Acacia dynamics (Joaquín and Gabriel, 2000).

Drought in the Sahel has had a significant effect on natural selection (Pierre, 2011). Studying vegetation dynamics in the transition zone from the savannah to the Sahel, in order to distinguish between the influence of the recent drought and the influence of overgrazing on the natural rangelands, found that drought affected especially the different flora species at the northern limit of their habitat (Breman, 1977). Similarly, 30-50% of households surveyed across 400-900 mm annual rainfall gradient, indicated to inadequate rainfall to be a cause of rangelands deterioration (Mertz,2010). There is evidence that in the 20th century warming was faster than the shifts in species ranges (Houghton 1990), what may lead to extensive biodiversity losses (IPCC 1996). Changes in the distribution of habitats may affect the range and viability of a number of species (Liddle, 1975).

Changes in landscape character and in the floristic composition are mainly anthropogenically driven (Wittig, et al., 2007). Huge increases in human population have resulted in a substantial degradation of environmental conditions (science.jrank.org.2011). Waugh (1999) attributed 70% of the problem of desertification to many factors among which is uncontrollable population growth. Population growth puts pressure on natural resources in drylands by increased demand for food by expansion into marginal and fragile lands, parcelling of land resources with each subsequent beneficiary owning an increasingly smaller plot, which is then over-cropped (Waugh, 1999).

Demographic and agricultural pressures in the Sahel were largely unable to account for differences between simulated and observed vegetation dynamics for the period 1982–2002 (Seaquist, et al., 2009). The biomass may undergo extensive modification when man or livestock appears, because it depends indirectly on seed stocks and on the hardiness of the fresh growth of annual grasses, the potential productive yield of which is linked to the time and intensity of grazing during the preceding period of growth (Pierre,2011). However, the response of fragmented vegetation to human

impact in degraded and degrading areas in Lake Manyara in Tanzania demonstrated that the vegetation types are strongly related to the degree of human impact and that the corresponding vegetation patches show different degrees of permeability to the species of the surrounding landscape (Enrico et al.,2003).

The efficacy of indigenous pastoral systems including optimal utilization of the existing natural resources, effective risk management way by evading drought conditions, avoids over exploitation of the natural resources by reducing concentration of livestock in one area, has been well documented (Homewood et al. 1991; Benhke et al. 1993). "Pastoralists have interacted with sedentary farmers but both population growth and increasing commodity production have led to the expansion of agriculture on formerly shared grazing lands (Fratkin 1997).The destruction of basic pastoral forage and forage resources by over-exploitation was already serious before the recent drought period in the Sahel. It has led to catastrophic results during years with rainfall significantly below the medium level (Nicholson 1978, Rain 1999, Mertz, 2010). In addition, grazing during the growing season reduces the number of new flower-bearing shoots and the number of seeds produced (Pierre,2011).

The influence of livestock is apparent at trampling and uprooting of young germinations, trampling of spikelet and the liberation of seeds, which counteracts the protection provided by the envelopes, dispersal of certain diasporas and successive occurrence of defoliation (Pierre,2011). Cattle grazing can result in a slowing of root growth, lowered moisture-carrying capacity, and overall loss of flora vigor, making forage more susceptible to disease and replacement by invasive species (ehow.2011).

According to Breman (1977) grazing in the Sahel affected good forage grasses like *Andropogon gayanus*, which were replaced by *Zornia glochidiata* and unpalatable *Elionurus elegans*. In addition, livestock grazing is generally not associated with variations in greenness in the Sahel (Seaquist, et al., 2009). Mean levels of the water holding capacity, organic carbon and available phosphorus are significantly higher in the ungrazed plots than in the grazed plots in Sudano-Sahelian ecological zone of Nigeria reveals that the (Gbadegesin; et al., 1995). Livestock effects in phosphorus availability on annual rangeland production around pastoral watering points in the Sahelian region of West Africa found significant effect on spatial patterns of herbaceous production during the year immediately following the drought (Philip,1998). Sheep and goats possess a certain degree of nutritional wisdom and no amount of feed scarcity could force them to feed on some undesirable forage species in Sahelian rangeland of Far North Province of Cameroon (Ngwa, et al., 2000). The agriculture potential in the Sahel is based on climatic and pedologic factors determining respectively the rain fed crops' cycles and soils productive rate (Sahel resources,2011). Loss of soil organic matter and the ability to allow high intensity rain to infiltrate and be stored for subsequent flora use were the most significant changes, with likely impacts on the productivity of rainfed agriculture (Bell, et al., 2011).

Rainfall depletion has been most severe in arid and semi-arid Sudan where between 1921-50 and 1956-85 annual rainfall has declined by 15 per cent, the length of the wet season has contracted by three weeks, and rainfall zones have migrated southwards by between 50 km and 100 km (Farouk et al. 1982, Hulme 1990, Elagib 2010). Desertification affected area between 12 – 18 N and 30-32E is estimated by 650,000 km^2 (Khogali, 2006).

At the same time, Sudan population increase by an annual growth rate of 1.93% and increased from 9.19 in 1950 to 26.07 in 1990 and then to 41.98 in 2010 and is projected to reach 63.06 in 2030 (Africapedia.2011, Encyclopedia of the Nations.2011). The trees have been cut down for fuel wood and to provide the animals with forage. Fighting over grazing land has been ongoing in Darfur since 1920 (UNEP Sudan, 2011). The main objective of this paper is to assess rangeland rehabilitation projects in Sahelian region of the Sudan by taking Giriegikh scheme in northern Kordofan state as an example which might enable pursuance if proved successful.

METHODS AND MATERIALS

(a) The Study Area

The area is part of the Sahelian region of the Sudan, locating between 13^0 $50^/$, 14^0 $30^/$ N and 28^0 $25^/$, 30^0 $50^/$ E and administratively belong to north Kordofan state (Fig.1). Possessing Sahel's physical environment, it was proposed in early 1970^{th} by Rangelands and Forage Administration, Sudan as one of Desertification Combat and Rehabilitation Programs "DECARP". The project initial design is oriented towards large scale rangeland rehabilitation (60000 ha) and goat restocking (CBRRP, 1997). In view of the expansion of rainfed farming and the free open goat grazing, the range land rehabilitation shifted toward large scale rehabilitation through the establishment o a well defined village council grazing allotments and the gradual shift from goats toward sheep breeding through goat replacement program (CBRRP, 1997). Range rehabilitation and improvement measures including seeding of seed, pellets seed and seeding will be practiced within the village councils grazing allotments. A rest rotation grazing system will be adopted for better utilization of natural grazing resources after rehabilitation and improvements are done. The gradual shift toward sheep breeding development will generate income for the purchase of grains from agricultural production areas of less fragile soils to ease agricultural expansion into rangelands. Long – term objectives of the scheme included reduction of global warming, acid rains, absorption of Gama rays and mitigating environmental pollution. Medium objectives targeted rehabilitation of natural rangelands and improvement of animal production, reclamation of degraded lands, desertification combat and sustainable development. Short–term objectives included diversification of income sources to evade one crop dependency risk, development of community capacity by introduction of improved technology, creation of a debt system to credit poor segments in the community and initiation of emergency plan to face drought situations.

