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Agro-Pastoralists Coping Strategy to Combat Environmental Changes in A Sub-Sahelian Region: Case Studies of Dar Hamar and Al Bederiya, Northern Kordofan State- Sudan

By

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Abstract :

Coping Strategies have become an important issue in international and domestic discussions on environmental changes. This paper deals with a local community Indigenous knowledge assigned to deal with the repercussions of the environmental degradation, in such an ecologically fragile area of the Sahel Zone. Design coping strategy is contribution of both managerial i.e. official strategies and community ventures. The main theme of the paper is to assess such strategy. The study area is located in Northern Kordofan. It lies about 60 km west of El Obeid. The study area forms the eastern part of Dar Hamer and the western part of Al Bederiya area, is the area to test arguments of the research paper.

The objective of this paper is to weight how the indigenous Sub-Sahelian community successes to cope with current environmental changes in Sub-Sahelian region. Accordingly, the coping strategy is measured through how much it succeeds attaining its objectives of sustaining the production levels under such pressing environmen-

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tal condition. Also, the strategy components, such as intercropping system, diversification of crop and wide spacing represent as most benefit, and high efficient, while cultivation of vast area in different direction represent as most low efficiency.

1-Introduction

A high proportion of the absolute poor in ecologically fragile areas is indigenous peoples, estimated at some 300 million worldwide. They depend on renewable resources to maintain their well-being. This has led to the development of livelihood system, which is well adapted to the harsh conditions in which they lived. Their holistic, traditional knowledge of their natural resources and environment constitutes a rich human heritage. However, their traditional ways of life are now being threatened, disturbing the delicate balance of natural resource use. Nevertheless, viable technology and institutional arrangements for resource conservation in these areas could be built upon indigenous knowledge; and similarly effective disaster prevention policies can benefit from coping strategies developed by the local population.

The negative effects of the 1970s droughts, which led to dramatic losses of human lives and visited hunger and abject poverty on millions of Sahelians was exacerbated by the fact that the coping capacity of the rural populations was stretched to its limit and therefore became inadequate to respond to the 'crisis' (Hulme, 2001). Inevitably, the constantly declining and irregular rainfall during that dry period was going to affect the economies and societies of the Sahel, which were primarily based on agriculture and other forms of natural resource use. But certainly, it did not have to cause damage of that magnitude had farmers enjoyed more diverse livelihood systems, or owned sufficient assets, or if they could resort to supplemental irrigation, adapted crop varieties and adequate soil and water conserva-

tion techniques. For example, climatologically speaking, the 1984 drought was more severe than that of 1973. Yet, it made relatively less damage as the economies and the societies of the Sub- Sahelian countries had, by the mid-1980s, developed more appropriate coping strategies to tackle such extreme situations (Batterbury, 2001).

Here, the researcher regards coping strategy as a response of an individual, group, or society to challenging situations. The coping strategy lies within the framework of the individuals/groups/society's risk aversion or tolerance level, i.e. they are instituted to minimize risk to make a safeguard against such a pressing situation. While some coping strategies may be brought into play by a stress factor, others may be an intensification of an already in-built strategy. Also, coping strategies may be broadly grouped as either managerial strategies or community strategies.

The Study Area:

The study area is located in a marginal area in the Sudano- Sahelian zone. Northern Kordofan. It lies about 60 km west of EL Obeid town, the capital of Northern Kordofan State. Administratively the study area is a part of El Khuwei administrative area, in Abo Zabad locality, and Abo Haraz administrative area, in Shiekan locality. The long poor road, with poor transportation, further aggravates the remoteness although there is new highway road being built. It includes many small villages (Fig. 1).

September the rainfall amount decreases until the end of October, while the November is a trace rainy month and December is a dry one (Barbour, 1961). Hence the average annual rainfall at this area is 358mm, and it occurs from July to September. The main relative humidity is 34% decreasing to 14% during the drier months and increasing to 60% in the wet seasons.

