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Property Rights, Development Policy and Depletion of Resources: The Case of the Central Rainlands of Sudan, 1940s–1980s

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ABSTRACT

Based on a case study of the Central Rainlands of Sudan, the paper challenges the assumptions and principles underlying the tragedy of the commons model and the property rights paradigm with regard to sustainability of resources owned in common. In the particular experience of the Sudan, and this is generally true of many developing countries, state interference in customary tenurial rights rather than communal property rights has been the ultimate cause of open access conditions of use and consequently of resource depletion.

KEY WORDS

Environmental degradation, customary tenurial rights, common property resources, nationalisation of land and common property resources, development policy

The debate on the relationship between property rights regimes and environmental protection, or the lack of it, is one of the most sustained debates in the social sciences. For example, the view that 'common' property is by its very nature liable to induce exploitative resource use practices which eventually lead to its own demise has become a dominant framework with which governments, social scientists and resource managers portray environmental and resource issues.[1] The 'inevitable depletion' of a property owned in common was believed to be true as early as during the time of Aristotle, who stated, 'what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest'.[2] In 1832, Lloyd compared the impact of grazing of a given number of stock in two pastures, one owned privately and the other held in common: he predicted that the number of stock

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in the common would be increased 'to press much more forcibly against the means of subsistence' while in the enclosed pasture, there would be a limit beyond which any rational person would cease increasing the size of this herd. He envisaged that the inevitable consequence of the increased stock size on the common pasture would be the depletion of the resource owned in common.[3] The debate took a sudden leap forward following the biologist, Hardin's, contribution.[4] In a discussion of the same subject as that of Lloyd, namely, the world population problem, Hardin used the example of common pasture utilised by all members of a community or 'open to all' to show what he called the 'tragedy of the commons', which obtained in the case of grazing too many cattle on a given common grazing site. He argued since the private benefit of grazing an additional head of cattle on a common pasture with the consequent damage to the common property exceeds the private cost because the latter is shared by all the members of the community, the rational herdsman will keep on adding one more animal to his herd and the same decision will be reached by all members of the community, thus over use and abuse are inevitable. 'Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in society that believes in the freedom of the commons. Freedom in a common brings ruin to all'.[5]

Similar assumptions also underlie the property rights paradigm concerning resources owned in common in which it is argued that resources that are subject to common property rights will sooner or later be depleted due to over-consumption and under-investment.[6] Though Hardin's allegorical use of the phrase 'tragedy of the commons' has been one of the most highly publicised and influential contributions in scientific debates, it has also been rejected by many scholars for lack of theoretical rigour and empirical evidence. Repetto and Holmes, for example, argue that the 'tragedy of the commons has almost become a myth' and claim that 'rarely has there been so influential a paradigm with so shaky a factual and conceptual basis'.[7] Circiacy-Wantrup also states that the 'catchy phase' has created confusion and argues that whether common property of natural resources represents a 'tragedy' in terms of environmental depletion depends on 'what social institutions – that is, decision systems on the second level – are guiding resource use' in both common and private property.[8] He further argues that agricultural land held in common by villages in medieval Europe was 'conserved by institutions based on custom and law before private property and the profit motive broke up these decision systems'.[9] There are also many other scholars whose works have heavily criticised the 'tragedy of the commons' model and the common property rights paradigm.[10]

One of the critical assumptions of the 'tragedy of the commons' model and the property rights paradigm is that unless land and the associated natural resources are owned and controlled privately or by the state, their depletion due to over-consumption and under-investment is inevitable. The panacea to the

commons 'dilemma' suggested by the 'tragedy of the commons' model and the property rights paradigm is either privatisation or state intervention. In Hardin's view, the only solution to the tragedy of the commons is either through 'private enterprise' or 'socialism'. The latter refers to state intervention even in non-socialist countries. He further observes, 'if ruin is to be avoided in a crowded world, people must be responsive to a coercive force outside their individual psyches, a "Leviathan", to use Hobbe's term'.[11] Ophuls had earlier argued in exactly the same fashion:

> … because of the tragedy of the commons, environmental problems cannot be solved through co-operation … and the rationale for government with major coercive powers is overwhelming … even if we avoid the tragedy of the commons, it will only be by recourse to the tragic necessity of Leviathan.[12]

The choice in Ophuls' view is between 'Leviathan and oblivion'. The thrust of the argument is that in the absence of privatisation, the 'tragedy of the commons' cannot be counteracted without heavy-handed state intervention. Many post-colonial African governments uncritically embrace this view. Thus, state intervention in the management of land and common property resources (CPRs) is widespread. Most researchers who have addressed this issue in the African context generally point out with regret that state intervention has been a recipe for depletion of land and CPRs.[13] Studies from elsewhere in the developing countries also show the same trend.[14] Governments may not be innately bad managers of resources even though the historical record of state ownership of land and CPRs in the Third World countries has been dismal and leaves no room for optimism.

The problems associated with state intervention are twofold. Firstly, in poor countries, governments view themselves as the sole providers of services and as vehicles of economic development and social progress. In the process, the drive for revenue maximisation tends to lock them into a system that forces them to over-exploit the land and CPRs, disregarding their long-term sustainability. This is done in the name of development. Thus, developmental use of land and CPRs and their preservation, instead of being perceived as complementary to each other and as constituting parts of the same continuum in national resource management regimes, are traded-off with each other by governments as if they represent incompatible dichotomies. In the trade-off decisions, the developmental use of land and CPRs prevails over their preservation.[15] Most governments, desperate to earn foreign exchange, find exploitation of forests and other CPRs an easy option too difficult to resist. In many countries this has led to serious problems of resource depletion. Secondly, government ownership of land and CPRs is exercised by forfeiting the ownership and usership rights of traditional resource users; this often leads to the breakdown of historically evolved resource-regulating institutions based on traditions, customs, kinship relations, moral pressures and restraints. Thus, enforcement and preservation of the newly

acquired state property rights requires continuous policing and monitoring. For governments with poor revenues, these costs become prohibitive and no effective control is exercised.[16] As Ghai perceptively observes:

> [W]hile the state took over formal responsibility for the management of commons and other resources previously governed by customary rules, it was rarely able to exercise effective control. This created the worst possible situation from the point of view of resource conservation: the traditional system of resource management was effectively undermined but nothing was put in its place. The result was uncontrolled and shortsighted exploitation of common property resources that further accelerated environmental degradation.[17]

The consequence is that land and CPRs, which were previously governed by historically evolved culturally prescribed and socially sanctioned institutional arrangements, became de facto open-access resources. In many countries, government intervention has set in motion a process of encroachment on the sources of livelihood of the rural poor: illegal seizure of land and CPRs by powerful members of local communities, commercial farmers and charcoal producers who come from distant areas to expropriate from the poor the source of their livelihoods. The reasons for this are varied but may include weak institutionalisation, poor administrative capabilities, corruption of politicians and civil servants and their collusion with the well off in the private sectors. This is exacerbated by poor incentives for public servants whose salaries may represent a small fraction of wages in comparable private sector employment, etc. Under such circumstances, resource allocation through administrative channels tends to lead to politicians and civil servants taking bribes from clients in return for granting access to land and other natural resources. Thus, government ownership of land and CPRs is often one of the indirect factors that cause environmental degradation.[18] Since independence many of the states in Africa have assumed control over land and natural resources regardless of their own administrative incompetence, their lack of financial and manpower resources, the long-established traditional property rights and resource management systems. The underlying theory of this policy and practice suggests that placing responsibility for control and allocation of natural resources, including land, in the hands of central governments results in optimal allocation and use of resources. As we shall see in the case of Sudan, for example, the reality in many of the post-colonial states in Africa seldom shows such to be the case.[19]

In Sudan, until the end of the 1960s, except in the riverain areas where land was privately owned, all land and the associated renewable resources were controlled by communities who were associated by common descent or common residence. Within each tribal homeland (*dar*), resources were controlled by the dar rights holders and there were intricate informal rules and agreements defining rights of access to, and use of, resources such as arable land, grazing lands, water, livestock routes, trees, forests, etc. These informal institutions were based on traditional value systems, norms and taboos. Non-compliance by

members with such rules was severely dealt with. In view of the individual members' heavy dependence on their communities for resource allocation, social support and protection, there was no incentive for non-compliance or free riding.[20]

The exclusionary nature of dar rights was recognised by the Condominium government and such rights were consequently enforceable at law.[21] The tribal leaders within their own dars were responsible for the allocation of resources, resolving of disputes, defining of migration routes and setting of dates for their respective tribes' seasonal migrations.[22] One crucial instrument which enhanced sustainable land use practices among the nomadic tribes besides the recognition of dar rights was thus the recognition by the colonial administration of the authority of the tribal sheikhs and chiefs over their territories and their subjects, as well as of the tribal body of laws and customs which regulated economic and social activities within the respective dars in Northern Sudan. The only limitation imposed by the government on 'native' authorities was that the 'native' laws and customs they applied to settle conflicts had to conform to the principles of justice, equity, morality, good conscience and order. Some of the land laws passed by the Anglo-Egyptian government also codified some principles of Sudanese customary law. These included some parts of the Land Settlement and Registration Ordinance (LSRO), 1925, the Prescription and Limitation Ordinance, 1928, and the Pre-emption Ordinance, 1928.[23] As al-Nur points out, from 'time immemorial' the Sudan with its predominantly nomadic and widely scattered tribes, had very rarely, if at all, been ruled and during the Funj Sultanate, the Turco-Egyptian rule and the Mahdiyya: '... the various tribes possessed administrative structures of their own, and their sheikhs either personally or through a majlis (council) of elders appointed by them, exercised powers of settling inter-tribal disputes and inflicted punishments which were necessarily compensatory'.[24]

During the Condominium, a 'Native' Administration, which built on the long-standing tradition of the Sudan, was introduced. Between 1922 and 1932, a series of laws were passed which vested on the heads of tribes judicial, administrative and executive powers. Though the rationales underlying the government's policy of indirect rule were not related to environmental protection,[25] the policy had tangible environmental dividends. Firstly, the resources within the dars continued being inaccessible to outsiders, including commercial farmers from the urban areas (save government intervention made in 'public interest'. Secondly, the tribal leaders within the various dars were vested, as in the past, with the powers and authority to manage the resources by enforcing rules based on old usage and precedent appertaining to resources owned in common. Owing to their ability to extract obedience and reverence stemming from tradition as augmented by government support, their decisions were unquestioningly complied with by their followers.[26] This created favourable conditions for devising resource-regulating institutional arrangements and for enforcing such arrangements at minimal costs of transaction, or at no cost at all. As Harrison, with an intimate knowledge of the nomadic societies in Sudan,

stated, '... the tribal leaders exercise their control by ensuring that ancient usage is observed and by settling any disputes that may arise.[27] Not only were the tribal leaders vested with judicial powers, but they had also at their service armed police forces (retainers) to enforce decisions. The resource-regulating conventions and customs were most effective among members of the same tribe, where pressure could easily be brought to bear against those who broke customary norms concerning utilisation of resources owned in common.

On April 12, 1927, the Civil Secretary circulated a memorandum to all governors in the provinces stating: '[A]s you know we are at present endeavouring to extend the principles of devolution by increasing the responsibility of the sheikhs in as many directions as possible', and consequently, 'it might be possible to hand over the sheikhs the conservation work hitherto done by Forest Rangers.'[28] He gave two reasons why the work of forest resources conservation

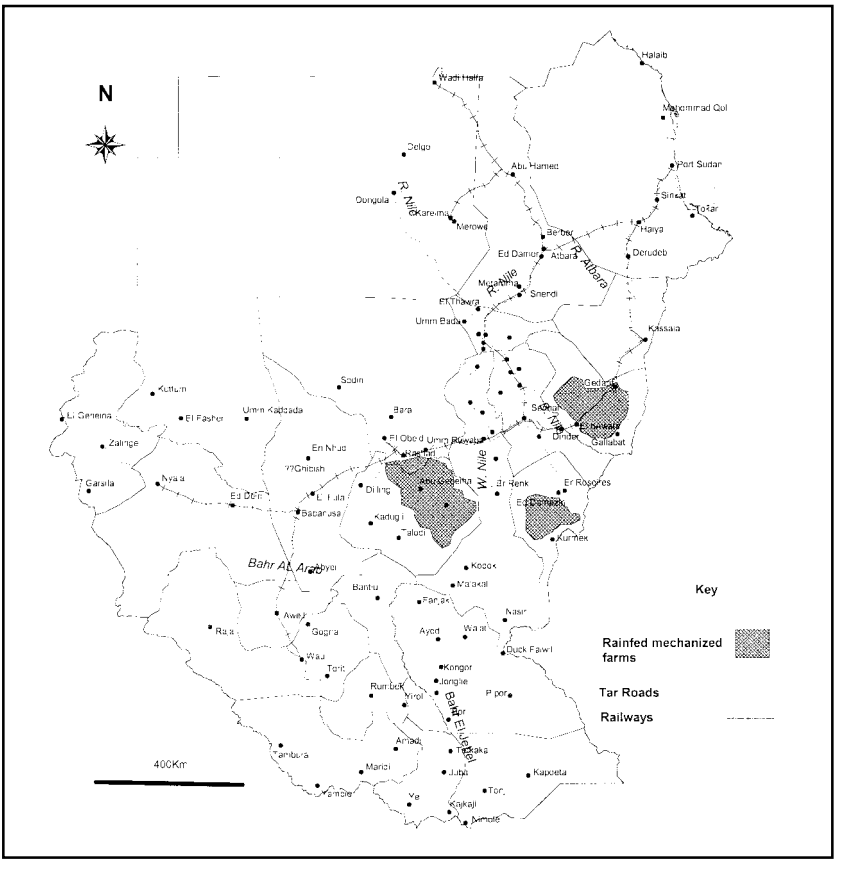

FIGURE 1. Central Rainlands in Sudan

had to be devolved to the tribal leaders. Firstly, there would be an annual saving to government on the salaries of the Forest Rangers in the range of £E17,000. He argued that the sheikhs could assume the responsibility in return for a minimum additional remuneration in the form of privilege rather than a financial reward.[29] The second reason given by the Civil Secretary was extremely pivotal. He argued: '[I] think the fact that the forests were in the hands of the people's own chiefs and not those of a government official would tend to make the work of conservation easier and more effective than it is at present.'[30] For example, the administration of gum forests in the Shukria Nazirate was devolved to the sheikhs under the presidency of the Nazir after the promulgation of 'The Powers of Nomad Sheikhs Ordinance' in 1922. By 1927, it was considered a successful experiment, indicating the possibility for extension through the medium of the Elders' Courts Ordinance in a much wider form of native administration.[31]

This paper examines the impact of nationalisation of land and the associated natural resources on communal ownership and environmental degradation It is hypothesised here that in Sudan state interference in customary tenurial rights rather than communal property rights has been the ultimate cause of open access conditions of use and consequently of environmental degradation. It is argued here that state ownership, by converting the previously exclusionary property rights into de facto open access resources, has unleashed unsustainable land use practices where entry is unlimited and use unregulated. Thus, the problem of resource depletion in the Central Rainlands is inextricably linked to firstly, the property rights regime under which land and the associated natural resources are held; secondly, the nature of development policies pursued by the consecutive state governments since independence; thirdly, the inability or unwillingness of the governments to formulate an overall land use policy; and fourthly, the inability or unwillingness of the same to enforce such a policy, inter alia, by policing and monitoring the activities of economic actors, especially of the powerful classes. In the following section, a brief history of rain-fed mechanised agricultural production is presented.