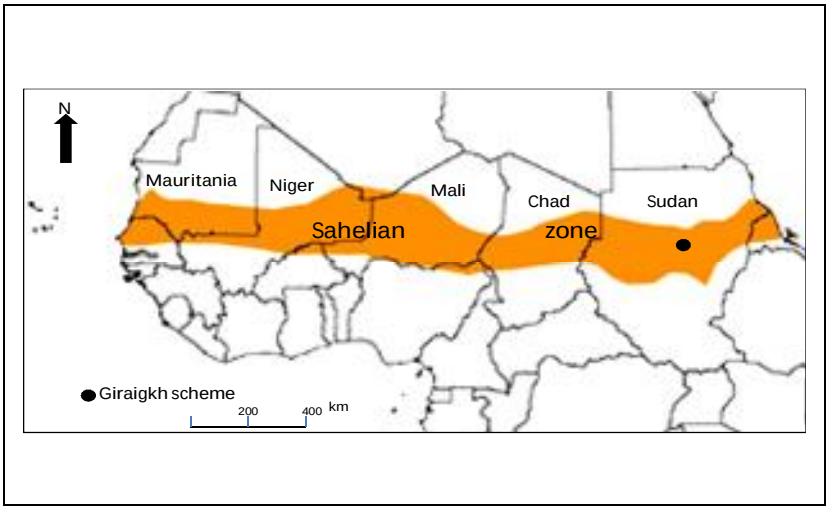

Fig.1: Sahelian region and location of Giriegikh Scheme

Absence of proper land use plans and the transference of the allocated budget to the scheme to refugees sedentary in eastern Sudan and water borne diseases combat programs in Sudan, DECARP had failed to implement Giriegikh scheme (AOAD,2005). In 1990, the United Nations Sahel Organization "UNSO" considered Giriegikh scheme objectives within rangelands rehabilitation projects in the Sahel Region of the Sudan and recommended that it should concern with new inputs for rangeland economies and ecological conditions. According to a signed treaty in 1990 between "UNSO" and NGO's, a field mission visited Nairobi and the Regional Scheme for Pastorals in East Africa. Negotiations led to formulation of Giriegikh scheme plan which was presented in Earth Summit in Rio de Janiro in 1992. Name of the scheme is amended to Community Based Rangeland Rehabilitation for Carbon Sequestration and Biodiversity "CBRRP" which did not specify Giriegikh in particular. A nominated mission in collaboration with Ministry of Finance and Economic Planning, Sudan and Forage and Rangelands Administration recommended five locations for the implementation

of "CBRRP" including Um Zariba in the White Nile State, Hamrt el Wiz, Um Sunta and Giriegikh in north Kordofan and Giraih in north Darfur. They agreed on Giriegikh in 1994 since it is socially and politically stable, has adequate services and rainfalls, underground water and biodiversity that will help into choice and implementation of proper rangelands rehabilitation techniques as well as absence of land ownership problems.

Financed by United Nation Development Program UNDP, Global Environment Fund GEF and Government of Sudan, the scheme started in 1996 with an area of 234,768 hectares targeting 17 villages out of 57 with population size of 6116 person belonging to Guama' and Koahla tribes. Protected Rangelands includes POPR and IOPR. Both are agricultural lands allotted as rangelands by their owners but they differ into that POPR are collectively protected while IOPR are individually protected. Cyclic grazing is applied in both. Every PR is divided into four parts. One part is left rest for two years. The remaining three parts apply rest grazing system by grazing into one part while the other two parts stays for their turn which allows for grasses maturity and seeds germination. There are also NPR which includes open rangelands inside the scheme "ORIS" and open rangelands outside the scheme "OROS".

(b) Data collection

Two surveys are carried out into villages inside and outside the scheme during October 2006. Ten villages, out of seventeen are chosen randomly inside the scheme (Fig. 2). Using ARKIN –H statistical table with mean standard error ± 0.2 and corresponding confidence level by 99%, the sample size is determined as 150 households out of 667 households, representing 22.5% of total population. For villages outside the scheme, 7 villages are chosen randomly. Their location near to the scheme was the main factor into selection. Using ARKIN – H statistical table with mean standard error ± 0.3 and corresponding confidence level by 99%,, the sample size accounted for 80 households out of 1059 households, representing 8% of total population. Direct interviewing among households is executed according to their accessibility.

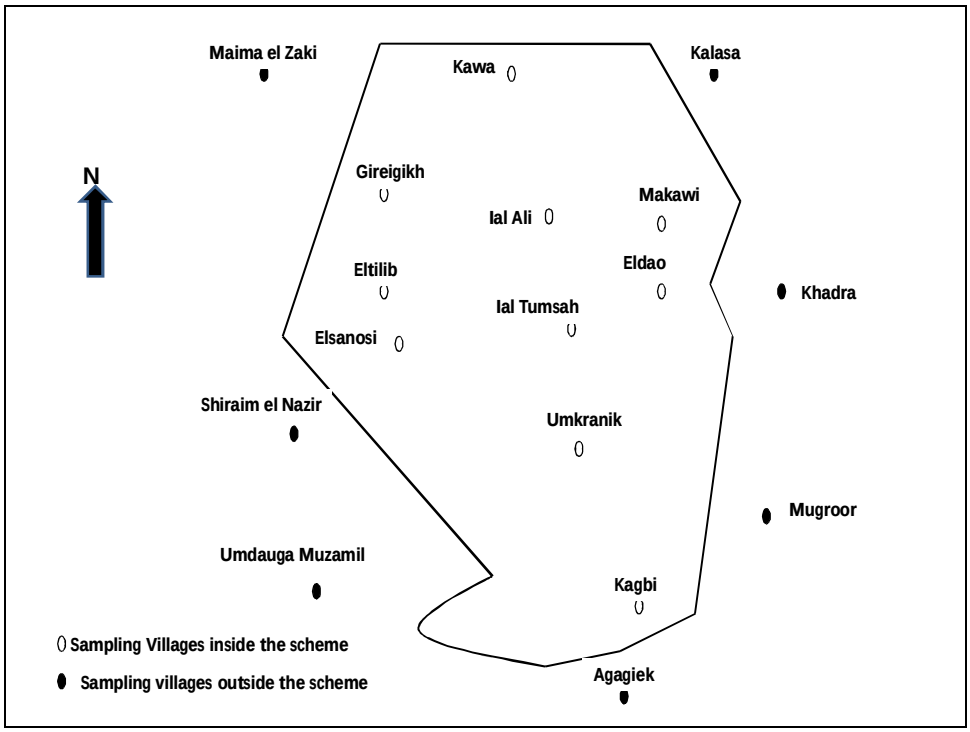

Fig.2: Sketching locations for population survey data in Giriegikh scheme

(c) Field measurement of flora communities

Flora field data, which is collected during 15/7 - 15/10 in 2005 and 2006, is designed to provide information on flora biodiversity, qualitative and relative indexes and to investigate scheme contribution into improvement of vegetative cover; rehabilitation of degrading rangelands through direct protection; efficacy of livestock development programs and Scheme efforts into natural trees reclamation. Choice of rangelands is based on random figures table. In POPR, Ial Ali, Kagabi and Sanosi are chosen. In IOPR, Ial Ali and Sararia el Dao are chosen. In ORIS, Kagabi, Ial Ali, Um Dauoga el Sanosi and Sararia el Dao are chosen while for OROS, Khadra and Um Gezira are chose (Fig.2).