The study area lies between latitudes 13º, 2'-13º, 3' N and longitudes 29º-30º E. It lies in savanna low rainfall; it is a typical Sahelian zone. It forms the eastern part of Dar Hamer and the western part of Al Bederiya area. It lies at an altitude of 520 meters above sea level, and it shows a high degree of uniformity as some plains exist like Elshag clay plain and some streams like Aldodyia Khor plus fulas, wadies and depressions.

Surface water determined by the amount of rainfall, geological formation, and natural configuration of the area, it could be classified into two categories:

a) Local surface runoff which depends on the amount of rainfall within the area.

b) Outside surface runoff, which refers to the flows collected in khors, wadies and depressions come from outside the area. It drains the area allowing water harvesting system (Tothill, 1948).

Generally, there are three main soil groups, sandy, clay, and sandy clay (Juraba or Sisa) characterizing the study area (Edmonds, 1942).

According to El Tom (1975), the annual coefficient of variation is 35.5 that increase to the north east of the study area where value of 246% may be attained near the north boundaries. The monthly coefficient reaches the lowest levels during the wet months.

In the study area, the dry months extend from December up to May. The rainy seasons begin in April and extend to June and July, which regarded as the rainy months. August is recorded as the most rainy month in which the agriculture production depends on its rainfall amount. As well water harvesting practices depend on it.

The average evaporation is 15.5 mm/day and increases to 20 mm/day in the hot summer months (El Tom, 1975).

The study area is low rainfall savannah belt, the north and eastern parts are low rainfall on sand Acacia Senegal Savanna zone, the western part is a low rainfall on sand, on which the main species are Marakh "*Lepatadenisa pyrotechnica*", and Arad "*Albizzia sericocephala*", Lao'at "*Acacia nubica*", Habeil "*Combretum cordofanum*", Hegleig "*Balanites aegyptica*", Arad, Darot "*Terminalia brownie*", Sunot "*Acacia nilotica*", Hashab "*Acacia sensgal*", Humeid "Sclerocarijal birrea", Sahab, "Anogeissus leicarpus" with very few Tabaldi "*Adansonia digitata*". The dominant grass species include Haskanit "*Cenchrus biflours*", Bogil "*Blepharis persicaa*", Shelini: "*Zornia diphella*", Difra "*Echinochloa colonam*" and Snna Makka" *Cassia actifolia* (Harrison and Jackson, 1958).

