Ethiopian Journal of Development Research, Vol. 12, No. 2, April 1990

SMALL-SCALE IRRIGATION AND FOOD PRODUCTION IN ETHIOPIA: A REVIEW

Helmut Kloos*

ABSTRACT. This paper examines the development and constraints of small-scale irrigation in Ethiopia, and its role in food production, particularly since the 1984/85 famine. Although irrigated agriculture in Ethiopia probably predates the Axum Empire, it is still unimportant in the highlands, and its potential role in food production may be greatest at lower elevations. The government-sponsored small-scale irrigation programme, although resulting in increased production in some producer cooperatives, has been plagued by civil war, the villagization and resettlement programmes, insecure land tenure, absence of adequate water use legislation and, above all, lack of peasant interest in the government-sponsored irrigated agriculture programme. A crop census by the Ministry of Agriculture in 1986/87 showed that the crops most commonly grown under irrigation in 1,020 peasant associations and producer cooperatives in four of the country's thirteen administrative regions were vegetables; the staples maize, potatoes and barley; fruits; the cash crops coffee and chat (Catha edulis); and sugar cane. Marked local and regional variations in cropping patterns were associated with market forces and prevailing agricultural systems. There is some evidence that food staples are now more widely irrigated than in the past and that the stimulant chat has been introduced as a cash crop into new areas. However, in order for significantly more Ethiopian peasants to use irrigation and to increase food production, it is imperative that recent changes in economic policy result in the development of economically, socially, technically and ecologically sound irrigation programmes, and greater confidence and initiative of peasants, who have become despondent under current governmental difficulties.

*Department of Geography, Addis Ababa University

I. INTRODUCTION

Irrigation development in relation to food production in Ethiopia is of interest in view of recurrent drought and famine conditions experienced by this country during the 1970s and 1980s and the high priority given by the Socialist Government to boosting food production and achieving food self-sufficiency. These objectives have been specified in the Ten-Year Perspective Plan (1984/85-1993/94) [70]. The major means of achieving these objectives include cooperative farming, large-scale agriculture on state farms, and government pricing and marketing structures. Nevertheless, production in the cooperative and state farms has decreased in recent years, and the initial gains in food production immediately after the 1974 revolution [57] were negated by subsequent economic decline. The annual growth rate of the agricultural sector, which provides employment for about 90 per cent of the working population, declined from 3.3 per cent in 1953-1959 to 0.3 per cent in 1974-1980 [76], and the per capita food production declined by 6 per cent between 1974 and 1985 [31]. Recurring famine, the civil war in northern Ethiopia, and economic policy have been identified as major factors in this downward trend [19], with rapid population growth and accelerated land degradation contributing to lower per capita production and consumption. Increased control of agricultural production and marketing through the Agricultural Marketing Corporation's quotas, fixed crop prices, and regulation of international trade and market places have been particularly strong disincentives for peasant production [19, 36]. Even when the country was relatively free of famine, as in 1977 and 1979, the daily per capita calorie supply was only about 1,700 calories, the lowest in Africa [30]. In 1980-1984, 10 per cent of the Ethiopian children were classified as severely malnourished, with an additional 60 per cent classified as mildly to moderately malnourished [40].

Dissatisfied with the poor performance of the economy, the Ethiopian Government in 1988 indicated the need for policy changes

[21], and in March 1990 proposed a series of new policy initiatives toward a mixed economy built on state, cooperative and private ownership. One of the major aims of the proposed policy is to assist and promote small-scale producers, and encourage and strengthen the private sector in general [25]. A government workshop held in October 1990 formulated draft policy plans for a national irrigation policy and strategy [70].

The objective of this paper is to examine the development of small-scale irrigation in Ethiopia with a view to better peasant food production. It proceeds by first highlighting some historical aspects of irrigation for the purpose of more fully evaluating prospects for further irrigation development under the present plans, and then examines the physical environment, developmental aspects and cropping patterns of the present government-sponsored small-scale irrigation programme, focusing on constraints besetting the still evolving programme. This study, the first one to consider historical and environmental aspects of peasant irrigated agriculture in Ethiopia, may contribute toward plans for socially, economically, technically and ecologically sound small-scale irrigation and sustained food production.