Data collection into protected rangelands is designated by determining the four corners of each PR in addition to a central point equidistance to each corner (Fig.3, A). In each corner and central point, a quadrant of 20 m ×20 m (400m^2) is taken to collect natural trees density. This gives five quadrants in each rangeland chosen and 25 quadrants for all PR. In addition, inside each quadrant an area of 1m × 1m is taken to collect grass data. For ORIS and OROS (Fig.3, B), firstly, a central quadrant is taken at the mid-distance between each two villages. Secondly, four quadrants are taken, two of them lie close to each village on either direction, while the remaining two quadrants are taken north and south the central quadrant equidistance to those close to the two villages (Fig.3, B). This gives five quadrants for each NPR and 30 quadrants as total for the six NPR chosen. Each quadrant area is 20m × 20m (400m^2). Inside each quadrant an area of 1m × 1m is taken to collect grass data. Distance between villages is determined by GPS device. In addition, some relevant flora data is collected from scheme's administration.

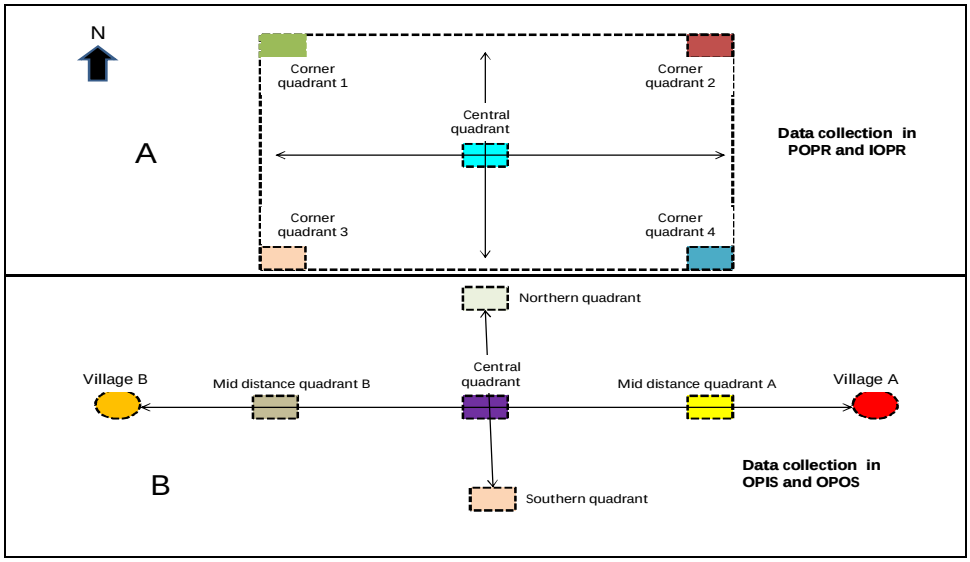

Fig.3: sketching methodology for flora data collection in, A: POPR and IOPR and B : OPIS and OPOS

(d) Data analysis techniques

For population survey data, percentages and means are used. Annual consumption of wood and charcoal is estimated by multiplying number of households by number of days of the year by household daily wood and charcoal consumption. Calculations of relative and qualitative indexes for vegetation used equations shown below.

$$\text{Re Relative Density} = \frac{\text{Density of one type of species(A)}}{\text{Total density of all types of species}} \times 100$$

$$\text{Re Relative Frequency} = \frac{\text{Frequency of one type of species(A)}}{\text{Total frequency of all types of species}} \times 100$$

Re Relative Abundance = $\frac{\text{Abundance of one type of species(A)}}{\text{Total abundance of all types of species}} \times 100$

Re Relative Coverage: $\frac{\text{Coverage of one type of species(A)}}{\text{Total coverage of all types of species}} \times 100$

Qualitative Density = $\frac{\text{number of species of one type (A)}}{\text{Total number of quadrants studied}}$

Qualitative Frequency = $\frac{\text{no. of quadrants where type (A) is found x 100}}{\text{Total number of quadrants studied}}$

Qualitative Abundance = $\frac{\text{number of species of one type (A)}}{\text{No. of quadrants contain that type (A)}}$

Qualitative Coverage: $\frac{\text{number of one type of species x 100}}{\text{Total species}}$

The analysis of variance at 0.1 significance level is run for vegetation abundance, frequency, density and coverage for comparison between PR and NPR. Man-Whitney test is run at 0.5 significance level to see differences between two means of biodiversity indexes in PR and NPP. Shannon – Wiener index is used to measure differences and to compare relative abundance of species inside PR and NPR. The formula is : $H = \sum (Pi) \text{ Log } Pi$, where $Pi = Ni/N$, Pi= abundance of species, Ni = coverage one type of species by number, N = coverage of all members of one species type (total of members in a sample), I= type of species. Simpson index is used to measure relative abundance of concentration of species inside PR and NPR. The formula is : $D=1- \sum (Pi)^2$, where Pi= Ni/N. Jackard coefficient is used to measure similarity between flora groups inside PR and to compare with OPOS. The formula is : $Gj = j/(a + b – j) \times 100$, where J = joint number of species of two communities, a = number of species of the first community, b = number of species of the second community. When % of similarity is high, similarity into flora community will be also high and wide spread by rangeland types. Forage and Rangelands Administration, Sudan has used percent of coverage to classify rangelands into poor ($0 - \leq 25$), medium ($25 - \leq 50$), good ($50 - \leq 70$) and excellent ($75 - \leq 100$) (FPA, 2005). This classification is referred to in this study.

RESULTS AND DISCUSSIONS

(a) Rangelands' flora biodiversity

Most of the occurring flora species are annual xerophytes which contribute by 65.2% into vegetative cover, while perennials contribute by 34.8%.. Biodiversity of flora species in rangelands is identified by 23 type (table 1), with an average of 16 type. IOPR ranks first in biodiversity by 19 type of flora species, followed respectively by POPR (17 type), ORIS (16 type) and lastly OROS (12 type). Biodiversity percent difference between IOPR and POPR is as small as 10%, while it accounts for 36.8% between IOPR and OROS (table 1). Testing the mean difference of flora biodiversity between "PR" and "NPR" by using Man-Whitney statistical test at 0.5 significance level, gives 0.79 calculated value which is higher than 0.69 critical value to deny for any significant statistical difference between them. Jaccard – coefficient for similarity of flora species between types of rangelands accounted 71% between IOPR and POPR, 80% between IOPR and ORIS and accounted 50% between IOPR and OROS. This indicates to high similarity of flora species between the two types of PR and also between them and ORIS.