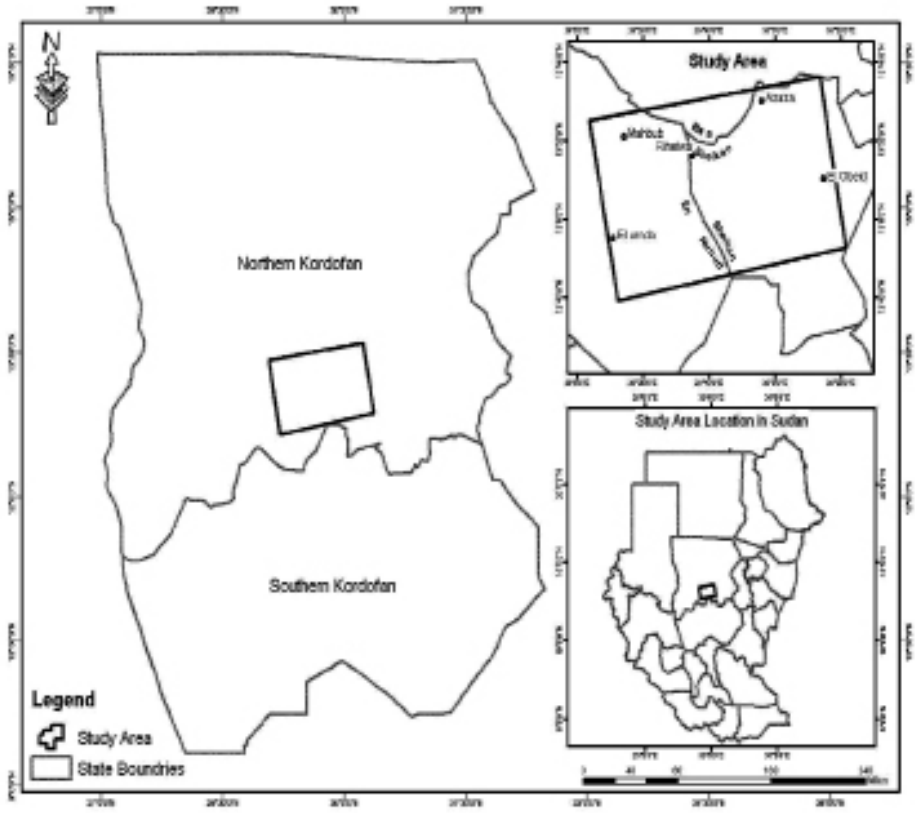

Figure (1): Location of the study area.

2-Material and Methods:

The methodology adopted is a both analytical and synthetical one. It allows to analyze collected data at several levels, as well as putting things in to synthesis to see the effect of factor on the other.

In the field both qualitative interviews with local producers (farmers and agro-pastoralists) were conducted in total, two local communities were selected from several small selected villages. The questionnaire includes many pre coded answer with open-ended questions was conducted to collect data. The statistical Package for social sciences (SPSS) has been used. The questionnaire data were tabulated and converted in to percentage.

3- Results:

In many areas of the world, peasants have often developed farming systems adapted to the local conditions, enabling farmers to generate sustained yields to meet their subsistence needs, despite marginal land endowments, climatic variability, and low use of external inputs (Wilken, 1987; Stigter, 1994; Denevan, 1995; Stigter et al., 2005). Agriculture coping strategies in the study area involve the following:

1- Shifting cultivation

Shifting cultivation was a traditional practice which is dominant method of agriculture in the study area and it has been practiced by all farmers especially those who won a large land, in shifting cultivation land was never over used or repeatedly cultivated season after season and year after year, This method of cultivation has sustained hundreds of distinct cultures in fragile ecosystems; the key to this success is sustainability. In shifting cultivation, the vegetation is cleared by felling of trees, burning weeds, and planting of crops for a short period, most often only for one year as in 1970s and 1980s. After harvesting the cultivated crops, the land is left for natural re-

generation and quickly forms secondary forest regarding land- use conservation; land was left to rest and to cover again with plants and leaves to enable it to accumulate organic manure.

The negative effect of this strategy is that it leads to vast clearing of forest to attain the purpose of this type of agriculture fallow system. But now with increased population the land has to be cultivated more than one a year.

2-Hash strategy

About 96.9% of the respondents use hash to prepare their lands for the new a agricultural season, (hash is a weeding operation used by indigenous farmers to remove the weeds from their lands 92.6% of them use indigenous tools such as "**Toreia**" *whicht is a local tool refer to as "hoe" ,* "**Fas**" "*which is a local tool refers to a hand axe*", and "**Jerayia**" '*which a local tool refers to a traditional tool made of a wooden hand with steel end*" ,and only 4.3% used modern methods "**Tracter**" mainly in a larger areas and for commercial crops such as groundnuts).

88.8% of respondents practice hash twice during the crop growing season one at the time of seeding, normally in first of July, and the second is in September, although in 1970s and 1980s indigenous farmers had only one hash during growing season. That is why 2.6% of the respondents keep on one time during crop growing season. About 5.5% practiced hash three times mainly in case of new virgin land.

The importance of hash is that it removes weeds from land, so it increases the soil fertility through the natural manure and keeps on moisture, nutrients and essential materials for crop growing. The majority of indigenous farmers believe in hash to increase crops productivity. The importance of this operation is increases the crops production by increasing soil fertility, so it makes agronomical benefit to the farmer, but it needs more manpower to clean the land twice.

3-Early land clearing

Land clearing is one of the most old coping strategy in the study area in which the indigenous farmers remove the pest and insects with crops residue after harvesting (almost about three months, mainly in February). It is practiced by 57.1% of the respondents, but about 43% leave the crop residues (stalk and bushes) in the field to increase the soil fertility. Although the farmers benefit from early rains (Butaini 'the first two or three times of rain in May'), but the risk of this operation is that it leaves the bare soil to wind erosion for almost three months. Also change of the time of rains from year to another with keeping on the same time of cleaning lead to reduce the amount of manure and fertilizers usage (Field work 2013).