RAIN-FED MECHANISED AGRICULTURAL PRODUCTION UNDER ANGLO-EGYPTIAN RULE

Throughout the Condominium period (1898–1955), the British officials were convinced that industry had no future in the Sudan and when the country became independent, the contribution of manufacturing to GDP was less than one percent and employed only about 0.03 percent of the country's workforce.[32] According to Niblock the reason why no efforts were made either by the public and/or private sector was that 'the government was convinced that industrial development would be wasteful and perhaps socially harmful. The possibility of substantial government investment in industry seems never to have been

FIGURE 2. R. von Slatin in a field of dhurah, possibly Kassala Province, 1906–1910. Reproduced by permission of Durham University Library.

seriously entertained'.[33] The agricultural development potential of the central clay plains in the Sudan was first identified in 1929 when the Kassala Cotton Company made an unsuccessful application for a concession in the rainlands to develop sesame production on large scale. After that, no further interest was shown in the area until 1943.[34] The Gedaref region was the first part of the country where mechanised rain-fed agricultural production was introduced.[35] During World War II, shortage of supply of food crops and oil seeds for the armed forces stationed in North Africa and for the population in the Sudanese towns led the colonial administration to initiate mechanised rain-fed crop production in Ghadambaliya, Gedaref region.[36] The Abu Habl flood irrigation scheme in Kordofan was also initiated during the same period.[37] One of the most critical factors that induced the government to explore new sources of food grain production was the exhaustion of soil nutrients in the riverain areas due to continuous cultivation without fertilisation and fallow periods. In the mid-1940s 'Much of the riverain land was exhausted through continuous wartime cropping, and was not in a condition to be further exploited'.[38]

In 1943 the Government rounded up 'idlers'[39] at Omdurman and Khartoum and took them to the central rainlands for manual production of sorghum. The shortage of food was mainly due to the disruption caused to maritime shipping during World War II.[40] External conditions worsened so much that in 1941, the country's trade was brought under the aegis of the Middle East Supply Centre and the Defence of the Sudan (war supply) regulations were promulgated in 1941 and the Sudan War Supply Board was created. A wartime economy was

introduced reflected in price control regulations, rationing, etc.[41] Measures were taken to make the Sudan as self-supporting as possible. In order to implement this policy and to counter the depletion of the reserve stocks of imported stocks, a number of agricultural schemes and factories were established for the production of sorghum, wheat, butter, soap, charcoal briquettes, etc.[42]

In 1945 the government surveyed and expropriated 340,000 feddans (fd.) of rain-fed cultivable land in the Ghadambaliya plains for the use of mechanised sorghum production.[43] The colonial government owned the scheme and the object was to increase agricultural produce both for export and local consumption.[44] In 1945/46 an area of 12,000 fd. of arable land was developed.[45] In the 1946/47 season the total cultivated area increased to 21,000 fd., but in 1947/48 the total area cultivated declined to only 3,000 fd. (Table 1). The average yields for the years 1945/46, 1946/47 and 1947/48 were 0.15, 0.32 and 0.26 ton per fd., respectively.[46] The causes of the failure during the first season were summarised in the Governor-General's report as follows:

> Throughout the year all agricultural operations were handicapped by shortage of staff, equipment and motor transport, and by the late arrival of implements. In addition, the rainfall, although fairly satisfactory in volume was distributed through the season as to prevent cultural operations for long periods of critical times.[47]

The daily wage-labour based scheme was abandoned because of the alleged 'laziness' of the forcibly recruited workers, and the high cost of supervision, housing and transport of food and water. The scheme's peak period of labour demand also coincided with that of the irrigation schemes in Gezira and Gash cotton schemes.[48] The major reason for the abandonment of the scheme, according to the Ministry of Agriculture's (MoA's) Working Party,[49] was because 'the producers ate almost as much as they produced'.[50] Another report attributed the failure of the scheme to the allegedly prohibitive costs of production mainly due to wages paid to labourers hired for weeding and harvesting at official government rates.[51] Another additional factor that contributed to the demise of the wage labour-based scheme was the low price of sorghum. The sorghum price during the same years as above was S£7.00 per ton and costs of production were in the range of S£18 per ton.[52] The scheme was obviously unviable.

In 1948/49 the scheme was abandoned and it was replaced by a new arrangement based on a partnership between the government and 'participating cultivators'.[53] The government was responsible for the supply of expropriated land, tractors, drinking water, treated seeds and locust bait, and for the maintenance of communication. The government also marketed the produce. The cultivators were responsible for the supply of labour for resowing of small areas by hand, weeding, thinning, crop protection against gazelle, grasshoppers locusts, harvesting and clearing the sorghum stalks at the end of the season. The

'participating cultivators' were given 28 fd. and 20 fd. in the drier and wetter areas respectively, and the produce was shared on a 50-50 basis between both parties. The participant cultivator was required to pay 10 percent tax on the marketable surplus of his share. Besides water he also received 3–5 feddans of land on a homestead where he could grow crops of his own choice.[54] In 1948/49 about 8,805 fd. were cropped and the average yield was 0.29 tons per feddan. In 1949/50 about 6,500 fd. were cropped with the 'participating cultivators' and seven holdings with 243 fd. each were also leased to local notables and merchants. The average yield was 0.12 tons per feddan.[55] The purpose of leasing the land to private operators was not only to contribute to an increased supply of food crops to the towns, but also to introduce the leaseholders to modern technology.[56] One of the major constraints to the expansion of mechanised rain-fed agriculture was the lack of drinking water. The vast areas in southern Gedaref could not be opened up unless there were perennial water supply sources. The Government was therefore determined to overcome this constraint. For example, in 1944 the Soil Conservation Committee recommended that as soon as possible after World War II, efforts should be made to improve rural water supplies in areas of potential development. Consequently in 1949, five hafirs with a total capacity of 100,000 m^3 were dug in Butana. Two large hafirs of 25,000 m^3 each were dug by the Gash Board at Aroma and Tendelai. In Kassala district five small hafirs were dug by hand in the grazing area between the Atbara River and Kassala.[57]

The aims were to encourage the opening up of new mechanised crop production schemes and to promote redistribution of population away from the limited number of water supply points. Top priority was given to the Gedaref region.[58] In 1950, 12 hafirs were dug in southern Gedaref region with a total capacity of 180,000 m^3.[59] In 1950 the high sorghum prices precipitated by the shortage of food supply motivated the Government to increase considerably the cropped area in the following season (1951/52). The scheme at Ghadambaliya was increased to 10,000 fd. and two other new schemes were opened up at Um Leiyun and in Saqiya Um Suqaura with 10,000 fd. each. The former was expropriated land, but the latter was an unsurveyed area. A pilot scheme was also started at Saqira Um Bileil. During that season, a total area of 31,000 fd. was planned to be under production. However, according to Laing only 6,818 fd. were cropped during that season. The 1950 Kassala Province Annual Report, however, gives a figure of 30,000 fd. cultivated on a crop-sharing partnership basis during that season.[60] The reason why only about 22 percent of the planned area could be cropped was mainly because of various mechanical difficulties arising out of the 'new untried and hastily assembled implements, so that much of the first discing remained to be done when there was a succession of very heavy showers'.[61]

THE WORKING PARTY LAYS DOWN THE FOUNDATION OF SUDAN'S DEVELOPMENT POLICY

By 1953 mechanised crop production in the Gedaref region was considered a failure by many observers. The reasons given included unfavourable climatic conditions manifested in low and erratic rainfall, attacks by pests, birds, plant diseases, unsuitable machinery, lack of drinking water,[62] low crop yields,[63] and the lack of adequate roads and marketing facilities.[64] On 28 June 1953, the Director of Agriculture formed a Working Party to examine the reasons for the failure of the two experiments and to pave the way for future development of mechanised rain-fed agricultural production in the Gedaref region. The terms of reference of the Working Party were '[T]o record the lessons to be learnt from the mechanised crop production scheme to date and to make recommendations regarding the future of such schemes having special regard to the part that should be played by tenant farmers'.[65] In a forward to the report, the Director of Agriculture stated: '[O]ne of the objects of producing this report was to assemble all relevant information on which the future policy of mechanised agriculture in Sudan could be based'.[66]

The Working Party found the performance of the 'participating cultivator' to be generally unsatisfactory because he was either inefficient or unavailable at the appropriate time in the agricultural cycle. Another factor which might have contributed to the poor performance of the 'participating cultivator' was lack of experience among the nomadic population of sedentary farming.[67] In view of the fact that the peak periods of labour demand for weeding and sesame harvesting did not coincide with the periods of peak labour demand for cotton picking at the irrigation schemes, the Working Party argued in favour of casual labourers on private farms.[68] This was contrary to the view expressed by Laing.[69]

The Working Party did not consider the two experiments a total failure because in their view, first, the financial results of mechanised crop production had begun to improve; second, valuable knowledge and experience had been gained; and third, the experiments had stimulated involvement of private operators in mechanised farming. In this sense, the experiment was successful in setting the trend for the future development of mechanised rain-fed farming. One of the major findings of the Working Party was that individuals had assumed responsibility over areas larger than they were able to manage in the context of the varied types of soil, weed flora, topographic diversity, soil and weather conditions, the availability of equipment, etc.[70] The failed experiences notwithstanding, in the Working Party's view, mechanised rain-fed agriculture should constitute the centrepiece of Sudan's future development policy and practice simply because the country did not have any other option. The Working Party recommended:

> Expansion of irrigated schemes is limited by water and capital; industrialisation is limited by poor natural resources of raw materials and power. The Sudan must therefore expand its economy on an almost entirely [rain-fed] agricultural basis... In brief, the Sudan ...must remain primarily an agricultural country.[71]

The foundation of mechanised rain-fed agricultural production in the central rainlands of the Sudan was laid down by the principles embodied in the economic policies of the Condominium Government as reflected, among other things, in the Working Party's report which was created by the government to determine the future direction of the country's economic development. All the post-independence governments have been faithfully implementing the principles embodied in this colonial report. It is argued here that the problem of inappropriate land use practices and consequently depletion of the renewable resources in the central clay plains of the Sudan is inextricably intertwined with the state's decision to expand the base of the country's national economy by 'almost entirely' expanding horizontally the mechanised rain-fed agricultural schemes to the neglect of good husbandry and sustainable land use practices.

The Working Party recommended against direct government involvement in running future schemes; it unequivocally stated: '[I]t seems there is no room for state farming in the Gedaref rainlands and that accordingly the role of the state must at present be limited to planning, stimulating, assisting and encouraging the efforts of private farmers'.[72] The Working Party further recommended that the future development of mechanised rain-fed farming should depend on the initiative and investment of the private sector. It recommended the allocation of schemes to private entrepreneurs and co-operatives. In accordance with the recommendations of the Working Party, the role of the government was to be limited to the provision of infrastructural services such as water, roads, marketing and credit facilities. The government subsequently heeded the advice of the Working Party and created a Land Allotment Board comprised of officials from the local, regional and national authorities.[73] The main responsibility of the Board was to demarcate and allocate land for government mechanised crop production, private investors, planned non-mechanised cultivation and cultivation by *hariq*.[74] After 1954, land was leased by the State to individual investors whereby each individual tractor owner was allocated a *meshrua* (farm unit) ranging from 1,000 to 1,500 fd.[75] Formally, the maximum limit of a scheme was 2,000 fd. in two separate sites consisting of 1,000 fd. each. The rationale for allocating two separate schemes was to enforce appropriate land use practice based on a three-course rotation in which each scheme would be cropped for three consecutive seasons to be followed by a fallow period of three seasons.