Table 1. Biodiversity, Relative Density, Abundance, Frequency, coverage for herbaceous plants spp. by rangeland types

	Local name	Latin name	Density				Abundance				Frequency				Coverage				Life form
			1 POPR	2 IOPR	3 ORIS	4 ORIS	1 POPR	2 IOPR	3 ORIS	4 ORIS	1 POPR	2 IOPR	3 ORIS	4 ORIS	1 POPR	2 IOPR	3 ORIS	4 ORIS	
1	Umfisaisat	*Ipomea cordofana*	29.2	8.3	23.3	38.0	26.1	10.7	17.8	38.9	15.1	11.8	15.5	17.7	31.9	8.8	28.2	69.7	Annual
2	Umagiga	*Blepharis edulis*	.28	.3	-	-	.03	1.1	-	-	1.4	1.5	-	-	.32	.32	-	-	perennial
3	Ummalbaina	*Euphorbia aegyptiaca*	.77	2.2	.21	.84	2.5	1.7	1.1	2.4	2.5	3.	.91	6.4	.53	.52	.24	.93	Annual forb
4	Umsamima	*Aristida pallida*	15.5	1.9	16.1	27.6	14.3	2.5	11.7	14.3	8.7	6.6	7.	13.3	14.4	1.9	19.5	13.1	perennial grass
5	Umgilaila	*Cymbopogon proximus*	-	.12	.21	2.4	.82	.59	.6	4.6	3.1	1.1	1.5	8.8	.74	.13	24.2	2.6	Annual
6	Bano	*Eragrosis tremula*	20.7	26.5	20.3	7.2	17.1	16.8	18.2	6.5	14.7	17.	18.6	10.0	.24	28.0	24.6	7.8	Annual grass
7	Hiraisha	*Indigofera sPR.*	.97	1.7	.84	.51	2.3	3.4	.97	-	4.6	3.3	4.6	3.2	.43	1.7	1.1	-	Annual forb
8	Huntoot	*Ipomea cardoiospelala*	6.4	1.9	-	.62	8.4	9.5	-	1.6	10.6	1.1	-	3.6	.70	2.0	-	.69	perennial
9	Huskaniet	*Cenchrus biflorus*	3.5	6.0	15.3	17.7	3.4	5.4	11.1	17.1	7.9	11.8	20.7	18.9	4.04	6.3	18.5	19.3	Annual grass
10	Hanzal	*Citrullus colocynthis*	-	.1	.21	-	.-	.69	-	-	-	.01	.91	-	-	.10	.15	-	Annual forb
11	Khalshaoa	*Oldenlandia virgata*	8.9	29.5	.56	.39	7.9	18.8	.31	1.3	6.6	12.5	3.7	2.8	11.4	31.3	1.1	.43	Annual forb
12	Dfra	*Echinochllia coioruion*	.73	2.6	-	-	1.4	5.3	-	-	2.3	2.6	-	-	.85	2.7	-	-	perennial
13	Raba'a	*Zalekha pentandra*	3.2	6.2	1.1	1.9	4.0	5.7	2.1	4.4	8.9	8.9	4.9	7.2	3.6	6.5	1.3	2.02	Annual forb
14	simsimelgimal	*Sesamum alatum*	.11	4.7	.1	-	0.63	1.6	.46	-	.62	1.5	1.2	-	.11	.47	.13	-	Annual forb
1	Shilini	*Zornia*	-	7.	3.	-	-	6.	6.	-	-	5.	2.	-	-	3.	3.	-	Annu

5		*diphylla*		1	3			8	0			5	7			7	9		al
16	Dhaian	*Farseetia ramosissima*	.73	.18	-	-	.63	.93	-	-	.4	1.1	-	-	.21	.20	-	-	Annual forb
17	Gau	*A. mutabtis*	7.2	4.2	17.3	-	9.3	6.7	22.5	-	8.9	5.9	10.1	-	.74	4.4	21.0	-	perennial grass
18	Miraikh	*Polygala eriopteria*	-	.45	.01	-	-	.93	1.8	-	-	1.6	2.8	-	-	.48	.62	-	Annual forb
19	Kura Gurab	*Cyperus compacutus*	.73	.3	-	-	.63	.69	-	-	.4	2.2	-	-	.11	.31	-	-	Annual
20	Adanelfar	*Requinena abcordata*	-	-	-	1.9	-	-	-	5.6	-	-	-	3.6	-	-	-	2.02	perennial
21	Sharia	*Tephrosia apollinea*	-	-	4.8	.84	-	-	.51	1.8	-	-	-2	2.2	-	-	.07	.93	Annual
23	Halama		-	-	.09	-	-	-	.76	-	-	-	3.9	-	-	-	.16	-	Annual

Note: 1= POPR; 2= IOPR ; 3= ORIS; 4= OROS

(b) Assessment of rangelands' floras composition (Relative density, abundance coverage and frequency indexes)

Relative density of perennials accounted highest by 49% flora/m^2 in ORIS and lowest by 17% flora/m^2 in IOPR. Perennial species of *A. mutabtis* and *Aristida pallida* contributes by 17.3% and 16.1% respectively in ORIS. Relative density for annuals accounted highest by 83% flora/m^2 in IOPR, mostly by *Oldenlandia virgata* by 29.5% flora/m^2 and *Eragrosis tremula* by 26.5% (table 1). Highest relative abundance of perennials is accounted by 46% flora/m^2 in ORIS, mostly *A. mutabtis* (22%) and *Aristida pallida* (11.7%). This index accounted lowest in IOPR by 31% flora /m^2 abundance. Annual grass species accounted the highest abundance by 69% flora/m^2 in IOPR, dominantly *Oldenlandia virgata* (18.8% flora /m^2) and *Eragrosis tremula* (16% flora /m2) while accounted lowest abundance in POPR by 38% flora /m^2. Shannon – Wiener index depicts variations into relative abundance of rangelands' flora by giving values of 0.866 for IOPR, 0.855 for POPR, 0.710 for OROS and 0.679 for ORIS. This indicates to homogeneity, relatively ordered distribution and abundance of rangelands' flora species into PR (table 1).

In addition, Simpson- index accounted 0.842 for IOPR, 0.831 for POPR, 0.823 for ORIS and 0.724 for OROS for relative abundance of concentration of flora species by type of rangelands. This indicate to that, IOPR , POPR and ORIS are identical into abundance index. Perennials relative frequency accounted highest by 70% flora/ m^2 in IOPR dominantly by *Cenchrus biflorus* (11.8% flora /m^2) and *Aristida pallida* (6.6% flora/m^2). They accounted lowest by 39% flora/m^2 in ORIS. This give percent difference by 31% between IOPR and ORIS. On the other side, annual grasses recorded highest by 61% flora/m^2 in ORIS dominantly by *Ipomea cordofana* (15.5% flora/m^2) and *Eragrosis tremula* (11.6%) flora/m^2 and lowest by 31% flora/m^2 in IOPR, giving percent difference by 50% between them (table 1). However, perennials highest relative coverage is recorded by 31.9% flora/m^2 in ORIS dominantly by *Aristida pallida* (19.5%) and *Cenchrus biflorus* (18.5% flora/m^2), and lowest by 13.2% flora/m^2 in OROS. Annuals recorded highest by 86% flora/m^2 in IOPR dominantly

Oldenlandia virgata (31.3%) and *Eragrosis tremula* (28%), while accounted lowest by 69.1% in OROS.