4-Ramil strategy

Ramail refers to the early sowing of seeds, before the rainy season, mainly in May and June, although the time of sowing changes during the last three decades and now. This strategy is used by 57.1% of the respondents, the benefits of ramail is to use the early rain to attain crop early mature before the end of the rainy season (although time of rain may change).Here the farmers depend on their previous experience to determine the time of ramail in case of failure, they resow seeds, because they have a time before the actual rainy season begins. The main reason behind ramail's failure is the long period of drought which follows the first rain. This is regarded as the main purpose that lead the rest to avoid the ramail mainly the smallholder poor farmers.

5- Polyculture **systm** "Intercropping strategy"

Polyculture is an agricultural strategy using multiple crops in the same space, in imitation of the diversity of natural ecosystems, and avoiding large stands of single crops, or monoculture. In polyculture, a farmer grows multiple types of crops (such as sorghum with sesame) in his field simultaneously to avoid the risk of crop failure and to make the maximum use of the land, especially the small holders. In the study area

the land tenure system depends mainly on Alsheikh's authorities which result in large plots to their relatives, while the smaller plots to the large number of other people, those who obligect to adopt such a strategy.

In the study area the traditional farmers, mainly smallholder use polyculture or intercropping strategy to:-

- adapt to local conditions, sustainably manage harsh environment and meet their subsistence needs without using mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural production.
- reduced the competition among crops that any crop has different demands, so all crops can use available nutrients in the same plot, or in same hole without decreasing soil fertility.
- coping with low soil fertility, because different crops can consume different types of nutrients in the different horizons of the soil.
- combine various production techniques as part of a typical household resource management scheme.
- save time, effort, and money, mainly in the case of family laboure during hash time.
- guarantee greater yield stability and less productivity declines during a drought than in the case of monoculture.

About 62% of respondents adopt polyculture or intercropping system. They plant sorghum with sesame in one field or in the same hole; here the traditional indigenous farmers use sorghum to protect sesame from wind which is regarded as the main cause of sesame failure production. About 60% of the respondents› plant crops among different crops previously planted or planted together at the same time, as in the case of sorghum and watermelon.

The negative effect of intercropping system is that there has been heavy burden of soil nutrients in different horizons in the same period of time.

6 - Shalikh strategy

All the respondents who practice agriculture in the study area apply Shalikh strategy. Shalikh refers to a method of taking out some of grown germinated seeds two weeks after seeding, because the farmers sow larger quantity of seeds in one hole to reduce the possibility of being blown away by wind. This strategy appears mainly due to wind erosion, due to process of early cleaning land, and cultivation in wind direction which lead to more degradation and when ramail strategy found the wind blows the seeds from holes. The farmers are aware of this; therefore they practice Shalikh to pull off some of the germinated seeds to reduce seeds competition.

7- Drought-resistant, tolerant quick maturing crops "Diversification of crops"

To offset crop failure arising from rainfall variability and unpredictability, farmers introduced several hardier (or drought-tolerant) species of the same crop. Also, as common practice farmers cultivate types of crops that can serve as a hedge against drought. The farmers in the study area prefer to use traditional grains, such as millets and sorghums, that are more drought-resistant and which increase productivity even with very little rain such as millet variety (Heriheir), a seasme (Heriheir).

Table (1) Chang in Crop varieties as a coping strategy.

Days required for maturity	Newly introduced crop varieties	Days required for maturity	Traditional crop varieties
65-80	Heriheir (millet)	85-100	Dimbi (millet)
75	Heriheir (seseame)	90-100	Tageel (sesame)
45-60	Elwaika Elkhafifa (Okra)	60-75	Elwaika Eltageela (Okra)

The importance of early maturing crops such as millet, sesame "Heriheir" and lady finger "Okra" has been introduced by farmers, as Table (1) shows how farmers substitute cultivation of Dimbi "late maturing crop" which needs eighty five to one hundred days by Heriheir (millet "millet quick maturing crop"). Also they substitute Seasme "Altageel" by Heriheir (seseame "sesame quick maturing crop). They also substitute the type of Okra Elwaika Eltageela (Okra) by Elwaika Elkhafifa (Okra) which needs only forty five to sixty days to mature. Such tolerant crops have been introduced in the whole study area to enhance food security.