In addition to political and economic factors that were instrumental in the increasing food crisis in the mid-1980s, it was the below-normal rainfall after 1979, and the total absence of precipitation in 1984 in much of the Northern, Eastern and Central Regions of Ethiopia, that transformed the deteriorating situation into the 1984/85 famine [50, 93]. Using human morbidity and mortality as a yardstick, this was one of the most devastating famines worldwide during recent years [9]. There is considerable evidence that famines in Ethiopia have become more frequent, severe and widespread since the 1950s [63]. Degradation of the agricultural resource base, particularly through intensified land use of the ecologically fragile mountain slopes by the rapidly growing population, together with overgrazing, deforestation and soil erosion, has been partly

responsible for the increasing vulnerability of the rural population to famine. The Ethiopian Highland Reclamation Study [32], the most extensive land evaluation study ever carried out in the country, revealed that soil degradation is rendering increasing areas of the highlands more susceptible to the effects of irregular and low rainfall, and unable to sustain the peasants even in years of normal precipitation. It concluded that intensive agriculture, including irrigation, in addition to land rehabilitation and resettlement of peasants from the chronic famine areas, is essential to assure food security for the growing population.

The view that the Ethiopian peasant is suffering not from lack of rainfall but from lack of ability to use agricultural potential [38] aptly summarizes the role of the underdevelopment process in his quest for food security. Different estimates put the total irrigable area of ethiopia at 1.8-3.5 million hectares, but by 1989 only about 140,000 hectares were irrigated, with about equal proportions devoted to small-scale peasant and large-scale commercial irrigation [37]. Brown [14] earlier estimated that peasant food production could be tripled, and the environmental degradation process slowed, by intensifying agriculture, confining cultivation and animal husbandry to the valley bottoms, and leaving the slopes in forest. This ecological relationship and the need for strong support of peasant agriculture were not given emphasis by Haile Selassie's Government, which instead promoted large-scale irrigation development as part of an agricultural policy that emphasized commercial agriculture and export crops. Although commercial production is also a major goal of the present Government, there is increasing recognition that small-scale irrigated agriculture is more appropriate and cost-effective. Modelling of irrigation development in the Awash Valley, where most large state farms are located, led to the conclusion that no new schemes are justified, in view of the current unfavorable economic situation and the rapid development of waterlogging and salinization problems [2, 28]. Small-scale irrigation was favored over large commercial schemes by the Ethiopian Highlands

Reclamation Study [32], and the Government implemented a peasant irrigation programme in response to the 1984/85 famine.

II. HISTORY OF PEASANT IRRIGATION IN ETHIOPIA

Irrigation in Ethiopia probably predates the arrival of the Semitic-speaking immigrants from Yemen and possibly agriculturalists from Sudan. Both groups may have introduced seed/plough cultivation and irrigation to Northern Ethiopia in the area of the later Axum Empire between 1,000 B.C. and 100 B.C. [34, 79]. In the 15th and 16th centuries, the Portuguese missionaries Alvarez and Almeida reported the use of irrigation in various localities in the northern highlands, and among the Afar in the lower Awash valley [4,62]. More recent accounts by travellers of peasant terracing and irrigation works were summarized by Pankhurst [72]. Persisting use of relatively advanced irrigation systems by various Cushitic and Omotic-speaking populations (all of them preceding the Semitic-speaking immigrants in Ethiopia) in areas that were incorporated into the expanding Ethiopian Empire under Menelik II, including the Konso, Burji, Amarro, Ochollo, Dorze and a number of Oromo groups [43, 69, 79, 82, 94], argues for the development of irrigation in the pre-Axumite period. A longer history of irrigation in Ethiopia would suggest that it was mainly constraints emanating from local social, political and environmental conditions, rather than the possible loss of the knowledge of irrigation technology by the southward migrating descendants of the Axumites, as suggested by Simoons [79], that were responsible for the relatively slow and localized development of irrigated agriculture in Ethiopia. The view that plough cultivation was a prerequisite or concomitant of irrigation development is no longer accepted, because of the evidence of the traditional use of irrigation in West, Central and East Africa [7, 75].