As can be seen from Table 1, even though land allocation to private investors on a large-scale began in the 1954 cropping season, no new *meshruas* (schemes) were developed during that season. During the first eleven years (1945/46–1955/56), no dramatic progress was made in terms of development of large scale

mechanised agricultural schemes in the central rainlands. The real take-off did not happen until the 1956/57 cropping season when the total area under cultivation increased from 5,000 fd. in 1954/55 to 200,000 fd. This was two years after the country achieved its independence from British colonial rule. This shows the commitment of the post-colonial state to the principles laid down in the Working Party's report, i.e., to 'expand its economy' almost entirely on the basis of mechanised rain-fed agriculture. It was the experiments carried out during Anglo-Egyptian rule, which eventually laid down the foundation for the future mechanised agricultural development policy of the independent state governments of the Sudan. The economic success of the farmers who developed the new schemes generated a considerable interest among merchants and retired and active high ranking government officials, as well as local notables, all of whom had access to credit.[76]

In the Gedaref region where the mechanised crop production began, the area sown to sorghum increased from 5,000 fd. in the 1954/55 cropping season to 56,000 fd. in 1955/56. In the following season, the developed area increased almost four-fold (Table 1). As can be seen from the data, the area under mechanised farming (sorghum production) grew without interruption up to 1990 with the exception of some seasonal fluctuations. The area under sesame also grew with considerable seasonal fluctuations between 1968/69 and 1988/89, before falling to an almost all time low in 1989/90 (Table 2). Sesame is less resilient to drought conditions or is more sensitive to variations in the distribution of rainfall. Early rains are especially crucial to whether or not sesame could be produced in a given season. There does not seem to be a direct correlation between the amount of rainfall and the area planted to sesame which indicates that beyond a given annual threshold, distribution rather than amount is critical in influencing cropping patterns.

Until 1968/69 mechanised rain-fed crop production was limited only to the Gedaref region. Mechanised rain-fed crop production began on a small scale in Blue Nile (145,300 fd.), south Kordofan (200 fd.) and Upper Nile (30,450 fd.) in 1968/69 as a result of the establishment of the Mechanised Farming Corporation (MFC) in 1968.[77] After 1968/69, the area under mechanised rain-fed crop production began growing gradually in the Blue Nile province and later in Upper Nile.[78] In 1968, the government established the MFC in response to a request from the World Bank to facilitate the participation of the Bank in financing the development of mechanised rain-fed farming.[79] The major responsibilities of the MFC included surveying, demarcation and allocation of land to private investors who would clear the land and provide machinery, often with credit from banks. Before land was allocated to an investor, the MFC had a responsibility to establish the 'creditworthiness' of the prospective farmer. This was measured by the ability of the prospective farmer both to raise about one-quarter of the estimated total initial capital investment cost and to make good loan repayments. Only the 'farmers' who met these criteria were to be allocated land. The criterion

Season	Total area (in fd.)	Total prod'n in (m.t.)	Yield (kg/fd.)1	5-year average kg/fd.)
1945/46	12,000			
1946/47		21,000		
1947/48		3,000		
1948/49		8,805		
1949/50		6,459		
1950/51		6,818		
1951/52		20,000		
1952/53		26,000		
1953/54		12,000		
1954/55		5,000		
1955/56		56,000		
1956/57	200,000			
1960/61	625,700	131,548	420	
1961/62	874,345	453,508	518	
1962/63	700,000	300,000	428	
1963/64	765,631	233,459	304	
1964/65	942,700	454,653	376	409
1965/66	892,755	371,332	415	
1966/67	1,146,700	222,558	149	
1967/68	1,634,495	686,943	605	
1968/69	676,330	181,590	268	
1969/70	1,219,675	313,056	257	339
1970/71	1,567,275	447,975	286	
1971/72	1,375,270	417,502	303	
1972/73	1,005,535	180,758	180	
1973/74	1,261,000	391,412	310	
1974/75	1,565,000	426,821	272	267
1975/76	1,944,455	775,838	399	
1976/77	1,915,690	572,791	299	
1977/78	1,847,611	461,903	250	
1978/79	1,848,000	554,000	300	
1979/80	1,672,074	467,370	358	321
1980/81	2,168,450	718,203	328	
1981/82	2,958,000	1,183,000	400	
1982/63	2,960,900	573,186	194	
1983/84	2,947,000	578,000	196	
1984/85	2,502,000	195,000	78	239
1985/86	3,016,000	1,146,000	380	
1986/87	3,170,600	1,017,085	321	
1988/89	3,551,320	n.a	n.a	

TABLE 1. Total area, total production and yield of sorghum in the mechanised schemes in the Gedaref region 1968/69-1989/90

Season	Area/fd	Production/tons	Yield kg/feddan
1968/69	298,900	37,059	120
1969/70	321,924	51,459	150
1970/71	278,282	41,465	140
1971/72	278,454	52,299	190
1972/73	370,686	81,352	220
5-year average kg/feddan			164
1973/74	441,500	71,559	160
1974/75	374,000	25,040	70
1975/76	302,550	26,759	90
1976/77	400,000	53,900	130
1977/78	344,200	46,467	130
5-year average yield kg/feddan			116
1978/79	193,871	26,172	130
1979/80	342,000	53,865	160
1980/81	321,950	48,195	150
1981/82	250,000	45,000	180
1982/83	221,620	25,043	110
5-year average yield kg/feddan			146
1984/85	330,850	23,054	70
1985/86	431,125	36,510	80
1986/87	470,335	62,911	130
1988/89	350,000	30,632	90
1989/90	200,920	33,750	170
5-year average yield kg/feddan			108

TABLE 2. Total area, total production and yield of sesame in mechanised schemes in the Gedaref region 1968/69–1989/90.

Table 1 Sources: For the years 1945/46–1950/51 R.L. Laing, Mechanisation of Agriculture in the Rainlands of the Angol-Egyptian Sudan 1948–1951, Sudan Survey Department, No. 750, Khartoum, 1953. For the years 1950/51–1956/57 Mechanised Farming Corporation, Khartoum. For the years 1968/69–1986/87 Tag el Din Hago, 'Agriculture Process and Systems' in Kassala Province Environmental Collection of Papers, Institute of Environmental Studies, University of Khartoum. For the year 1989/90 compiled from the archives of the Mechanised Farming Corporation, Khartoum.

Table 2 Sources: 1968/69–1976/77 Mechanised Farming Corporation, Agricultural Statistics Bulletin No.2, 1979; 1977/8–1982/83 Mechanised Farming Corporation, Agricultural Statistics Bulletin, No.3, 1984; the data for 1983/84-1989/90 are compiled from the archives of the Mechanised Farming Corporation, Khartoum and Gedaref.

of 'creditworthiness' clearly demonstrated the government's agricultural policy bias in favour of the well-to-do members of the society. This was to the detriment of those traditional farmers and pastoral groups who derived their livelihoods from the resources which the MFC was mandated to allocate to the so-called 'creditworthy farmers'. These were rich merchants, tribal chiefs, top civil servants and retired army officers.[80]

According to the Mechanised Farming Corporation Act, 1970, about 60 percent of the land was to be allocated to local inhabitants of the region, but in the absence of accurate records of places of birth and residence and in the light of widespread corruption, it was easy to establish either that one was a local inhabitant or to produce a forged birth certificate to that effect.[81] The second responsibility of the MFC was to channel and to facilitate credit to leaseholders for the purchase of machinery and for clearing of land. There were three sources of credit supplies for the commercial farmers engaged in mechanised rain-fed crop production. These were the World Bank, the Arab Fund and the state-owned Agricultural Bank of Sudan (ABS). In the two former sources of credit, the MFC 'plays an intermediary and channelling' role while in the latter it 'facilitates such loans merely by issuing certificates of farm allocation'.[82] Such certificates of farm allocation are still a prerequisite for qualifying for a loan from the ABS. The third responsibility of the MFC was to act as a role model by operating state owned pilot schemes in areas where mechanised farming was unknown so that the activity could be emulated by private investors. The state owned farms were at least theoretically expected to be centres of training, experimentation and research.

During the initial period, land was leased for one year, renewable for an indefinite period.[83] The one-year lease period was later considered too short; it was thought that it might discourage long-term investment. The lease was later changed to eight years renewable, again for an indefinite period of time. It was later raised to 25 years.[84] Initially land rent was as little as one piaster (S£0.01) per fd. per year;[85] later this was increased to five piasters (S£0.05) per fd.[86] The market rent at that time was S£1 per fd.[87] A typical mechanised rain-fed farm was owned by an absentee leaseholder or by an illegal possessor in the undemarcated[88] areas who hired an agent (*wakil*) to manage the farm on his behalf. All agricultural operations except cultivation were executed by hiring seasonal manual labour. The cultivated area under mechanised rain-fed crop production increased dramatically after the establishment of the MFC in 1968 and as we shall see below after nationalisation of all land by the state in 1970.[89]

COMMUNAL PROPERTY PERCEIVED AS AN OBSTACLE TO ECONOMIC DEVELOPMENT

As mentioned earlier, except in the riverain areas where land was privately owned, throughout the Condominium period and until the end of the 1960s, all land and the associated renewable resources were controlled by communities who were associated by common descent or common residence. Outsiders were either excluded or needed consent from the rights holders to gain access to resources located within the tribal homelands or dars. Thus, in the various state governments' view, two obstacles constrained the ambitious plan to develop the agricultural sector, namely dependence on erratic rainfall which led to heavy seasonal fluctuations in crop production and the dominance of traditional rain-fed farming and pastoralism which were considered wasteful of resources. The government tried to overcome these constraints by expanding the area under irrigated farming (the New Halfa and the Rahad Irrigation Schemes were initiated to grow cash crops for export in the post-independence period by emulating the experiences of the Gezira irrigation scheme which was established by Condominium government in the early 1920s for cotton production) and by undermining dominance of the traditional rain-fed agriculture. This view has dominated the outlook of the country's policy-makers throughout the post-independence period. For example, a report by the Ministry of Agriculture stated that the dependence of agricultural production on natural rainfall in the Sudan is exacerbated by the existence of the vast rain-fed traditional farming.[90]

The reasons why the government perceived traditional rain-fed agriculture and pastoralism as obstacles to agricultural development were: (i) the dominance of communal or tribal ownership of land and other natural resources allegedly discouraged investment, impeded improvement of farming methods and constrained the government's possibility to allocate land for development projects where economic return would be presumably highest; (ii) the government feared that the unsettled status of the country's land resources and lack of clearly defined property rights might discourage investments in projects where there was a dispute over title to land; (iii) as in the rest of Africa, the government of Sudan also considered communal land ownership as being the major cause of environmental degradation because such a property rights regime was wrongly equated with open access.[91] Thus, the government was determined to overcome any real or perceived obstacle to its ability to allocate land and the other resources in the country to activities where return was believed to be highest. However, instead of defining land rights by adjudication and registration as was planned by the Condominium Government,[92] the government as part of its comprehensive nationalisation programme opted for an apparently 'cost-effective', but in the long-term unsustainable short-cut, i.e. outright confiscation.

NATIONALISATION OF UNREGISTERED LANDS

Towards the end of the 1960s, the policy to develop mechanised rain-fed agriculture as prescribed by the Condominium government's Working Party in the early 1950s was endorsed with renewed determination and greater vigour as constituting the centrepiece of the independent government's agricultural development strategy. It was hoped that expansion of rain-fed agriculture would dramatically increase agricultural production enabling the country eventually to become not only self-sufficient but also a major food exporter.[93] Not only did this vision become more compelling over time, but also the people in power thought that this goal would remain unachievable unless some fundamental institutional changes were effected to restructure the whole edifice on which the property rights of the various resource users in the country rested. It was thought that such a measure would give the managers of the state unfettered powers to dispose of the country's basic resource – land – to activities which could potentially generate more revenues to investors, public treasury and consequently to themselves. The only way the government could do this was by changing the long-standing, customarily prescribed and socially sanctioned communal property rights regime to a state property rights regime. This was accomplished when the state through the enactment of the Unregistered Land Act (ULA), 1970, vested in itself the power to limit the ability of the nomads and the traditional cultivators throughout the country to enjoy the benefits derived from the use and enjoyment of land, water, forest and other resources in the country. After the enactment of the ULA, the government was free to allocate land for development or other projects operated by both public and the private sectors without being constrained by communal ownership of land or other traditional institutional arrangements. By promulgating the ULA, 1970, the government vested in itself ownership of all unregistered land in the country. Section 4(1) of the Act states:

> Notwithstanding anything contained in the Land Settlement and Registration Act, 1925 or any other law in force, all land of any kind whether waste, forest, occupied or unoccupied, which is not registered before the commencement of this Act shall, on such commencement, be the property of the Government and shall be deemed to have been registered as such, as if the provisions of the Land Settlement and Registration Act, 1925, have been duly complied with.

Freehold registered (invariably in the riverain areas) up to that date was recognised as private property, but no freehold could be created subsequent to the promulgation of the ULA, 1970. Leasehold has been the only form of tenure for land allocation in the development of the rain-fed mechanised schemes. Despite the Condominium Government's intention to register all land as stipulated in the Land Settlement and Registration Act 1925, by the time the country became independent (January 1, 1956), over 90 percent of all land and nearly 100 percent of the other renewable resources were under the possession and control of tribal communities and individuals.[94] Unlike the Land Registration and

Settlement Act, 1925, which gave the government a presumptive right of ownership of '[A]ll waste, forest and unoccupied land...' until proved otherwise,[95] the Unregistered Land Act, 1970, gave the government full ownership over all unregistered lands, including the occupied lands. The only exception was when the President of the country exempted a certain piece of land on the ground that it would be unjust to apply the provisions of the Act because it was used by private persons long before the commencement of the Act.[96] No measures of redress were provided by the Act against presidential denial of exemption. The decision of the President was final subject to no appeal. Under the ULA, 1970, compensation was discretionary and this discretion was exercised to evict traditional users – small cultivators and pastoralists – without any compensation.[97] Where local traditional users are displaced by an expansion of mechanised scheme, they are supposed to receive land as compensation, and existing MFC regulations require that the commercial farmer within whose scheme the evicted smallholder previously cultivated must compensate the smallholder for the expense of clearing the new land. This, however, applies only to smallholder cultivators. When the evicted are pastoralists, no compensation in cash or kind is given. It is important to note that the regulation of the MFC is seldom heeded because there are no mechanisms to enforce it. Owing to their powerlessness and impoverishment, smallholders are unable to negotiate with powerful scheme owners. The right of compensation does not also exist in law. It is discretionary and whether it was applied to a large extent depended on power relations of the parties involved.