These examples of crops diversification are of great significance to resource-poor to farmers living in marginal environments. Farmers are aware of their environment and specially the fluctuation of rainfall. These make the basis for adaptive natural resource management strategies. The privilege of cropping diversification systems is stability and ecological resiliency under such a climatic extreme variability.

8- Crop wide spacing

The farmers introduce the strategy of wide space between each two rows to reduce crop competition for water and soil nutrients, hence, crops have a chance to grow well. About 89% of the respondent agree that the space between rows have been change from 1970s and period after drought 1984, Table (2) shows the spacing, which is regarded as an indicator of soil deterioration.

The main shortcoming of this strategy is that it needs more land area to increase the interval between two rows with more deforestation. It increases the rate of soil wind erosion due to this new spacing system.

Table (2): Interval between crop's rows.

Interval between rows		Type of crop
≤1980s	≥1970s	
3-5 feet	2-3 feet	Millet
2-3 feet	1-2 feet	Sesame
5-7 feet	3-5 feet	Watermelons

9-Cultivation of vast area in different directions

This strategy appears as the result of rainfall fluctuation, distribution, and according to insufficient amount. Thus, the farmers cultivate their large land area in different directions to avoid rainfall regime and consequent crop failure. This avoided by cultivation in different direction. This strategy applies by only 38.3% of the respondents, i.e. those who have vast plots. While the small holding farmers are not able to practice cultivation of vast area in different direction strategy, due to both, they haven't vast area, and to high cost of labor.

The main disadvantage of this strategy is that it needs more land under cultivation, which means remove of more vegetation cover that gradually results in environmental degradation, and deterioration of soil fertility in such marginal area.

4- Discussion

1 Relation between households' age and coping strategies

Table (3) shows the age is not a factor to adopt the indigenous strategies. Rather, it seems that all respondent practice strategy according to another factor, such their persuasions and pressure of environmental stress.

These coping strategies do not only help the farmers meeting their subsistence needs, but also encourage biodiversity conservation.

Table (3): Cross tabulation relation between respondents' age and coping strategies.

No. of households	Have you adopted any coping strategies?			Age
	No. of response	No	Yes	
				≤15
24		19	5	15-30
173	1	79	93	30-45
151		43	108	45-60
63		10	53	60-75
9		1	8	≥75
420	1	153	266	Total

5-2- Gender and coping strategies

In the study area women have to keep on land, because the land regarded as a source of life, according to Table (4), there is no significant relation between sex and the use of coping strategies, although the number of women in the selected sample is small due to the land tenure in the study area and to social customs.

Table (4): Cross tabulation relationship between gender and coping strategies.

Total %		Have you adopted any coping strategies						Sex
		%	No response	%	No	%	Yes	
92%	390	.3%	1	36.7	143	63%	246	Male
8%	30			33.3	10	66.7%	20	Female
100	420		1	36.4%	153	63.6%	266	Total

Relation between educational level and aims of using coping strategies

According to field work, the education levels have no significant effect on the aims of the adopting strategies as it seems the aim to increase crop production is the most important to all farmers with different educational level. This main the role of activities is to obtain good production and to avoid the failure of agriculture seasons.

Coping strategies efficiency in study area

The difference between practicing the coping strategies in the study area depend on their efficiency to the farmers, according to respondents, Hash, Shalikh, Intercropping system, diversification of crop and wide spacing represent as most benefit to farmers, and high efficient. Cultivation of vast area in different direction represents the lowest efficiency, because it depends on a large plot of land, and this won by only few numbers of households.

Table (5): Efficiency of agricultural coping strategies in the study area.