Annuals including *Ipomea cordofana* and *Oldenlandia virgata* recorded highest values in density and coverage in all rangelands while perennials recorded lowest in all indexes concerned. The analysis of variance for comparison between types of rangelands into indexes concerned, gave F-ratios of 2,68 for density; 4,53 for abundance and 1,37 for coverage. These values are less than the critical value of 6,17 corresponding with each index which reject any significant statistical differences. On the contrary, 14,82 F-ratio for frequency is higher than 6.17 critical value, to agree with significant statistical difference.

(c) Qualitative density, abundance coverage and frequency indexes

The average qualitative density in PR is 8 plant/m^2. In POPR this index ranged between 36% plant/m^2 *Ipomea cordofana* and 13% plant/m^2 *Sesamum alatum*, while in IOPR, ranged between 49% plant/m^2 *Oldenlandia virgata* and 0.2% plant/m^2 umgalila and *Citrullus colocynthis*. In NPR qualitative average density is 11.2% plant/m^2. In ORIS it accounted 30.4% plant/m^2 IPOMEA CORDOFANA and 0.12% plant/m^2 *Tephrosia apollinea*. In OROS it ranged between 67% plant/m^2 *Ipomea cordofana* and 0.7% plant/m^2 *Oldenlandia virgata* (table 2). Qualitative abundance mean value in PR is 12.3% plant/m^2. In IOPR it accounted 54.6% plant/m^2 *Oldenlandia virgata* and 1.7% plant/m^2 umgalila. In POPR it accounted 41.% plant/m^2 *Ipomea cordofana* and .04% plant/m^2 Blepharis edulis. In NPR average qualitative density is 13.9% plant/m^2. In ORIS it accounted 44.3% plant/m^2 *A. mutabtis* and 0.1 plant/m^2 *Tephrosia apollinea*.

In OROS it ranged between 75.4% plant/m^2 *Ipomea cordofana* and 2.5% plant/m^2 *Oldenlandia virgata*. Simpson- index accounted 0.866 for IOPR, 0.855 for POPR, 0.679 for ORIS and 0.710 for OROS for qualitative abundance of concentration of flora species by types of rangelands. In addition, average qualitative frequency in PR is 28.5% plant/m^2. In IOPR it ranged between 92 % plant/m^2 *Eragrosis tremula* and 0.04 % plant/m^2 *Citrullus colocynthis*. In POPR it ranged between 73% plant/m^2 *Ipomea cordofana* and 3% plant/m^2 *Sesamum alatum*. In NPR, average qualitative frequency is 38% plant/m^2. In ORIS it accounted 90.7% plant/m^2 *Eragrosis tremula* and .3% plant/m^2 *Tephrosia apollinea*. In OROS it accounted 88% plant/m^2 *Ipomea cordofana* and 14% plant/m^2 *Oldenlandia virgata*. Moreover, average qualitative coverage in PR is 5.3% plant/m^2. In IOPR it accounted 31.3% plant/m^2 *Oldenlandia virgata* and 0.1% plant/m^2 *Citrullus colocynthis*. In POPR it accounted 22.6% plant/m^2 *Eragrosis tremula* and .1% plant/m^2 *Tephrosia apollinea*. In NPR, average qualitative coverage is 5.5% plant/m^2. In ORIS it accounted 23.3% plant/m^2 *Ipomea cordofana* and .1% plant/m^2 *Tephrosia apollinea*, hantoot and *Sesamum alatum*. In OROS, it accounted 54% plant/m^2 *Ipomea cordofana* and .5% plant/m^2 *Oldenlandia virgata* (table 2).

Table 2: Qualitative Density, Abundance, Frequency, coverage for herbaceous plants spp by rangeland types, Giriegikh in 2006

	Local name	Latin name	Density				Abundance				Frequency				Coverage				life form
			1 POPR	2 IOPR	3 ORIS	4 OROS	1 POPR	2 IOPR	3 OPIS	4 OROS	1 POPR	2 IOPR	3 ORIS	4 OROS	1 POPR	2 IOPR	3 ORIS	4 OROS	
1	Umisaist	Ipomea cordofana	36	13.8	30.4	67.0	41.4	31.1	35.0	75.4	73.0	64.0	68.0	88.0	30.0	8.8	2.3	54.0	Annual
2	Umagiga	*Blepharis edulis*	.35	.5	-	-	.04	3.2	-	-	7.0	8.0	-	-	.30	.32	-	-	perennial
3	Ummalbai	*Euphorbia*	.95	3.7	.27	1.5	4.0	4.9	2.2	4.6	12.	16.0	4.0	32.	.5	.52	.20	10.	Annual forb

	na	*aegyptiaca*									0			0				1	
4	Umsamima	*Aristida pallida*	19.5	3.1	21.0	48.7	22.7	7.2	22.9	27.7	42.0	36.0	30.7	66.0	13.2	1.9	16.1	14.2	perennial grass
5	Umgilaila	*Cymbopogon proximus*	.8	.2	.27	4.2	1.3	1.7	1.3	8.9	150	6.0	6.7	44.0	.70	.13	.20	2.8	Annual
6	Bano	*Eragrosis tremula*	25.6	44.0	26.5	12.7	27.1	48.7	35.8	12.7	71.0	92.0	81.3	50.0	22.7	28.0	20.3	8.5	Annual grass
7	Hiraisha	*Indigofera sPR.*	1.2	2.8	1.1	.9	3.7	9.9	1.9	2.9	22.0	18.0	20.0	16.0	.4	1.7	.87	.6	Annual forb
8	Huntoot		7.9	3.2	-	1.1	13.4	27.4	-	3.1	51.0	6.0	-	18.0	6.6	2.0	-	.75	perennial
9	Huskaniet	*Cenchrus biflorus*	4.3	9.9	200	313	5.4	157	218	332	380	64.0	90.7	94.0	3.8	6.3	153	210	Annual grass
10	Hanzal	*Citrullus colocynthis*	-	.15	.20	-	-	2.0	1.3	-	-	.04	-	-	-	.10	-	-	Annual forb
11	Khalshaoa	*Oldenlandia virgata*	110	49.0	1.1	.7	12.5	54.6	6.1	2.5	32.0	68.0	16.0	14.0	10.5	31.3	.86	.47	Annual forb
12	Dfra	*Echinochllia coiorui on*	.9	4.3	-	-	2.2	15.4	-	-	110	14.0	-	-	.8	2.7	-	-	perennial
13	Raba'a	*Zalekha pentandra*	3.9	10.3	1.4	3.4	6.3	16.6	4.03	8.5	43.0	48.0	21.3	36.0	3.4	6.5	1.04	2.2	Annual forb
14	simsim elgimal	*Sesamum alatum*	.13	.75	.15	-	1.0	4.7	.9	-	3.0	8.0	5.3	-	.1	.47	.11	-	Annual forb
15	Shilini	*Zornia diphylla*	-	11.7	4.3	-	-	19.8	-	-	-	30.0	-	-	-	3.7	-	-	Annual
16	Dhaian	*Farseetia ramosissima*	.9	.3	-	-	1.0	2.7	-	-	2.0	6.0	-	-	.2	.20	-	-	Annual forb
17	Gau	*A. mutabtis*	8.9	6.9	227	-	14.8	19.5	44.3	-	43.0	32.0	44.0	-	.7	4.4	.17	-	perennial grass
1	Mirai	*Poly*	-	.7	.7	-	-	2.	3.	-	-	14	1	-	-	.4	-	-	Annua