The Act also prohibited establishment of easements,[98] acquisition of rights in or titles to such land by prescription[99] unless the President of the Republic had ordered that the provisions of the Act should not apply. This shows that the ULA, 1970, eliminated a fundamental principle, which had constituted a cornerstone of the customary law of the country and the body of land legislation enacted during the colonial period. The Title of Lands Ordinance, 1899, provided that registration should not affect the right to acquire a title by prescription. Prescription refers to the acquisition of a right to property by uninterrupted possession for a prescribed period. The Deeds Registration Ordinance, 1908, made similar provision. The Land Settlement and Registration Ordinance, 1925, also stated that registration of title did not necessarily affect the right of another person to acquire title of the registered property by prescription. The Prescription and Limitation Ordinance, 1928, expressly provided that 'ownership of land may be acquired by peaceable, public and uninterrupted possession thereof by a person not being an usufructuary of a period of ten years, provided that if ownership is claimed against the Government the period shall be twenty years instead of ten.' The ULA, 1970, prescribed, '[I]f any person is in occupation of any land which is registered or deemed to be registered in the name of the Government, the Government may order his eviction from such land and may use reasonable force if necessary.'[100]

SOME CONSEQUENCES OF NATIONALISATION OF LAND AND COMMON PROPERTY RESOURCES

The impact of nationalisation of land and the other renewable resources on the country's system of land tenure and consequently on the environment has been dramatic. After the promulgation of the ULA, 1970, all the land which previously was under the control of the pastoralists and traditional cultivators, save the arable lands in the riverain areas which were registered as private holdings, and nearly all the natural resources such as forests, rangelands, water, etc. came under government ownership.[101] The ULA, 1970, eliminated the exclusionary nature of dar rights and by doing so removed the most critical element which underpinned the traditional resource management systems throughout the country. This overnight change in property rights shook the foundation on which the land use practices that had been developed since time immemorial through a method of trial and error. Even though the ULA, 1970 was repealed by the Civil Transaction Act, 1984, which came into being as part of the disputed Islamic September Laws,[102] no changes in this regard have occurred. The Civil Transaction Act, 1984, like the Unregistered Land Act, 1970, exactly states that all unregistered land (including all rain-fed land) belongs to the Government. In fact the Civil Transaction Act, 1984, goes farther than the ULA, 1970, in the sense that lands that had been registered under exceptions to the ULA in the northern region were restored to government ownership. The Civil Transaction Act, 1984, came as part of Nimeiri government's attempt to Islamise the Sudanese society. The Nimeiri government did not last long after the promulgation of the Civil Transaction Act and hence had no impact whatsoever on the land tenure system of the country. The effects of the ULA, 1970, continued as before.

Some of the most important consequences of nationalisation of land and the other renewable resources are: firstly, arable land, grazing lands, woodlands, surface water, and animal routes have been converted to de facto open access resources where entry is unlimited and use is unregulated. Secondly, after the coming into force of the ULA, 1970, the tribes and the traditional cultivators continued to have access to grazing, arable, woodlands and water resources (provided they were not evicted by commercial expansion of agriculture) over which they lacked control. This had twofold consequences. On the one hand, the resources within their territories became open to outsiders who were no longer bound to observe any rules regarding access to, and use of, the resources they used. On the other, because the traditional resource users lacked control over the resources from which they derived their livelihoods, there was fierce competition with 'strangers'. This was because the previously communally controlled exclusive resources had effectively become open-access resources which meant that anyone could gain access and use the resources in any manner they deemed fit. Access to an uncontrolled resource is calamitous. '[N]othing incites people to deplete forests, soils, or water supplies faster than fear they will soon lose access to them'.[103] The communities were no longer responsible for devising and

enforcing institutional arrangements which regulated access to, and use of, the resources among their own members and outsiders. Every individual was free to utilise the CPRs and arable land, as he/she deemed fit without being constrained by institutional rules. Unlimited entry and absence of regulatory rules led to intensive competition, reflected in excessive felling of trees and clearance of land for cultivation. Thirdly, after the conversion of the former exclusive access resources into de facto open-access resources, the previously strictly defined territories occupied by the different tribes and sections of the tribes in the various dars disappeared, leading to tribal intermingling. Demarcation of arable and grazing areas was no longer possible. After the tribes lost the power to admit or exclude outsiders into their territories, massive influxes of immigrants with no local environmental knowledge entered the central rainlands. Unlike in the past, the strangers were required to follow no conditions of entry or resource use. Fourthly, the ULA, 1970, also undermined the powers of the tribal chiefs because they lost the foundation on which their authority rested, namely land and CPRs. The power base of the native organisations was deeply undermined because all the land and the CPRs became state domain. De jure, the rights of the tribes and their traditional leaders were reduced to the right of usufruct. Consequently, their role in devising institutional arrangements for the regulation of resource allocation, use and enforcement was either substantially weakened or eliminated. The native administration was also abolished by the People's Local Government Act in 1971 as a continuation of the policy of 'modernisation'. Fifthly, the ULA, 1970, has introduced far-reaching changes in the general system of property relations. The Government was unwilling and unable to create an institutional framework and mechanism for allocation, regulation and enforcement of the newly created property rights regime. Thus, when an institutional vacuum was created, a certain degree of chaos and confusion set in, in which powerful groups from the towns began opening up large tracts of land which were previously exclusive property rights of the pastoral and sedentary communities. In the absence of effective institutional arrangements – governmental or traditional – which regulated access to, and use of, resources by clearly defining routes of seasonal nomadic movements, grazing and arable lines, water rights, territorial boundaries of tribes and sections of tribes, etc. and in the absence of effective enforcement mechanisms, sustainable use of resources was no longer possible. Like a Pandora's box, the ULA, 1970 discharged various actors who competed avariciously for uncontrolled access to, and use of, scarce arable, grazing, woodland and water resources. Not only was the result ravenous resource use and over-exploitation of the natural resources, but also the resources, which were previously used by subsistence users in the best and sustainable ways, were encroached upon by large-scale mechanised commercial farming. One of the most damaging environmental consequences of state ownership of land and the other natural resources in the Sudan is the vast horizontal expansion of rain-fed mechanised farming which has led to environmental degradation in the Central rainlands. This is discussed in what follows.

HORIZONTAL EXPANSION OF MECHANISED RAIN-FED AGRICULTURE AS A ROOT CAUSE OF RESOURCE DEPLETION

It is worthwhile to state that since the introduction of tractors in the central clay plains, the emphasis has been on horizontal expansion rather than on intensification designed to increase productivity by improving the techniques of agricultural production. Consequently, the strategy of every commercial farmer has been to increase total production from increased acreage and not from increased productivity per unit of land cultivated resulting from improved agricultural husbandry. From the point of view of the individual commercial farmer who was required neither to comply with traditional institutional arrangements regarding levels of intensity of resource use nor to internalise the costs of the environmental damage he caused, it made short-term economic sense to maximise returns by bringing as much land as possible into the production process and to keep capital investment and recurrent costs at a minimum by not improving the quality of the cultivated land resource. Until the 1980s, this was made possible by the 'abundance' of virgin land in the area. It is worth noting, however, that the so-called 'abundant' land was either part of the traditional pastoral grazing area or part of the land that belonged to traditional small cultivators. Because of the ULA, 1970, all land had become government property readily accessible to commercial farmers disregarding local interests and rights. Worse still, the government was so weak that it was unable to exercise the ownership and control rights that it had vested upon itself. In effect government ownership of land and the other renewable resources has converted the previously communally managed resources into de facto open access resources where entry by the powerful merchant and bureaucratic classes is unlimited and their land use practices unregulated. The various governments' lack of capability to intervene in the management of the environment has been exacerbated by civil war; low pay and poor work conditions of government employees causing loss of motivation and loss of morale and a drain of talented administrators and academics; a decline in law-and-order; and chronic political instability.[104]

By 1970, mechanised rain-fed farming, with its low capital input requirements and tempting short-term high yields had become too tantalising and irresistible to development super-zealots, as well as to the country's merchant and bureaucratic classes. Even though clearing of new land involved costs in terms of labour and equipment, these costs were minimal compared to the level of investment that would have been required to improve the quality of the cultivable land. The individual commercial farmer was not required to comply with local institutional rules, firstly because he was an outsider and thus, did not recognise the authority of the traditional institutions, and secondly because land and the CPRs had also become de facto open access resources where in effect neither the traditional nor the government resource-regulating requirements applied. Similarly, s/he was not required to internalise the costs of the environmental damage or the reduced productive capability of the land (resulting from

exploitative land use practices with no investments made to enhance productivity or to maintain soil fertility) because the land had de facto become ownerless, or an open access resource where no rules were enforced to place an upper limit on the exploitative behaviour of commercial farmers. De jure land belonged to the state, but de facto in most cases, state ownership of land meant no ownership. In the long-term, this land use practice proved to be unsustainable. This has constituted the core of the environmental problem in the area. This does not, however, imply that no laws, regulations and recommendations on appropriate land use practices, such as the use of fertilisers, crop rotation, improved seed varieties, fallowing and retention of trees as shelter belts, etc. did not exist. Mechanised rain-fed scheme operators were formally required to construct a windbreak of 40 metres in width around each farm. Rather, these laws and recommendations were seldom adhered to or were deliberately ignored by the commercial farmers[105] and neither the MFC nor the Forests National Corporation (FNC) was able to enforce them because of lack of political will, administrative and financial capacities and manpower shortages. The problem of manpower shortage faced by the MFC can, for example, be illustrated by the fact that for the whole Kassala Province there were only twelve senior agriculturalists for an area of three million feddans: four on state farms; eight on the World Bank sponsored schemes; and none in the private sector.[106] Their activities were also severely hampered by lack of resources such as transport facilities.

It was in the latter where the root cause of resource depletion lay. However, ironically, there were no agricultural inspectors in the private sector where most of the environmental damage took place. That was the reason why the conditions of the lease – requirements of good husbandry, such as tree planting, crop rotation and other soil conservation measures – are seldom observed. It is also due to this that there was uncontrolled expansion of mechanised rain-fed farming in the undemarcated (unsurveyed and unmapped) areas. The data in Tables 1, 2 and endnote 107 show that total acreage was increasing steadily over the years with only seasonal fluctuations. The seasonal fluctuations in acreage are attributable to rainfall variability, producer price fluctuations, and inadequate supply of machinery, fuel, spare parts and labourers. The total area under sorghum increased from 676,330 fd. in the 1968/69 season to 1,219,675 fd. in the 1969/70 season. This was the time when land was nationalised by the government. In 1982/83, the total area under mechanised rain-fed crop production (sorghum, sesame and cotton) in the provinces reached all time high – 6,089,794 fd.[107] Of the total area under mechanised crop production, 51 percent, 24 percent and 15 percent are in regions of Gedaref, Dammazin and Dilling, respectively. Most of the remaining areas are in Renk and some in Kosti. About 71 percent of rain-fed cotton is produced in Dammazin and the balance (29 percent) in the Gedaref region.[108]

Even though the policy of the MFC is to double the total area under the plough in the 1990s,[109] there is likely to be no measurable growth because of land shortage. For example, almost all the rain-fed land in Kassala Province, espe-

cially in the Gedaref region, is used and there is little room for further rapid horizontal expansion.[110] Most of the expansion in acreage has hitherto taken place in the undemarcated lands in the southern parts of Gedaref. According to the 1968 Mechanised Farming Corporation Act, one of the responsibilities of the MFC was to protect the mechanised farming areas from being degraded. This was expected to be accomplished by careful identification, surveying and demarcation of the areas suitable for mechanisation. The purpose of this land use planning was to exclude the degradation-prone areas from being brought into the production process. In addition, the MFC was responsible for devising and enforcing sound and sustainable land use practices in the cultivated areas. The requirements stipulated by the Mechanised Farming Corporation Act, 1968 were never enforced effectively and consequently, land allocation and use became chaotic and exploitative. In the undemarcated areas, slopes and degradation prone lands were brought under cultivation without the knowledge and consent of the MFC

The horizontal expansion of mechanised crop production can be attributed to two major factors. Firstly, fear of and decline in productivity of old schemes led mechanised farm owners to respond by horizontal expansion so as to maintain or increase overall production. The data in Tables 1 and 2 clearly show that the ability to open up new farms by abandoning the old ones enabled the farmers to stabilise yields. In the central clay plains of the Sudan, there is an unmistakable relationship between decline in crop yields and farm age. Continuous cultivation without fallow periods or fertiliser inputs results in depletion of soil nutrients and this has a negative effect on soil productivity.[111] Among small farmers, the problem of soil exhaustion resulting from continuous monocropping constitutes the single major cause of crop yields decline.[112] Though the data on the 5-year averages in Table 1 show a discernible pattern of fertility decline over time, the extent of the change would have undoubtedly been more pronounced had it not been for the ability of the commercial farmers to open up virgin lands in the undemarcated areas in response to fertility decline in the old schemes. In the Gedaref region, there is a direct relationship between depletion of soil productivity and continuous cultivation without fallow periods or fertiliser application. The absence of a sharp yield decline over time is explained by the fact that the large mechanised scheme owners have been able to open up new farms illegally in the undemarcated areas whenever there is a slight indication of crop yields decline or an increase in weed infestation. Both are associated with soil nutrient depletion resulting from continuous cultivation without fallow periods or fertiliser application. This strategy has clearly enabled them to maintain stable productivity levels at the expense of stripping huge tracts of land of vegetation cover. What is more damaging to the environment is the fact that those who open up new farms seldom abandon their old farms completely. The majority continue cultivating, albeit carelessly, their exhausted land not because they expect to harvest good crops but as a means of gaining access to low cost fuel and ration

(for wage-labourers) allocations which are used for cultivating virgin lands and to prevent tree regeneration in order to retain their possessory rights.