Type of strategy	Percentage of households	Efficiency to cope with change
Hash	96.9	High
Early Cleaning Land	57.1	Medium
Ramil	57.1	Medium
Intercroping System	62	High
Shalikh	100	High
Diversification of Crop	92	High
Wide Spacing	92	High
Cultivation of Vast area in different Direction	38.3	Low

RECOMMENDATIONS:

- Annual variability of rainfall is a major constraint to agricultural sustainability in the study area. Farmers introduced several indigenous strategies to avoid the risk of crop failure. But climate change exacerbate this problem, the use of climate information, using seasonal climate forecasts to inform farmers, herders and other users will be necessary to avoid surprises.

- Climate change put additional constraints to agricultural production, such as water deficits due to low rainfall or high evapotranspiration. This needs to upgrade agricultural technologies, although traditional producers use high yielding varieties together with drought-tolerance and drought escaping crops/varieties.
- Availing information delivery is critical in the process of enhancing the adaptive capacities of the agro-pastoralists to climate change. Information on weather or new technologies can be transmitted to the farmers using rural radios and other media such as mosques and the rapid spread of mobile telephone is now opening up new opportunities and should be used fully to reach the remote and marginal areas.
- Land management system manifested by land law should consider environmental degradation, so it must not be completely applied by the local authorities "Al Sheikh", who responsible for unequal distribution of agriculture plots.
- Good farm agriculture practices such as use of efficient nitrogen fertilizer and manure to improve farm yields, farm energy efficiency, cover cropping, and development of local markets should be promoted.
- Climate change may increase pests and diseases which regarded as a major threat to crop production and food security in the study area such as desert locust) that, desert locust when appears is considered as a regional ecological problem.

REFERENCES:

- Barbour, K.M., (1961), The Republic of the Sudan: A Regional Geography, London, University of London Press, 292p.
- Batterbury, S.P.J., (2001), Landscapes of diversity: a local political ecology of livelihood diversification in southwestern Niger. Ecumene, 8: 437–464.
- Denevan, W.M., (1995), Prehistoric agricultural methods as models for sustainability. Advanced Plant Pathology, 11: 21-43.
- Edmonds, J.M., (1942), The distribution of the Kordofan sand. Geol. Mag. 129: 18-30.
- El Tom, A.M., (1975), The reliability of rainfall over the Sudan Geogrphafiska Amler, Series A, Vol. 54 , No. 1 , 1972.
- Harrison, M.N. and Jackson, J.K., (1958), Ecological classification of the Vegetation of the Sudan, Forest Bulletin No. 2, Ministry of Agriculture, Khartoum, Sudan.
- Hulme, M., (2001), Climate perspectives on Sahelian dessiccation: 1973–1998. Global Environmental Change, 11: 19–29.
- Stigter, C.J., (1994), Management and manipulation of microclimate', in Griffiths, J. F. (ed.), Handbook of Agricultural Meteorology, Oxford University Press, Chapter 27, pp. 273–284.
- Stigter, C.J., Dawei, Z., Onyewotu, L.O.Z. and Xurong, M., (2005), Using traditional methods and indigenous technologies for coping with climate variability, Climatic Change, 70: 255–271.
- Tothill, J.D., (ed.), (1948), Agriculture in the Sudan. Oxford Univ. Press, London.
- Wilken, G.C., (1987), Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America, University of California Press, Berkley, p. 302.

List of terms

- Butaini: Rain that fall two to three times in May
- Darat: Harvesting season
- Dimbi: Millet late maturing crop
- Dokhan: Millet late maturing crop
- El waika Eltageela: Okra late maturing crop.
- El waika Elkhafifa: Okra quick maturing crop
- Heriheri: Millet quick maturing crop
- Jerayia: Traditional tool, like spade, used for weeding.
- Jubraka: Plot around permanent settlement
- Juraba/sisa soil: Sandy clay soil
- Khor/Wadi: small seasonal water course
- Ramal: Early sowing of seeds
- Shalikh: is a method of pulling and taking out some of the germinated seeds after fifteen days of its growth
- Sheikh and Omda: Traditional tribal leaders at the village level (local admistration)
- **Tageel :** Sesame late maturing crop
- **Toriya :** Digging hoe