8	kh	*gala eriopte ra*		5				7	5			.0	2.3			8			l forb
19	Kura Gurab	*Cyperus compa cutus*	.9	.5	-	-	1.0	2.0	-	-	2.0	12.0	-	-	.1	.31	-	-	Annual
20	Adan elfar	*Requin ena abcord ata*	-	-	3.3	3.3	-	-		10.8	-			18.0	-	-		2.2	perennial
21	Sharia	*Tephro sia apollin ea*	-	-	.12	1.5	-	-	1.0	3.4	-		.03	22.0	-	-	.06	1.01	Annual
23	Halama		-	-	1.7		=	-	1.5	-	-		17.3	-		-	.13	-	Annual

Note: 1= POPR; 2= IOPR ; 3= ORIS; 4= OROS

Trees density measurements depicted *Leptadenia pyrotenica* ranking first in all rangelands. pIn IOPR *Leptadenia pyrotenica* density is 28 tree/ha. followed by *A. seyel vor sayal* 4 tree/ha., *Z. spina Christi* 3 tree/ha. While *Panicum turgidum* and *Balanites aegyptiaca* recorded lowest by less than a tree / ha. In POPR *Leptadenia pyrotenica* recorded 24 tree/ha., followed by *A. tortillis vor raddiana 9 trees/ha.* While *Z. Ziziphus spina-christi* and Alag recorded less than a tree/ ha. In ORIS, *Leptadenia pyrotenica* recorded 20 tree/ ha. followed by *A. seyel vor sayal* 6 trees/ha/ and *A. tortillis vor raddiana 4 trees/ha.* while *Ziziphus spina-christi* and *Maerua crassifolia and A. albida* recorded less than a tree/ha. In OROS, *Leptadenia pyrotenica* recorded 21 tree/ha. followed by *A. tortillis vor raddiana 4 trees/ha.* and *Ziziphus spina-christi* 3 trees/ha. while *A. seyel vor sayal* and *A. albida* recorded less than a tree/ ha.

(d) Assessment of changes into Rangelands' floras relative and qualitative indexes

The scheme contributing into the improvement of vegetative cover compares the vegetation situation before and after the introduction of the scheme in the study area into relative density, abundance, frequency and coverage (Fig.4). From 1997 through to 2006, relative density increased from 0.3% flora/m^2 to 8% flora/m^2, relative abundance raised from 5.4% to 12.3% and also relative coverage raised from 14.3% to 28.5% while average frequency dramatically increased from 0.1% to 9.3% (Fig.4). Density is almost similar between 1997 up 1999 and sharply increased between 1999 and 2006. The same trends are noticed into frequency and coverage except abundance which shows smooth curve.

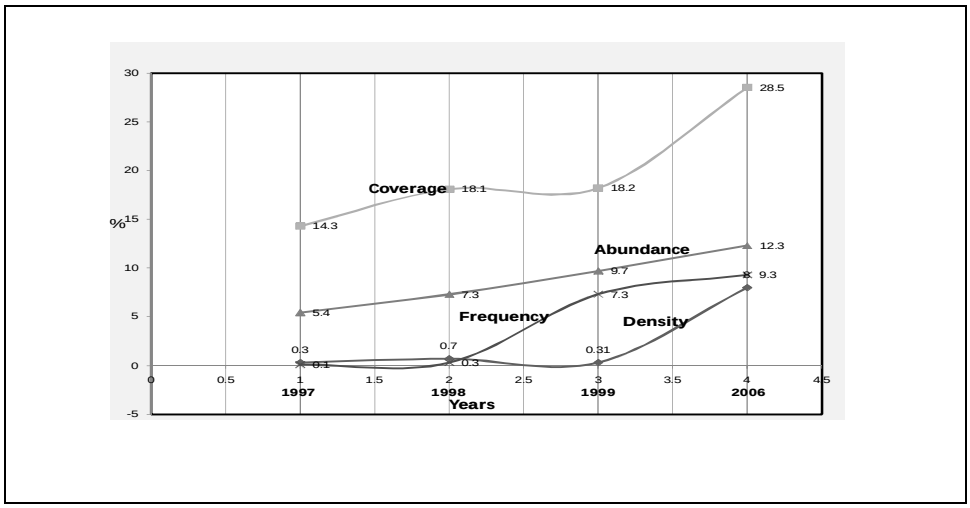

Fig.4 : Measurements for flora relative density, frequency, abundance and coverage in PR : 1997-2006. (source of data (1997-1999):Giriegikh Scheme's Administration)

(e) Assessment of rehabilitation of degrading rangelands through direct protection

People have used to protect their rangelands by themselves (11.3%) or by building fences (33.4%) or benefit from farmers during the rainy season (25%). Effects of rangelands protection into rehabilitation and improvement in PR and NPR compares percents of alive, litter and bare soil during pre rainy season (May months from 1997-2001) and after the rainy season (October months from 2002-2006). Results depicted that (Fig.5), PR graded Good into percent of alive flora in pre rainy season and Excellent during the period following the end of the rainy season based on Forage and Rangelands Administration standard in rangeland classification. This indicates to improvement into percent of live flora following the rainy season. Tackling the same index in NPR, during the month of May show declining trend into alive flora and then increasing by 2000 to continue declining during periods following rainy season up to 2004 while slightly increased by 2005. Percent of alive flora in NPR is fluctuating and far below PR (Fig.5).

Percent of litter in PR for pre and after the rainy season depicted a declining trend line, although slightly fluctuated, raised and finally declined by 2006. Pre rainy season, litter declined sharply in contrast to after the rainy season months which depicted increasing trend between 2002-2003 and then decreased gradually up to 2006. In NPR, litter was detected in 2000 and 2001 as slightly decreasing, stabled and started declining during two years in the period following the end of rainy season. Concerning percent of bare soil in NPR, it was slightly increasing for pre rainy season and slightly declined after the rainy season. In PR, this situation is dissimilar, where for the pre rainy season, percent of bare soil slightly decreased, considerably dropped and continued dropping up to 2004 season, then decreased and slightly increased.