The ability of the commercial farmers to open up new farms has been facilitated by the relative ease of access to new cultivable land in and outside the demarcated areas, and by the relatively low investment costs required to operate a farm of about 1,500 fd. for which three-quarters of the total investment cost was obtained from loans mediated or facilitated by the MFC. In addition, the inability of the state to intervene in order to enforce the requirements of good husbandry and environmental protection, as well as its support in the form of fuel for agricultural machinery and food for wage labourers at official prices provided favourable opportunities for the commercial farmers to exceed the limits of their demarcated farms or to open up new farms in the undemarcated areas. As can be observed from the data in Table 3, commercial farming in the undemarcated areas in Mufaza, Hawata and Qala en Nahal was dramatically increasing. Between 1980/81 and 1988/89 the total cultivated area in the surroundings of these districts increased by over 221 percent. It is important to observe that all this land was located in the undemarcated (unplanned) area which means that the commercial farmers opened up these new farms without their being surveyed, mapped, demarcated or allocated by the MFC. These data clearly demonstrate that after the state took over the ownership of all the unregistered land, the nationalised resources had become open-access readily available for thoughtless exploitation by the most powerful classes in the society.

COMPETITION FOR LAND IN THE GEDAREF REGION

In order to demonstrate the extent of the chaos which characterises agricultural development in the central rainlands of the Sudan as a consequence, on the one hand, of the coming into force of the ULA, 1970, and later the Civil Transaction Act, 1984, and on the other, the inability of the state to intervene in soil conservation and environmental protection, an attempt is made to measure the amount of land that has been developed in the undemarcated (unplanned) areas in the Gedaref region illegally.[113] The amount of land cultivated in this sub-sector shows the effect of state ownership of land and other natural resources on sustainable land use practices.

It is not possible to determine with certainty for every year the extent of 'unplanned' or illegal expansion of mechanised rain-fed agriculture. Whenever possible, the amount of land cultivated in the unsurveyed and undemarcated areas was documented, based on the information available in the archives of the MFC in Khartoum and Gedaref. The results are given in Table 3. The amount of land cultivated in the undemarcated areas shown here, however, does not give the full picture of the extent of illegal land seizure in the southern part of the Gedaref region. There were many commercial farmers who opened up land in the

Agricultural season	Area in feddans
1980/81	123,200*
1981/82	250,000*
1982/83	197,000
1984/85	133,600
1988/89	396,030*
1989/90	315,000*
1990/91	310,000

TABLE 3. Total undemarcated area cultivated in three districts in the Gedaref region (Hawata, Mufaza and Qala en Nahal) 1982/83-1990/91 (sesame and sorghum) in feddans

Source: Compiled from the archives of the M.F.C, Khartoum

* This area was only for sorghum. Data on sesame were not available.

	Total area cultivated fd.	Demarcated fd.	Undemarcated fd.	Undemarcated % of total
1981/82	3,289,655	1,418,359	1,871,296	57.0
1982/83	3,231,000	1,398,434	1,832,566	57.0
1983/84	3,532,858	n.a	n.a	n.a
1984/85	2,816,805	1,645,882	1,170,923	42.0
1985/86	3,831,125	n.a	n.a	n.a
1986/87	3,640,865	1,832,060	1,808,805	50.0
1988/89	3,901,320	1,732,750	2,168,570	53.0
1989/90	3,158,320	1,501,820	1,656,500	53.0

TABLE 4. Data showing the proportion of demarcated and undemarcated cultivated land in the Gedaref region 1981/82-1989/90

Source: Compiled from the archives of the Mechanized Farming Corporation, Khartoum. (n.a = breakdown not available)

undemarcated areas without any authorisation and some of them did not subsequently register their *meshruas* with the MFC. The data in Tables 3 and 4 only refer to the amount of land opened up without authorisation, but subsequently registered with the MFC by the farmers in order to gain access to cheap diesel allocation, and the distribution of commodities as rations to seasonal workers.

The operators of farms in the 'unplanned' or undemarcated areas enjoyed privileges equal to legal mechanised farmers with regard to allocation of commodities (food items and diesel) at official prices, which represent a small fraction of the prices in the informal market. The only difference between the two was that the illegal mechanised farmers were unable to receive loans unless they

possessed certificates of allocation issued by the MFC. It is noteworthy to state that many are able to obtain such certificates retroactively. The illegal mechanised farmers formed their own union in order to protect their illegal seizures of arable land, but above all to lobby for access to incentives equal to those available to the farmers operating legally allocated farms. As a result, they have wielded considerable influence on government policy and, therefore, have succeeded in securing rights to allocations of fuel and food rations for seasonal labourers as if they had not broken the existing land allocation regulations. Instead of being punished, the recalcitrant is rewarded – the irony of a weak, corrupt and incompetent state. This was exacerbated by the perennial fiscal crisis, which reduced the ability of the consecutive governments to formulate and enforce land use policies and environmental protection laws and by-laws. The need for revenues in terms of foreign exchange (proceeds from cash crops) to finance imports and the need for food crops to ensure supply to urban dwellers also induced the state governments to succumb to the pressure of commercial farmers.

Only those farmers who voluntarily registered their illegally opened up schemes in the undemarcated areas with the MFC were liable to pay lease fees. If a farmer who opened up a farm in the undemarcated area did not register his illegally operated farm with the MFC, he was not charged lease fees. As can be seen from Table 4, the amount of mechanised rain-fed agriculture in the undemarcated areas was larger than in the demarcated areas for all the seasons except for 1984/85, which was a major drought season. As stated earlier, since only the farmers whose farms were registered with the MFC paid lease fees, there were many who preferred not to register their illegally acquired farms to avoid the charges.[114] The main incentives for illegal mechanised farmers to register their farms with the MFC were: (i) allocation of fuel from the MFC at official prices which constituted a small fraction of the re-sale value of diesel on the black market; (ii) allocation of sugar, lentils, soap and edible oil for seasonal agricultural labourers at official prices; and (iii) those whose meshruas were registered with the MFC were issued certificates of allocation which were necessary for obtaining loans for the purchase of tractors and disc-harrows from the World Bank or the Arab Fund through the MFC or from the Agricultural Bank of Sudan (ABS). The registered land and crops were used as collateral for such loans.[115] Cheap fuel was made available to all farmers irrespective of whether or not their farms were in the demarcated or undemarcated areas provided such meshruas were registered with the MFC. Compliance or non-compliance with environmental protection and good husbandry requirements as stipulated in the forestry legislation or in the terms of the lease agreements were not preconditions for allocation of cheap fuel and other commodities. There were many farmers whose meshruas were in the undemarcated areas, but who in order to gain access to cheap fuel and commodity allocations, registered their illegally opened up farms with the MFC.

There were, however, some disincentives that outweighed these benefits and hence discouraged a farmer from registering his illegally opened up farm with the MFC. Firstly, the illegal nature of the act induced the farmer to remain silent either for fear of being fined or losing his possession of the land. This fear was more perceptual than real because in reality no consequence was suffered as a result of illegal possession of schemes in the undemarcated areas. In fact, the MFC did not reject any registration request filed by such farmers. In most cases, certificates of allocation were issued to illegally acquired schemes by the MFC without any legal or other repercussions. Non-compliance with environmental requirements did not in any way prejudice the farmers' possibility of registering the illegally seized scheme. Secondly, the lease charges collected by the MFC had increased considerably in recent years. The lease charge was increased gradually and by 1991 it reached S£5 per fd. This charge was collected from farmers operating schemes in both the demarcated and undemarcated areas. Thus, in light of these disincentives, there were many commercial farmers who opened up new schemes for cultivation and subsequently chose not to register their possession with the MFC.[116] For the rich farmers with adequate capital it was simply more profitable not to report their holdings to the MFC. The level of unauthorised expansion of mechanised rain-fed farming was, therefore, no doubt more than that which has been indicated in Tables 3 and 4. For example, Hago estimates that the total undemarcated area cultivated in the Gedaref region at three million fd.[117] Other estimates also give the same figure,[118] but none of them gives the source from which they derived their data. According to the report of the Land Tenure Task Force, in 1987 there were about 2–3 million feddans under unauthorised mechanised cultivation in the central clay plains.[119] Even though the figure of three million feddans of illegally operated schemes in the region may sound plausible, in reality the area in the undemarcated land may be more or less than three million feddans. The true extent of the illegal land seizure is not known. All data on mechanised rain-fed farming were collected from surveys based on samples of farmers, and since the total number of the farmers, including those whose holdings were in the undemarcated areas were unknown, there was no way by which the total area of the farms in the undemarcated land could be ascertained with an acceptable degree of accuracy. What is worrying from the perspective of resource conservation is that unauthorised cultivation 'is not motivated by a need for more land but rather as an alternative to the investments needed to maintain soil fertility'.[120] This suggests that land in the mechanised rain-fed schemes is used by commercial farmers on the basis of 'use and dispose' in which no investment is made to improve productivity or to replenish depleted soil nutrients. The problem of fertility decline is instead solved by neglecting or abandoning old schemes in favour of clearing new sites illegally. The Land Tenure Task Force, which was formed by the government to look into rain-fed mechanised crop production, concluded its report stating: 'land must henceforth

be regarded as a scarce and threatened resource.' It recommends that MFC 'consider a moratorium on new leasing for mechanised cultivation and introduce more rigorous monitoring of farming methods and conservation measures required under the leases'.[121] The committee also recommended longer leasehold terms as rewards for observation of the windbreak and rotation requirements, elimination of all subsidies to mechanisation, and rents which more closely reflect the productive value of the land. It notes that if government cannot control unauthorised mechanised cultivation, it will be very difficult to require better husbandry on the holding as the sanction of eviction is ineffective.[122] Such an acknowledgement by a government task force indicates the seriousness of the problem of land grabbing and consequently of uncoordinated and chaotic land use practices which have detrimental effect on the sustainability of the renewable resources on which the large majority of the country's population are directly and indirectly dependent for their livelihoods.

ENVIRONMENTAL IMPACT OF HORIZONTAL EXPANSION OF MECHANIZED RAIN-FED FARMING

The principles upon which mechanised rain-fed crop production is based were spelled out by the Working Party that was set up by the Condominium Government in 1953. The whole development approach recommended by the Working Party not only suffered from environmental blindness, but the recommendations openly undermined the existing and future environmental conservation efforts. The sole concern of the Working Party was to introduce measures that would make real its vision of 'the rise of a great new region of mechanised farming, stimulated and organised by the state and carried out by a new class of tractor farmers'.[123] This is precisely what the post-colonial state in the Sudan has been trying to achieve and herein will be found the root cause of resource depletion (environmental degradation) in the areas where there has been rapid horizontal expansion of mechanised rain-fed agriculture. Some of the calamitous consequences of this development strategy are discussed below.

Deforestation

When the Working Party presented its report, all the central clay plains of the Sudan were wooded,[124] and one of the major preoccupations of the Working Party became finding a cheap method of clearing the woodlands. It was stated that a serious effort would be made to 'apply the economical method of chain clearing to talh (*Acacia seyal*) – so far woodland'.[125] Studies on ring barking and use of chemicals for land clearing were already under way at Tozi[126] and the Working Party expressed its hopes for the positive outcome of the experiments.

The environmental consequences of chain clearing, ring barking and the use of chemicals were disregarded completely. The Working Party's hostility to the principle of environmental conservation is indicated by one of its statements. Being aware of the detrimental environmental consequences of its recommendations, the Working Party stated:

> [O]bviously the Forest Department will be concerned with the protection of firewood areas and the economic utilisation of the timber from the cleared land... It will be clear that extensive forest conservation for conservation's sake will not be compatible with the developments we regard as necessary. In any case even one million acres is a very small fraction of the total woodland available.[127]

The Working Party not only perceived the area's forest resources as inexhaustible, but its members also conceptualised development and conservation as representing a dichotomy rather than constituting two essential parts of the same continuum. There is ample empirical evidence to show that development without conservation, especially in farming systems where no modern inputs or fallow periods are applied to augment the productive capability of the soil, often leads up a blind-alley; the development in the central clay plains of the Sudan is a clear example. In the Working Party's view, the cover of savanna woodland of the clay plains was so rich that no need was felt for conservation of the forest resources. The central question was not, however, whether clearing one million feddans of woodland would deplete the country's forest resources, but rather whether the land use policies and practices it recommended would be sustainable in the long-term. This seemed to be of no concern to the Ministry of Agriculture which set up the Working Party, and worse still the independent state governments, their policies on paper notwithstanding, have been faithfully following an agricultural development policy along the lines set forth by the colonial Working Party This approach has, over time, proved to be divestive of the natural environment. The consequence has been prodigious land use practices of the 'new class of tractor farmers' as envisioned by the Working Party in 1954. The expansion of mechanised rain-fed agriculture in the central clay plains of the Sudan was so dramatic that Simpson and Khalifa in 1976 wrote,

> [A] visitor to the Sudan cannot but be impressed by the great agricultural developments now taking place in the Central Rainlands. Land which was bush only a few decades ago, now has been transformed into great open spaces of arable cropping which at harvest time must resemble both in appearance and at the present rate of expansion, the scale of the prairies of North America. The achievement and the possible future potential grips the imagination and one admires the energy and managerial ability of the pioneers who moved their machines into the wilds and ploughed up the bush.[128]

For the authors, the transformation of the woodland into bare ground in a matter of a few decades was a record of achievement and hence worth admiration. What they seem to have overlooked is that at the heart of the problem of land degradation in the clay plains of the Sudan lies the destruction of vegetation without regard for conservation measures and long-term sustainability requirements. According to the standard definition, deforestation is 'a complete clearing of tree formations (closed or open) and their replacement by non-forest land uses'.[129] The major cause of forest resources depletion in the Central Rainlands of the Sudan is this 'impressive agricultural development' whose method of land use has been characterised as 'strip' or 'soil' mining (O'Brien 1983). The consequence of this prodigious land use practice has been massive vegetation destruction and soil degradation.

Before the introduction of mechanised cultivation, the clay plains had been covered with savannah woodland.[130] Tothill, then Director of Agriculture, described the Gedaref region in the 1940s as a 'vast and unpeopled [area of] Acacia tall grass forests as well as open grass plains'.[131] One of the most dramatic impacts of the expansion of the mechanised crop production in the area has been wholesale destruction of vegetation cover in an area covering over six million feddans (see data in endnote 107) Barbour described the vegetation cover in the Gedaref region in the 1940s as the following:

FIGURE 3. Plough drawn through cotton fields by a steel cable attached to a traction engine, 1937–1983. Reproduced by permission of Durham University Library.

> [T]o the south of the railway line and to the west of the ridge there is at first a belt of land partly or wholly cultivated, beyond which lies a region of forest that stretches for miles to the south. In the northern portion the forest consists of talh, kitr, hashab and safar Acacias with numerous heglig; these grow close enough together for their branches to touch...[132]

These areas are now bare-lands devoid of vegetation. The Working Party in the early 1950s thought that the clearing of one million acres of land was only a very small fraction of the woodland then available; now, 45 years later, not even a small fraction of the forest resources which were then available remain unaffected. By 1985 commercial cropping had caused the clearing of about five million hectares of good savannah woodland.[133] Most of the area is now devoid of vegetation cover because mechanised farming has rendered the area treeless. Grasses and herbs have also been destroyed. Commercial farmers in pursuit of high profits disregard appropriate land use requirements prescribed by the MFC and the Forests National Corporation.

One of the most serious consequences of the horizontal expansion of mechanised rain-fed farming is the destruction of trees; this constitutes the major cause of deforestation. The standard practice of mechanised farming in the central clay plains is to remove all natural vegetation including the roots from the farmland. All the cultivable lands are scraped clear of tree matter with no windbreaks or shelterbelts left to protect the soil against solar radiation and wind erosion. This is exacerbated by spontaneous expansion of mechanised rain-fed crop production. The latter is not amenable to any control and the farmers do not comply with requirements designed to protect the environment or to minimise the risk of soil and vegetation degradation. This does not imply, however, that it is only the illegal mechanised farmers who disregard conservation requirements. The farmers in the demarcated areas equally ignore environmental protection requirements. The Forests Act, 1989 (Act No.14), for example, states,

> [O]n allocating land to any project for any purpose, the Corporation shall be notified in adequate time for obtaining its approval as regards the existence or absence of forests, the number of trees and possibility of disposal of such trees and the effect of removal of the same on the environment.
>
> Subject to the provisions of subsection (1) the owner or tenant of the land shall convert the trees of such forests, when cut, to forest produce, and shall also inform the Corporation of the felling operations so as to revise the percentages provided for in subsection (3) (a) and (b). Subject to the provisions of subsection (2) the following percentages shall be left in the case of agricultural investment, as green belts for the purposes of protection and production:
>
> (a) a percentage not less than 10% of the total area of a rain-fed project:
>
> (b) a percentage not less than 5% of the total area of an irrigated project.

The underlying assumption of this legislation is that there is a land allocating authority, which should inform the FNC whenever new land allocations are made. There is indeed, an authority, which is supposed to allocate land to investors. However, as we saw earlier, over 50 percent of all the recorded mechanised rain-fed farming in the south western region of Gedaref is opened up without the authorisation of the MFC and consequently without its knowledge and approval. The problem of illegal seizure of land is by no means limited to the Gedaref region. It is a universal problem throughout the central clay plains of the country, which are known as the 'granary of the Sudan'.

The MFC can only notify the FNC regarding land it allocates in the demarcated areas. The farmers in the undemarcated areas are, for example, not bound by the requirements stipulated in Section 20 of the Forests Act, 1989. The officers of the MFC argue that it is not their responsibility to enforce or monitor farmers' compliance with existing environmental requirements. They do not even refuse to issue certificates of allocation to farmers who have opened up schemes in the undemarcated zones without authorisation. The MFC is not concerned with issues relating to environmental protection.[134] If spontaneous expansion of mechanised farming were to be brought under control, if farmers took heed of the MFC's recommendation of short fallow, and if the requirements of wind breaks or shelter belts were strictly enforced, the severity of resource depletion resulting from over-cultivation, deforestation and wind erosion would have been partially averted. The fact that the staff of the MFC have argued that it is not their responsibility to monitor whether or not environmental requirements or recommendations on fallow periods are complied with may indicate that its [the MFC's] recommendations of short fallow are primarily designed to promote increased crop production rather than environmental protection. Since the means to the two ends are the same, one would expect that tightly knit systems of co-operation would exist between the MFC and the FNC. In reality there does not seem to be adequate liaison between the activities of the two corporations.[135] As stated earlier, the MFC should inform the FNC of land allocations it makes; however, not only do commercial farmers open up farms without being allocated the land by any government authority, but even land allocated by the MFC to commercial farmers has either not been notified to the FNC, or the latter has failed to enforce the environmental requirements stipulated in the Forests Act, 1989. Farmers are by law required to leave at least 10 percent of the cultivated area uncleared of vegetation to serve as a shelterbelt,[136] but all the schemes throughout the district are devoid of any vegetative cover.

The available evidence clearly shows that commercial farmers in the area completely disregard the requirements stated by the Forests Act. For example, farmers cultivate their farms without leaving 'green belts' as required by the Forests Act. This is universally true in both demarcated and undemarcated areas. Worse still, farmers who deliberately violate the clearly stated environmental requirements suffer no consequences. All the mechanised rain-fed farms in

Mufaza, Qala en Nahal, Hawata, etc. are in undemarcated areas (Table 3). The land was opened with complete disregard for any forms of legal requirement. The reasons why trees were removed from the meshruas were mainly to facilitate tractor use for cultivation. Farmers also believed that trees compete with crops for space and moisture; cause shade to be cast on cropped ground; harbour destructive birds; and function as sanctuary to destructive insects.[137] These developments showed that mechanised rain-fed farming was expanding without any control from the technical agencies such as the MFC, the FNC or the Land Use Department.

Depletion of soil nutrients

Before the introduction of tractors in the 1940s and 1950s, land was usually cultivated by *seluka* (plough stick) and *harig*. Clearing land using these traditional cultivation technologies did not necessitate the removal of obstructions such as big trees or roots of trees. Arable land around trees was cultivated leaving the trees intact. Only the undergrowth vegetation was slashed for cultivation. Tractor cultivation requires clearing and stumping to remove every kind of obstruction that may decrease efficiency or cause breakage. This either eliminates or dramatically reduces the rate of regeneration of the destampted plants. Thus, the introduction of a new technology was an important factor in the process of environmental degradation in the central clay plains, not only by causing vegetation destruction but also by enabling the commercial farmers to bring huge tracts of land under cultivation. In the past, given the accumulated fertility of the soil over centuries, the primitive nature of the cultivation technology and the subsistence nature of the economy, only small tracts of land were cultivated for a few consecutive seasons and were subsequently left to rest. This was changed by the introduction of tractors and by commercialisation of agriculture. This does not imply, however, that modern technology and commercialisation of economic activities are synonymous with resource depletion. Both technological changes and commercialisation are compatible with the principles of environmental conservation provided they are preceded by a careful assessment of environmental impact and there is comprehensive land use planning. The existence of environmental impact assessment and comprehensive land use planning on paper is of little importance. What is important is whether or not the government concerned has the political will, finance and infrasturctural and institutional capability to enforce them. A transparent and accountable administrative structure is also critically important. An important precondition for the implementation of sound land use planning is a clear definition of property rights regimes (communal, private or state) and protection and enforcement of such rights at all levels. Without clearly defined and secure tenurial rights and effective and efficient mechanisms of enforcement of such rights, over use of the available resources is inevitable. All these were lacking in Sudan. Ibrahim, for

example, argues, '[W]here there is ambiguity over user rights, pastures are often recklessly exploited to the degree of complete destruction, i.e, a process of strip-mining'.[138]

In the central clay plains there is evidence to show clearly that mechanised crop production on the one hand, has led to over-cultivation and on the other, has had a detrimental impact on soils. Indicators of soil degradation are change in soil structure, texture and fertility. In this area, Hassan and Osman found that mechanisation had a detrimental impact on the physical properties of the soil. They found that the loosening, pulverisation and the pressure applied to the soil by various machines caused change in the size and number of air voids.[139] El Khalil also found a direct positive correlation between discing frequency and development of compaction.[140] Continued discing may lead to the formation of hardpan[141] and it is argued that this crust formation may be is perhaps one of the causes of run-off and crop failures in the district.[142]

Mechanical analysis of soil samples in the region has shown that a positive correlation exists between change in soil texture (measured by reduction in clay content or increase in sand particles and reduction in saturation percentage) and increased time of cropping.[143] The degree of change of texture was, for example, higher in the older schemes of Ghadambaliya[144] suggesting that deterioration of soil texture is associated with the age of farm plots.[145] These are clear indicators of soil degradation due to continuous cropping (over-cultivation) without fallowing or fertiliser application. There are also studies to show that change in soil structure in the region is an increasing function of frequency of cropping.[146] With increased years of cropping, permeability and the water-holding capacity of the soil were reduced indicating degradation. Reduced nitrogen and phosphorus contents were also observed with the increased years of cropping. Change in pH was also found to be an increasing function of increased years of cropping. In the older schemes, a higher pH value was observed indicating soil nutrient depletion resulting in yield decline per unit of land.[147] Shallow disc ploughing has also led to the concretion of the subsoil, while lack of tree roots and the increasing compactness of the clayey soils have enhanced run-off velocity and hindered water seepage and moistening of the soil.[148] A soil study of the Gedaref region also shows development of crust on the soil surface due to continual ploughing at a fixed depth of 5mm. The study concluded that the crust caused run-off and resulted in crop failure.[149] Results of experiments in another study in the area (Qala en Nahal) also showed similar results.[150]

Inappropriate land use practices

After independence, consecutive post-colonial governments encouraged directly or indirectly the rich merchants in the country to participate in the development of mechanised rain-fed agriculture. The low rent paid for land by

commercial farmers, combined with the low fixed capital investment required to open up new sites for cultivation encouraged wasteful land use practices by commercial farmers. Commercial farmers cultivated their holdings continuously until the risk for fertility loss resulting from soil nutrients exhaustion was felt. After how many years of continuous cropping without the use of productivity-boosting intervention does soil become exhausted in the central clay plains of the Sudan? There cannot be a universally valid answer to this because agricultural productivity is not solely a function of rich soil nutrients. There are other factors which have a bearing on productivity. There is, however, a general agreement among researchers that in the central clay plains, continuous cropping without fallowing or fertiliser application is one of the causes of soil nutrient depletion. The exact threshold beyond which an old scheme is no longer worth cultivating is not clear. Bryant, for example, states that yields decline sharply after an initial high.[151] In their survey of large mechanised farms, Simpson and Khalifa found that crop yields tended to fall below economic levels in about nine to ten years after initial cultivation.[152] Other available evidence suggests that the soils in the Gedaref region can be exploited for about four years continuously, after which time yields decline and noxious weeds become dominant.[153] There are others who argue that often after five or six years, productivity declines and farmers are forced to give up cultivation of the plot.[154] The soil in the cleared land is exhausted after five years of continuous cropping.[155]

The commercial farmers in the area then start to farm a new site, either by obtaining a new lease from the MFC or by opening up a new farm in the undemarcated area illegally, and then repeat the process of clearing and consequent depletion of soil nutrients. The widespread neglect of old schemes after their soils have been 'strip-mined' to exhaustion is one of the major causes of resource depletion in the central clay plains. One aspect which needs to be examined, however, is whether the hitherto (at least until the 1980s) relatively 'abundant' supply of uncleared land, the low initial investment costs required to open up a farm and the lack of government control have been encouraging farmers to neglect their old farms when there was a slight decrease in yields but long before the complete exhaustion of the soil nutrients in the farms concerned was reached. This aspect seems to have been hitherto taken for granted, i.e., the fact that a farm has been neglected or abandoned by a commercial farmer in favour of a newly opened up farm may not necessarily mean that the soils are completely depleted or a natural process of replenishment will not take place. In a case study in the Qala en Nahal area, Kibreab's findings show that most of the small farmers cultivated their plots for over twenty years continuously due to land shortage, but there were a few farmers who still earned incomes from such plots even though yields were very low.[156]

The main difference may lie in the economics of the two activities. The Qala en Nahal scheme is based on subsistence economy while the mechanised rainfed schemes are operated for profit. The rationales underlying the two economies are different and so are the definitions of soil nutrient exhaustion. The threshold

for tolerable fertility decline is inseparably linked to the management objective of the activity. When yields drop below 0.1 ton per feddan, the land is seldom considered by commercial farmers as worth cultivating,[157] whilst the subsistence farmers in the said scheme continued cultivating their plots until the marginal productivity of labour was near zero or when yields were reduced to minuscule levels. No commercial farmer intending to stay in business could afford to do this. In the private sector, individual profitability was the governing principle and left on his own, the individual commercial farmer, more often than not, used the government land resource carelessly. This carelessness was reflected in the uncontrolled horizontal expansion of new schemes to the total neglect of investments in productivity-augmenting inputs such as fertilisers or leguminous fodder plants, which could have helped to counter, soil nutrient depletion. In fact there is an important aspect which has so far not been considered in the available literature. One of the factors that encouraged commercial farmers to neglect or abandon their old schemes in favour of opening up new ones was the drive to cut costs of production in the form of savings on wages that would have otherwise been paid to labourers hired for weeding the old schemes. Labour inputs for weeding per unit of land cultivated are far lower in newly opened up virgin farms than in old farms. In a case study in the Qala en Nahal refugee settlement scheme, weeds, especially the noxious ones such as Striga harmontheca, grew more vigorously in older farms than in farms located in virgin soils; consequently the costs of weeding in the old farms were relatively prohibitive.[158] Bebawi, El-Hag and Khogali's study in the region also shows the same results.[159] This may suggest that with higher labour inputs, some of the abandoned farms may still be worth cultivating. The commercial farmers and not the government seem to be in control and as long as this situation continues, the former will remain reluctant to increase voluntarily their costs of production and hence new farms will be preferable to older ones. This attitude of 'use and dispose' is calamitous and if it is not stopped, not only will there soon be no land available for mechanised rain-fed farming, but the living conditions of the pastoralists and the small cultivators will also be much worse than at the present.