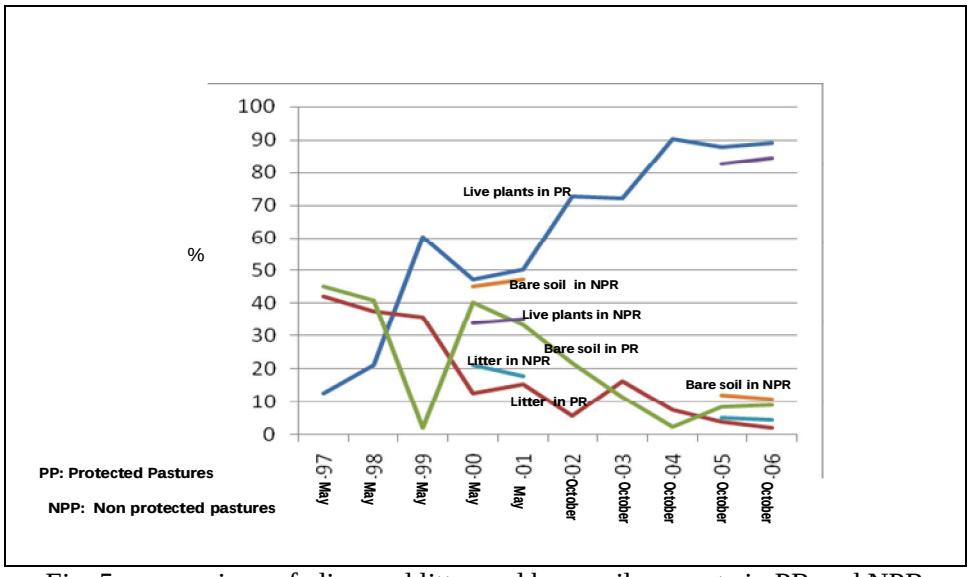

Fig. 5: comparison of alive and litter and bare soil percents in PR and NPR for pre and after rainy season periods, 1997 – 2006

(f) Assessment of the efficacy of livestock development programs

The scheme efforts into livestock development program have started by educating local people and villages' councils into seeding of seeds to compensate disappeared palatable rangelands flora species. *Medicago sativa, Sorghum vulgare, Vigna ungiculata and Zea maize* have been introduced as irrigated green fodder crops, depending on underground water over an area of 43 feddans. This is firstly works to provide new feeding source for sheep during critical dry months. This strategy also targeted benefit from crops hard residues and dry fodder which are difficult for animals to feed on, through raising nutritive value by mechanical and chemical processing. This will provide more food for animals, reduce animal pressures on rangelands, strategic reserve for critical time and to secure whole year fodder availability. *Moulas* blocks are produced which chemically composed by 82.4% Mloas, 2.5% Nitrate, 7.1% salt and 8% water and distributed through among concerned herders and grazers. Later on, people possessed grinding machines where production reached 12400 Mukab in 2000 instead of 1600 Mukab in 1998. In addition, Silage making and Hay– making techniques for green fodder conservation improved nutritive value of agricultural residues through non aerobic hydration and contributed into alleviating forage deficiency during dry season. People owned processing machines for silage production where they annually producing around 1000 BALAT. Also, people shifted from old direct sun drying forage conservation technique to shadow drying technique. Forage cultivation continued in POPR and IOPR by the introduction of *Coccinia spp.*; *Sorghum vulgare; Pennisetum typhoidium* and *Vigna spp.* as well as gardening of *Coccinia spp*., *Hibiscus sabdariffa; Cymopsis spp. Citrullus vulgasis* and some other fruits that their residues can be used as summer forage. Forage production per unit area in Ial Ali IOPR during 1997-1998 was 258.1% which is fivefold the rate of increase in other rangelands while some other POPR rangelands have low per unit area forage production such as Kagbi (21.8%) and Sanosi (9.76%).

These efforts made people more convincing with protected rangelands in order to secure animal feeding during summer "critical period", income generation through renting PR for cyclic grazing (75.4% of the respondents) and the short distance the animals cut to reach feeding sources. In addition, provision of veterinary services in PR has contributed into declining incidence of animal diseases from 18.6% to 10%. Although of these good results, Irrigated fodder production project did not succeed to provide adequate animal forage, due to spread of forage infectious diseases, weakness of community participation into public work (75%) due to inclusion of many villages into one farm, weakness of forage purchasing power due to dependency on irrigated forage (75%), while 37% referred that to weakness of the scheme administration. However, few people (6%) referred that to the factor of disagreement among local people of the study area.

Livestock program targeted the shift towards sheep increasing sheep versus goat declining. In the first animal census in the scheme in 1996 there were 6602 heads of goat which were excess to sheep and cows. Goat number increased to 9216 head (23.1%) in 1999, then declined to 6161 head (–33.1%.) by 2006. This due to more perception among people (87.4%) by goat threatens vegetation cover. This fact became clearly known to 51.5% of the respondents through the scheme's experience, while 8.3% knew that through their own experience. It is found that the most suitable places for sheep keeping are valleys (Khors) due to ground water availability and absence of diseases. The scheme administration encouraged people to replace goat by sheep through sales of goats outside the area, slaughtering them due one head of sheep, buying sheep by the money earned from goat sale and marketing of goat outside the study area. Through time, this program succeeded into replacing 3645 heads of goat by sheep which represents 38.7% of the total goat number in the targeted areas. This is more enhanced by desire of herders and grazers to replace goat by sheep (86%). In addition, the scheme efforts into nomads sedentary worked towards changing herders' attitudes to adopt programs on direct provision of animal feeding and drinking water. Number sedentary nomads increased from 11,4% to 20.7% while some others tribes such as Kawahla tribe have completely settled. The scheme also made sedentary nomads participating as representatives into grazers councils and into relevant operations with respect to their views into solving problems and training.

3.6. Assessment of efforts into natural trees covers reclamation

Tree cover reclamation targeted educating people and villages' councils into seeding of seeds to compensate for disappeared tree species, plantation and conservation of existing tree cover, supplying by young trees and establishing experimental nurses to produce 10,000 offshoot per year. 91.3% of the population surveyed used plant young trees as they perceived their perception importance into combating desertificationm while 58.7% of them have continued planting young trees even though the program ended. Tree plantation inside rangelands is confirmed by 40.7% of the population surveyed where *Leptadenia pyrotenica* mostly used as sand barriers. Considerable numbers of *Z. spina Christi*, *A. tortillis vor raddiana*, *A. seyel vor sayal* have been used into rangelands fences. also *A. seyel vor sayal* has been introduced in the fourth round rotation because it is the most affected tree species by drought and desertification.

The scheme administration provided young *A. seyel vor sayal* by the assistance of forestry administration in Bara town. However, 26.2% of the population surveyed have contact with forestry administration to bring more young *A. seyel vor sayal*. This is because they perceived its role into soil fertilizing, nitrogen sequestration, keeping ecological balance as wind barriers to conserve crops, in addition to their economic revenues. 73.8% of the surveyed population have completely stopped *A. seyel vor sayal* logging and similarly *Leptadenia pyrotenica* marakh (53.5%), *A. seyel vor sayal* (20.6%), *Z. spina Christi* (14.6) and *A. tortillis vor raddiana* and *Balanites aegyptiaca* (11.5%). Environmental improvement into vegetative cover have improved wild life. Animal and bird communities of *Gazella docras; Lepus copensis; Sciurus anomal Lus; Vulpes vulpes; Felis selvestris; Chlamy delis-undulate* and creepers including *Vananus griseus, Psammophis , Coluber ventromace* and *Riopa sundivalli* have flourished. Programs into tree cover reclamation also targeted introduction of improved stoves in order to reduce wood and charcoal consumption which is estimated as 4.2 kg /day/household or 187026 kg/year. This requires 6680 *A. Senegal and* 8540 *Acacia tortillis* to be logged annually. However, daily consumption of wood and charcoal had declined by 1.7 kg which gives 51 kg / month per household of *A. Senegal* and *Acacia tortillis* which will annually conserve 1533 *A. Senegal* and 1960 *Acacia tortillis* by 21.9 dry mass weight. The scheme also had succeeded into shifting from complete dependence on trees as source for building material to the introduction of mud by 50%. This will conserves 10 trees from logging per household and elongate maintenance period to five years instead of one year round maintenance and reduce cost of maintenance by 30%. However, 40.3% of the surveyed population have adopted that method.