The horizontal expansion of mechanised rain-fed crop production with its far-reaching destructive environmental impact has been taking place not only with the approval of the various national governments, but with active encouragement and provision of incentives [to the environmental offenders] in the form of financial and infrastructural support from government and international credit institutions, including the World Bank, Arab Fund and the ABS. For example, between 1969 and 1972, a total area of 180,000 fd. and another 57,000 fd. (extension) were developed in the Samsam area in Gedaref region utilising US$5,000,000 World Bank loan. Between 1973 and 1981 about 270,000 fd. in Um Seinat and another 150,000 fd. in Habila, Gedaref region, were developed using US$10,250,000 World Bank funds. Between 1981 and 1984 another US$16,000,000 of World Bank funds were invested in different areas designed to overcome the constraints faced by the mechanised rain-fed schemes in the

central clay plains of the country. Between 1969 and 1984 the World Bank provided a total of US$31,250,000 plus £S10,000,000 to promote horizontal expansion of mechanised rain-fed agriculture.[160] The Bank did not attach any environmental impact assessment requirement to its funds nor did any of the other funders.

The commercial 'farmer' has been required to raise just one-quarter of the capital needed for the purchase of tractors, wide level disc harrows and to meet the costs of land clearing. The balance of the investment cost has been secured through loans from the World Bank, Arab Fund or the ABS at subsidised interest rates.[161] The environmentalists who complain that the government and the financial institutions such as the World Bank, the Arab Fund and the ABS have been indirectly subsidising the costs of destruction of the natural environment by commercial farmers may not be far from the truth. This does not in any way suggest that no such loans or donations should have been made available to the government or to the commercial farmers. For a poor country such as the Sudan where there is a dearth of capital, such loans or donations are important. However, whether such loans contribute to long-term development or impede prospects for development is dependent not only on transparent, efficient and accountable governance, but also on the specific conditions attached to the allocation of such loans. For example, if the loans were allocated as a means of rewarding those farmers who complied with environmental protection and good husbandry requirements and by the same token to penalise recalcitrant farmers by withdrawing or withholding of loans and other incentives such as fuel, rations to workers, etc., the present problem of massive destruction of vegetation resources and depletion of soil nutrients would have been avoided and the financial institutions such as the World Bank would have spared themselves from being accomplices to those who cause environmental damage.

It is common knowledge that recommendations regarding windbreaks and crop rotation largely go unheeded. Thus, monocropping is another cause of fertility decline in the district. In order to avoid soil nutrient depletion due to continuous cropping without fallow periods, investors were allocated two schemes, 1,000 fd. each. A three course rotation, i.e, cropping for three successive seasons of one scheme, moving to the other scheme and leaving the first as fallow for three seasons, and then returning to the first after cultivating the second for three seasons, was originally planned by the government.[162] However, the commercial farmers did not follow this cultural practice. The two farms were often located in different places and compliance with the three course rotation would have meant incurring costs for moving the agricultural machinery from one site to the other. Instead, the farmers continued growing sorghum in one scheme until yields declined. When productivity declined due to depletion of soil nutrients or weed infestation, the farmers abandoned their old schemes and applied for new allocations or opened up illegal farms in the 'unplanned' or undemarcated areas.

After 1968 farmers were given two farms of 1,000 fd. each in adjacent areas, designed to cut the costs associated with removal of agricultural machinery. However, most of them continued cultivating both farms simultaneously without practising any fallowing. The farmers who were allocated farm units of 1,000 fd. were urged to leave 250 fd. fallow and to grow sorghum, sesame and cotton in the remaining 750 fd. Farmers continued to ignore fallowing requirements even though the 1,000 fd. schemes were later increased to 1,500 fd to encourage farmers to practise rotation.[163] Instead, they cultivated their schemes continuously until fertility declined below economic levels, when they either opened up a new site in the undemarcated area or obtained a new lease elsewhere. The consequence of this ravenous land use practice has been degradation in terms of soil erosion, loss of fertility and deforestation of large areas.

Even at present the MFC recommends farmers to follow certain cultural practices, including crop rotation; however, these recommendations are rarely heeded. For example, in southern Gedaref where the rainfall and type of soil support a sesame crop, there are only a few farmers who alternate sorghum with sesame. For example, in the 1969/70 season, about 26 percent of the total area was planted with sesame (Tables 1 and 2). The share of sesame, however, dropped dramatically in 1981/82 to less than 7 percent. One main reason why farmers were reluctant to grow sesame was because the crop is highly dehiscent or shattering if not harvested at the optimal time. Uneven maturing of the crop further exacerbates the difficulty. For example, when the crop on the main stem is mature, the branches may not be ripe. Waiting for the branches to mature causes loss of crop through shattering. Early harvesting may also cause loss. Research on improved seed varieties with minimum dehiscence and even maturing may provide scheme owners with an incentive to adopt rotational cropping by increasing the share of sesame crop on their meshruas. While it is an established fact that sorghum monocropping is one of the factors that causes soil exhaustion, the commercial farmers in the clay plains succeeded in maintaining a stable yield levels (save the seasonal fluctuations, among other things, caused by changes in the amounts and distributions of rainfall), mainly by abandoning their farms before yields began to decline in favour of newly opened virgin lands.

Though the 5-year average yields in tables 1 and 2 show a pattern of decline over time, especially for sorghum, the effect of continuous cultivation, without fallow periods or fertilisation, on fertility is more clear among small farmers in the area in which the possibility to shift to a new farm site in response to productivity decline is either limited or absent. This was tested in the refugee settlement schemes in the area where the opportunity to counter fertility decline by bringing new cultivable land under cultivation was prohibited by law. The refugee farmers were forced to crop their small plots continuously without fallow periods or fertiliser inputs. The consequence has been a sharp decline in soil fertility resulting from depletion of soil nutrients and heavy infestation by

noxious weeds such as *Striga hermontheca* (Buda) and *Sorghum sudanensis* (false sorgum or Adar).[164] In the large-scale commercial farms, this scenario was avoided by the availability of virgin land for cultivation. Land shortage will inevitably lead to the unfolding of a similar scenario as in the refugee settlement schemes in the near future. In the 1980s, shortage of cultivable land had forced many of the commercial farmers to stay longer on the same farms than they did in the past. The consequence has been soil exhaustion reflected in depletion of soil nutrients and increased weed infestation.

Careless use of large tracts of land resulted in wasteful use of a scarce resource. Vast areas of former schemes were abandoned 'which are useless even to more sustainable forms of agriculture'.[165] Given the existing knowledge, it is unsafe to conclude that all the old farms abandoned by commercial farmers in the central clay plains of the Sudan are irreversibly degraded. This is because firstly, whether an environmental change is permanent or temporary is difficult to determine a priori. This can only be determined in a longitudinal study, which is lacking at the present. Secondly, at present there is no clear knowledge about the kind of natural processes of regeneration that take place once the pressure on the resource concerned is removed in response to fertility decline. The outcome cannot also be isolated from the nature of the environment in question. Some environments are more resilient than others are, i.e. their capacity of recovery can remarkably be very high. Others could be quite sensitive; i.e. they could undergo changes as a result of slight exposure to pressure. This suggests that there is no universally valid criterion of resource use intensity, which could enable us to distinguish irreversible environmental changes from reversible ones. The question of reversibility or irreversibility notwithstanding, however, continuous monocropping in the central clay plains of Sudan has considerably contributed to the depletion of the resources resulting from inappropriate land use practices pursued by the commercial farmers in the rain-fed mechanised sub-sector. In light of the loose conditions under which land is leased by the MFC, the relative ease with which new schemes are acquired in the undemarcated areas and the lack of government control regarding cultural practices, the commercial farmers in the area tend to look at land not as a resource that needs careful conservation and maintenance but, whenever returns fall below a certain threshold of productivity, as an object that could be discarded at will. They make no investments to increase productivity per unit of land or to maintain soil fertility. Cultural practices such as the leaving of uncleared shelter belts, crop rotation including planting of leguminous crops, fertiliser or organic manure applications are unknown.[166]

Displacement of subsistence producers

Not only was the problem of land degradation in the central rainlands inextricably linked with the illegal expansion of mechanised rain-fed farming, but also most of the expansions into the undemarcated areas occur in sites which formerly

belonged to pastoral and small cultivator communities. As can be seen from the data in Table 3, the large tracts of land that were developed in the undemarcated areas in Hawata, Mufaza and Qala en Nahal previously belonged to pastoralists and small cultivators. It was only after the promulgation of the ULA, 1970, that these areas became open access readily available for exploitation by commercial farmers. Thus, one of the consequences of the expansion of large scale mechanised rain-fed farming in the central clay plain is the displacement of small cultivators and the pastoralists. The negative environmental impact of the expansion of mechanised rain-fed farming is not, therefore, limited to the areas directly affected by mechanisation. As lands previously belonging to traditional resource users were lost to mechanised rain-fed agriculture, people and animals were pushed out of their traditional, watering, grazing and cultivation areas. This coupled with rising animal and human numbers led to overstocking with the consequence of overgrazing and overcultivation in the limited remaining areas.[167] Expansion of mechanised rain-fed agriculture into former grazing areas has infringed on grazing areas, cut rangelands, disrupted nomadic routes, blocked access to watering points and pushed the small farmers and pastoralists to smaller and more marginal areas.[168]

Pastoralists and small farmers in such areas resorted to exploitative land use practices in order to make ends meet within the context of growing poverty and a shrinking land base. This was exacerbated by loss of control and access to arable lands, rangelands, water resources, routes to such resources, woodlands, etc. on which their survival depended. Commercial farmers supported by the government and by international funding agencies have been causing environmental damage in pursuit of profits while the pastoralists and subsistence farmers have been causing considerable land degradation in order to secure the basic means of survival in the context of diminishing environmental resources. It is worthwhile to point out, however, that the root cause of resource depletion in terms of soil and vegetation degradation was state ownership which led to uncontrolled horizontal expansion of mechanised rain-fed farming greatly contributing to the breakdown of the long-established traditional resource management systems among traditional resource users. The breakdown of such systems, as we saw before, was detrimental to sustainable land use practices in a degradation-prone ecosystem.

This process of dislocation was considered inevitable even by the Working Party in the beginning of the 1950s, but in their view it was a price that had to be paid to achieve agricultural development on the scale envisioned by the committee. It was argued, 'this [the displacement of pastoralists and small cultivators] must be accepted and indeed welcomed, but every effort must be made to protect those who are not directly affected and who prefer their old way of life'.[169] The Working Party was only concerned with the rights of those who were not to be affected by expansion of mechanised rain-fed agriculture. Those customary property rights, which conflicted with the 'right' of the government to allocate any land for the purpose of developing the mechanised rain-fed agriculture

schemes, were not to be recognised. No right that impeded rapid expansion of mechanised rain-fed agriculture was enforceable. It was stated, '...we believe that all land required for development of mechanised farming should be expropriated to the state'.[170] In order to facilitate development of mechanised farming, the Working Party called for the extinguishing of all other rights as provided by law and custom.[171] This was precisely what the ULA, 1970, was designed to accomplish, i.e. elimination of all communal customary property rights. The consequence has been far-reaching in terms of displacement of the pastoral and cultivator communities from their ancestral lands. Many of the displaced traditional farmers were reduced to seasonal agricultural wage labourers in the mechanised rain-fed and irrigation schemes. The clearance of large tracts of land has also deprived many of the subsistence producers of important supplementary incomes earned from the previously communally owned CPRs. This in many cases has worsened the living conditions of many rural families who previously fell back on the products of CPRs before the latter became converted into open-access common resources and became depleted as a result.

For example, the expansion of commercial mechanised crop production was one of the major causes of the acute land shortage faced by the small farmers on and around the Qala en Nahal refugee settlement scheme. The refugees in the Qala en Nahal settlement like the Sudanese small farmers and pastoralists in the Gedaref region were faced with the problem of managing resources, which were under heavy external and internal pressures.[172] Even though there were certain differences between the nature of the problems faced by the refugee farmers and the Sudanese small farmers, generally it was the expansion of commercial interests that was breeding marginalisation and poverty among the traditional resource users. Marginalisation and poverty have become the cause and effect of environmental degradation in the areas that are utilised by pastoral groups and traditional cultivators. As argued by Ibrahim,

> The unfettered expansion in large scale agriculture, particularly in rain-fed mechanised farming, in south Kassala [Gedaref region] has had far-reaching impact on pastoral nomads. It reduced grazing areas, disrupted nomadic routes and blocked access to watering points originally intended to serve pastoralists. It not only forced concentration of pastoral herds, but also brought pastoralists into a confrontation with farmers because of trespassing... [173]

Ecological imbalance

The environmental effects of mechanised farming are succinctly summarised by Nayal's findings in which the loss of wild predators, such as wild cats and snakes, has led to an increase in the number of rats and birds. The disappearance of insect-eating birds has also led to the destruction of crops by pests.[174] Simpson and Khalifa's study also shows similar findings in which the rapid horizontal

expansion of mechanised rain-fed agriculture has upset the balance of nature and as a result 'pests, diseases and noxious weeds have been quick to exploit the new opportunities afforded for their multiplication'.[175] Uncontrolled expansion of mechanised rain-fed farming in the central rainlands has, over time, become a kind of cancerous growth which has contributed to the breakdown of soil resilience, erosion, deforestation, displacement of peasants and pastoralists and the weakening or elimination of the traditional resource management systems which were instrumental in the sustainable use of the scarce resources thereby causing ecological disequilibrium.

NOTES

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[1] Godwin and Shepard 1979: 265.
[2] In Ostrom 1988.
[3] Lloyd 1977: 11.
[4] Hardin 1968; 1978.
[5] Hardin 1968: 1244.
[6] See Demsetz 1967; 1964; Cheung 1970; North and Thomas 1977; Johnson 1972; Bottomley 1963; Picardi and Seifert 1976.
[7] Repetto and Holmes 1984: 615.
[8] Ciriacy-Wantrup 1971: 43.
[9] Ibid.
[10] Runge 1983; 1984; 1986; Bromley 1985; Ostrom 1990; Sudgen 1984; Brubaker 1975; Cox 1985; Goodwin and Shepard 1979; Circiacy-Wantrup and Bishop 1975; Bromley and Chapagain 1984; Berkes 1985; Berkes and Farvar 1989; Kibreab 1996; forthcoming.
[11] Hardin 1978, 314.
[12] Ophuls 1973, 228–9.
[13] Abu Sin 1992; Mohamed and Abu Sin 1992; El Moula 1985; O'Brien 1985; Ghai 1992; Kibreab 1996; Lane 1990; Repetto and Gullis 1988; Shepherd 1989; Vivian 1991; Brokenshaw and Little 1987.
[14] Jodha 1986; 1985; Johri and Krishnakumar 1991; Karanth 1989; Jain 1988; Blaikie 1985; Blaikie and Brookfield 1987; Damodaran 1991; Bromley and Chapagain 1984.
[15] Damodaran 1991.
[16] Bromley and Chapagain 1984; Kibreab 1996.
[17] Ghai 1992: 11.
[18] Grainger 1990; Blaikie 1985; Blaikie and Brookfield 1987; Karanth 1989; Jodha 1986; Kibreab 1996; Abu Sin 1992; 1989.
[19] See Ghai 1992.
[20] For more elaborate discussion on the dar rights and the informal institutions that contributed to sustainable resource use before and during the Condominium period, see Kibreab forthcoming.

[21] See Kibreab forthcoming.
[22] Ahmad 1974; Asad 1970; Cunnison 1966; Harrison 1955.
[23] El Mahdi 1976: 80.
[24] Al Nur 1991.
[25] The most important reason why the Condominium government introduced indirect rule in the Sudan was to weaken the nascent nationalist movment in Sudan. The second reason was to minimise the cost of administration (Daly 1986: 360).
[26] See R. Davies, Report on Dar Kababish, 9 July 1915, SAD 6 27/1/1-21; G.W. Bell, The Tribal Courts of the Sudan, Palestine and Transjordan, 1943, ASD 700/4/12-13.
[27] Harrison 1955: Appendix 6, 13.
[28] Circular from the Civil Secretary to Director of Agriculture and Forests, 12 April 1927, NRO, Civsec. 30/2/6.
[29] Ibid.
[30] Ibid., emphasis added.
[31] Ahmad 1974; Harrison 1955.
[32] Niblock 1987, 45.
[33] Ibid.
[34] Ministry of Agriculture [MoA] 1954.
[35] Laing 1953; Agabawi 1968; 1969; O'Brien 1983; Simpson 1978. Kassala Province Annual Report 1943, NRO, Kassala 2/12/44; Report of the Governor-General on the Administration, Finances and Conditions of the Sudan in 1945, 1947-48 Cmd. 7316 xvi 277, p. 58.
[36] Report of the Governor-General on the Administration, Finances and Conditions of the Sudan in 1945, op.cit, p. 58.
[37] Laing 1953.
[38] Report of the Governor-General on the Administration, Finances and Conditions of the Sudan in 1945, op.cit, p. 58.
[39] The term 'idlers' was what the government used to refer to the unemployed urban poor. Though they might have not been formally employed, there must have been some earning their living otherwise they would not have survived.
[40] Davies 1964.
[41] Report of the Governor-General on the Administration, Finances and Conditions fo the Sudan in 1939-41 London, H.M. Stationary, Cmd. 8097, p. 10.
[42] Report of the Governor-General on the Administration, Finances and Conditions of the Sudan for the years 1942 to 1944, London, H.M. Stationery Office, Cmd. 8098, p. 10.
[43] Kassala Province Annual Report 1945, NRO, Kassala 2/12/46
[44] Report by the Governor-General on the Administration, Finances and Conditions of the Sudan in 1945, op.cit, p. 70.
[45] In the 1945 Annual Report of Kassala Province, the total amount of land cultivated in that season was given as 21,000 fd.. See Kassala province Annual Report, 1945, NRO, Kassala 2/12/46. The Governor of Kasssala Province stated, 'By almost super-human efforts, and in spite of the non-arrival of machinery up to time, of pests of every kind, of the failure of mowing drills to arrive until late September and the difficulties always attendant upon a new experiment, the Senior Agriculturalist and his assistants managed to put some 21,000 fd. under crop.' (Ibid.)
[46] Laing 1953.
[47] Report by the Governor-General on the Administration, Finances and Conditions of the Sudan in 1945, op.cit, p. 70.

[48] Laing 1953.
[49] On 28 June 1953, the Director of Agriculture formed a Working Party to examine the reasons for the failure of the two experiments and to pave the way for future development of mechanised rain-fed agricultural production in the Gedaref district.
[50] MoA 1954: 1.
[51] Laing 1953.
[52] Simpson 1978: 8; Affan 1984: 18.
[53] Kassala Province Annual Report 1948, NRO, Kassala 2/12/44.
[54] Laing 1954: 40–41.
[55] The low yield was among other things due to low rainfall during that particular season.
[56] Laing 1953: 8–9.
[57] Kassala Annual Report 1950/51, NRO, Kassala 2/12/44.
[58] Davies 1964: 103.
[59] Kassal province Annual Report 1950/51, NRO, Kassala 2/12/44.
[60] Kassala Annual Report 1950/51, NRO, Kassala 2/12/44; Report by the Governor-General on the Adminstration, Finance and Conditions of the Sudan for the year 1950-51, London, H.M. Stationary Office, Cmd. 9798.
[61] Laing 1953; Davies: 1964, 101. The unsuitability of the machinery especially during the early years can be indicated from Davies' remarks in which he states, 'In 1944 an odd collection of machinery, including converted bren gun carriers, was gathered together for field trials'.
[62] Laing 1953; Davies 1964: 102; O'Brien 1983; Simpson 1978.
[63] Simpson 1978.
[64] O'Brien 1983.
[65] MoA 1954.
[66] McCall in MoA 1954.
[67] Affan 1984: 20.
[68] MoA 1954: 16.
[69] Laing claims that the peak labour demand in the mechanised crop production schemes coincides with the peak labour demand in the irrigation schemes.
[70] MoA 1954: 11
[71] Ministry of Agriculture (MoA), Working Party Report on the Mechanical Crop Production, 1954 (emphasis added).
[72] MoA 1954: 11.
[73] The members included: the Chariman of the Province authority, or his deputy, as Chairman, the Inspector of Agriculture, as secretary and Executive Agent, the Director of Agriculture or his representative, as well as two representatives elected by the council concerned and two members from the armed forces.
[74] Agabawi 1968: 76. *Hariq* cultivation is a kind of shifting agriculture which is said to be unique to the Sudan, in which fire is set on old dry grasses in order to burn the young green grass which is the potential weed of the season. Sorghum is then sown and no further weeding is needed.
[75] Agabawi 1968, 76.
[76] ILO 1984: 27.
[77] MFC 1979.
[78] Ibid.
[79] Bryant 1977.
[80] Affan 1984: 25.

[81] Affan 1984: 99.
[82] Ibid.
[83] ILO 1984: 27.
[84] Osman Ibrahim, Director of the Mechanised Farming Corporation, Gedaref, Personal Interview, December 4, 1991.
[85] Ibid.
[86] Affan 1984: 27.
[87] Simpson 1978: 99.
[88] Undemarcated areas refer to the areas which are not surveyed and mapped for development by the Mechanised Farming Corporation.
[89] See Tables 1 and 2, and note 107.
[90] Ministry of National Planning 1979.
[91] Personal interview with the Director General in the Ministry of Africulture (Khartoum, 1991); Personal interview with Director of Mechanised Farming Corporation (Gedaref, 1991).
[92] See the Land Settlement and Registration Act, 1925, which was passed by the Condominium Government to provide for the settlement of rights to land and for the registration of title to land.
[93] See for example, *Sudanow* 1977.
[94] Abu Sin 1992.
[95] The Land Settlement and Registration Act, 1925, Article 16(c).
[96] Section 3 of the Unregistered Land Act, 1970.
[97] See, for example, Dickerman 1987, 227.
[98] A right accessible to an owner of land over the adjoining land of another.
[99] Section 5 of the Unregistered Land Act, 1970.
[100] Section 8 of the Unregistered Land Act, 1970.
[101] Abu Sin 1989; Kibreab 1996.
[102] Abu Sin 1989.
[103] Durning 1989: 42.
[104] Blaikie 1989.
[105] Report of the Land Tenure Task Force 1986.
[106] Bryant 1977.
[107] Expansion of mechanised rain-fed schemes in the Sudan 1982/83 by region

Region	Sorghum	Sesame	Cotton	Total
Gedaref	3,009,380	221,620	10,420	3,241,420
Dammazin	1,274,500	221,725	23,425	1,519,650
Dilling	900,000	34,655	0	934,655
Renk	349,135	16,810	0	365,949
Kosti	28,120	0	0	28,120
Total	5,814,175	494,816	33,845	6,089,794

Source: Mechanised Farming Corporation, Agricultural Statistics Bulletin No. 3, Khartoum, 1984.
[108] MFC 1984.
[109] Report of the Land Tenure Task Force 1986.
[110] Hago 1989: 141.
[111] Simpson and Khalifa 1976; Kibreab 1996.

[112] Kibreab 1996.
[113] See Note 88.
[114] Osman Ibrahim, Director of the M.F.C., Gedaref, Personal Interview, December 4, 1991
[115] Ibid.
[116] Ibid.
[117] Hago 1989: 153.
[118] Ibrahim 1989: 2.
[119] Report of the Land Tenure Task Force 1986.
[120] Ibid.
[121] Ibid.
[122] Dickerman 1987: 228.
[123] MoA 1954: 40.
[124] Ibid.
[125] MoA 1954: 42.
[126] During that time the cost effectiveness of these methods of land clearing was being studied at Tozi.
[127] MoA 1954: 42.
[128] Simpson and Khalifa 1976.
[129] Singh et al. 1990.
[130] MoA 1954: 42.
[131] In El Tayeb 1985.
[132] Barbour 1953.
[133] Ibrahim 1984: 218.
[134] Osman Ibrahim, Director of M.F.C., Gedared, December 4, 1991
[135] This was confirmed by data elicited in an interview with the staff of the Forest National Corporation in Khartoum, 1991, 1993 and 1994
[136] Forests Act, 1989, Article 20(3a)
[137] Personal interview with commercial farmers in Gedaref, Hawata, Mufaza and Qala en Nahal, 1983; 1985; 1989; 1991; 1994.
[138] Ibrahim 1984: 227.
[139] In El Moula 1985: 77.
[140] El Khalil 1981.
[141] El Moula 1985: 77.
[142] Bryant 1977; Sudanow 1978.
[143] El Moula 1985; Kibreab 1996.
[144] El Moula 1985.
[145] Kibreab 1996.
[146] El Moula 1985: 97; Kibreab 1996.
[147] Brady 1974.
[148] Ibrahim 1987: 221.
[149] Bryant 1977.
[150] Kibreab 1996.
[151] Bryant 1997.
[152] Simpson and Khalifa 1976.
[153] El Moula 1985: 92.
[154] Ibrahim 1984: 223; O'Brien 1985.
[155] Personal interview with farmers in the Umsagata, December 1991; November 1994.

[156] Kibreab 1996.
[157] Bryant 1977.
[158] Kibreab 1996.
[159] Bebawi, El-Hag and Khogali 1985.
[160] MFC 1984.
[161] Ibid.
[162] Hago 1989.
[163] Ibid.
[164] Kibreab 1996.
[165] Bron quoted in El Moula 1985: 77.
[166] El Moula 1985: 77.
[167] Suliman 1986; Hago 1989.
[168] Ibrahim 1989; Abu Sin 1992; Kibreab 1996.
[169] MoA 1954: 46.
[170] MoA 1954: 43.
[171] Ibid.
[172] Kibreab 1996.
[173] Ibrahim 1989: 3.
[174] El Nayal, referred to in Bryant 1977.
[175] Simpson and Khalifa 1976: 1.

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