Giriegikh rangelands flora composition includes annual and perennial xerophytes grasses and Acacia trees of Sahelian Sudan. Biodiversity, flora relative and qualitative density, abundance, frequency and coverage almost rank higher into PR. Higher biodiversity into PR refers to organized protection against overgrazing and over cultivation, fire, provision of better conditions for seed germination, gentle topography/soil elevation and relevant community awareness into conservation of their area's biota. High similarity into flora species between the two types of PR and ORIS refer to

transference and spread of natural vegetation in an environment of identical physical conditions, soil type land use practices. The high values of flora densities in NPR outside the scheme which are heavily grazed due back to the dominance of invading flora species such as *Tribulus terrestris* . The life form spectra of the flora of heavily grazed and of protected areas in the Sudanian zone show great differences. On areas intensively grazed the percentage of therophytes is evidently higher than on protected areas. Just the opposite is true for the phanerophytes. Their percentage is higher on the protected area than on the grazed zones (Wittig, et al., 2007). Trees density measurements ranked *Leptadenia pyrotenica* first in all rangelands as they highly potent to spread and to grow fast and also widely used into sand dune stabilization and into siege of farms. Improvement into tree relative density, abundance, coverage and frequency is evident in all rangelands *where A. seyel vor sayal* are nationally supported to produce Arabic Gum. In addition, people's perception of *A. seyel vor sayal* environmental role as wind barriers, into the agricultural rotation and as live walls for farms enhanced its introduction in the followed rest rotation.

During Summer all rangelands deteriorate into flora density, frequency, abundance and coverage and also expected decrease in feeding activities. This is natural because of rising temperature, drought and that all rangelands become vulnerable to overgrazing regardless of great exerted protection efforts. Protected rangelands graded Excellent during the period following the end of the rainy season recording declining line into litter percent. This is similar to Sahelian area of Burkina Faso where the amount of litter of *Acacia raddiana, Balanites aegyptiaca* and *Ziziphus mauritiana* which is available and accessible to animals showed that their contribution to the potential production of rangelands was important in glacis and sandy soil rangelands with regards to the importance of species in the woody flora composition of these rangelands (Sanon et al., 2005). Moreover, browse species contribute substantially to the availability of feed for livestock where the farmers classified them according to their availability, their nutritive value, and several other usages. The feeding activities of all animal species decreased from rainy to dry season, with the decline in forage availability, while resting and ruminating activities were increasing at the same time (Sanon, 2007). The rising in percent of bare soil during summer in all rangelands might due to susceptibility to over cropping also which is similar to most soils in dry Australia which show a degree of degradation due to cropping, although the extent was dependant on both duration and intensity of cropping and the original soil fertility status (Bell, et al., 2011).

Improvement into rangelands is also a result of introducing Silage and Hay– making techniques for green fodder conservation. They have improved nutritive value of agricultural residues through non aerobic hydration and contributed into alleviating forage deficiency during dry season. They also made people to shift from old technique of direct sun drying to shadow drying technique where some IOPR during 1997-1998 have succeeded into achieving fivefold fodder production compared to some NPR.

Decline of Goat number in Giriegikh is similar to all Sudan, where people are shifting away from goat as they feed heavily on all spectra of flora species. However, the effects of grazing pressure between-tussock sward height 4–5 cm or 6–7 cm and mixed cattle and sheep or monospecies sheep on Nardus tussock cover and structure, vegetation dynamics, animal performance and invertebrate biodiversity, showed the decline of Nardus cover by 22% units on the cattle-plus-sheep treatment grazed at a between-tussock sward height of 4–5 cm (Gordon, 2000). Sheep and goats made a shift in their feeding activities from grazing to browsing when the herbaceous biomass decreased (Sanon, 2007).

The experience of increasing number of sedentary nomads in Giriegikh is a result of national efforts, improvement into rangelands and drought. This is similar to the pastoralist communities in the north and north-eastern districts of the Kenya (Actionaid.2011) and nomadic peoples of the Sahel region in Niger (Woodke, 2007). In the latter nomadic Tuareg have lost their herds of cows and sheep and seen their traditional lands destroyed due to drought. Some groups of them are taking action to improve poor soils, stop the spread of the desert and respond to the effects of climate change, established ‘fixation sites’ since 1990 to enable them to survive the changes. This enable communities to develop a social infrastructure and education, training, health and rangelands management projects, while still keeping hold of many of their traditional pastoral ways. There are now 22 fixation sites and each has a management council elected from the local community (Woodke,2007). These efforts of

education and training are somehow similar to tree reclamation program in Giriegikh which targeted educating people and villages' councils into seeding of seeds to compensate for disappeared tree species, introduction of improved stoves and shifting from complete dependence on trees as source for building material.

Giriegikh in north Kordofen is similar to PSB in Kishi Beiga in Burkina Faso which is launched in 1991 and initially involved only the village of Beiga. It is now operative in nineteen hamlets from three administrative units (villages), and in 1998 was estimated to cover an area of 400km2. Its first tasks were to set up a Village Land Use Management Council, *install* various utilities and start work on participatory diagnosis and various measures against desertification (Matthias, 2000).

CONCLUSIONS AND RECOMMENDATIONS

The general findings of this study are as follows:

a) Protected rangelands depict higher rates of flora biodiversity, density, abundance, frequency and coverage compared to non protected one.
b) Protection efforts of rangelands succeeded into increasing percent of alive flora, decreasing percent of litter and bare soil.
c) There is shift from goat to sheep keeping, reduction into wood and charcoal consumption, replacing tree by mud as building material and increasing rates of nomads sedentary.
d) Environmental awareness among people is evident when they became keen enough to keep and conserve their natural environment through collective works.

Future prospects are promising as they hold satellite data which have recently shown that much of the Sahelian region has experienced significant increases in photosynthetic activity since the early 1980s, thus re-energizing long-standing debates about the role that people play in shaping land surface status, and thus climate at regional scales (Seaquist,et al., 2009). Through a comprehensive resource management policies which take into consideration all of the ecological and socioeconomic sides, Giriegikh's rangelands can further develop to cope with increasing population and animals. Since the project was initially community based, this strategy should continue targeting grass root society, financing poor segments through micro-credit system, introduction of new breeding animal species that adapted to drought and producing much meat and milk to generate income for rural community and continuation of community environmental awareness.

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