During most of its history in Ethiopia, irrigation was on a small scale, rudimentary and mostly seasonal, in contrast with the modern commercial schemes which began to appear after the turn of the century and especially between the 1950s and 1970s. Simple diversion of streams by rock and earth dams was commonly practiced in many areas, and terracing with more elaborate water conveyance systems was widely used in the traditional areas of extensive plough culture in northern Ethiopia and in the areas of intensive hoe culture in the south and southwest [16, 94]. A FAO consultant [47] noted the close relationship between peasant irrigated agriculture and highly developed terraces in the highland region. Along the Red Sea coast and in the lower Awash valley, a simple form of basin flood irrigation still exists today, both among farmers and agropastoralists. Flood retreat irrigation for pastoralism and seasonal agriculture, similar to the wet land utilization system elsewhere in tropical Africa [75, 77], continues to be used by pastoralists in the lower Wabe Shebelle valley, the Afar in the middle Awash valley, the Anuak and Nuer on the Baro/Akobo/Gilo plain in western Ethiopia, and the Dassanech, Mursi and other pastoralist groups in the lower Omo valley [16, 54,90]. There is increasing evidence that irrigated agriculture has traditionally served as a safety net for various pastoralist groups in East Africa [7] and Ethiopia [54] during times of drought. This is a relatively neglected subject in Ethiopia, partly because of the exclusion of the lowlands from the small-scale irrigation development programme of the Ministry of Agriculture which is discussed below.

The traditional land tenure system in the Ethiopian highlands was a major deterrent to the development of peasant irrigated agriculture during the pre-revolution period, and of central importance in the low socio-economic level of the Ethiopian peasantry. The system of land tenure and inherited rights to property and community membership (*rist*), involving endless segmentation of farms and the control of income rights by the land owners (*gult*) absorbed much of the peasant output, while stultifying technological and general development [18, 62]. Numerous

technical reports by aid organizations and the Ministry of Agriculture confirm this situation, and also the related constraints on nutritional deficiencies, work patterns and outmigration [59].

Demographic and military factors have emerged as major deterrents to peasant irrigation farming in some parts of Ethiopia, particularly in Tigray and Eritrea. The high labour requirements of terrace cultivation, maintenance and repair, together with poor accessibility and insecurity in the northern war zone, as well as the low potential for mechanization and the emigration of rural labour from famine areas, are instrumental in agricultural disruption and terrace abandonment [87, 59]. This situation has also been reported from Yemen, where soil erosion increased on abandoned terraces, and both the agricultural area and production decreased [92]. Abandonment of irrigated terraces in the area of Ankober town after its decline in the 1890s as Emperor Menelik's capital indicates the roles of the Ethiopian court, outmigration, and changes in the ethnic composition of the local peasant population in irrigated agriculture [60]. Decline of peasant irrigated agriculture in other parts of Ethiopia, as in the Konso area in Gamo Gofa Region [47] remains to be studied in depth.

III. THE PHYSICAL ENVIRONMENT

Much of the Ethiopian highlands are well endowed with the basic resources of agricultural development - good soils, an amenable climate and considerable farming skills - but they suffer from erratic rainfall. Eighty-two per cent of the Ethiopian population live in the highlands above an altitude of 1,500 metres, where sedentary agriculture has always prevailed [55]. Annual rainfall totals in the highlands vary between 300 - 2,200 mm, declining from the western to the northern and eastern parts of the country, and are lowest in the famine-prone regions of Wello, Tigray, Eritrea and Hararghe. Three-quarters of the highland region has a mean length of growing season of over 180 days, and all but 2 per cent

has a length of growing season over 90 days. These relatively high values are partly due to the high clay content of the predominantly volcanic vertisol soils, which confers high water-holding capacity [51]. The potential for water storage and stream diversion for irrigation is high and the reasonably fertile and workable soils are suitable, but the lengthy dry season limits the number of perennial rivers and streams, and the mountainous topography precludes irrigation in many areas [45, 46]. It has been estimated that small-scale irrigation can increase agricultural production in Ethiopia by 5 per cent at most, although its potential contribution may be significantly greater in more arid lowland areas [32]. According to Hewett [46], crop yields may be increased between 5-40 per cent under irrigation for different cereals and pulses. The total irrigable area for small-scale irrigation in Ethiopia has been estimated at between 165,000 - 300,000 hectares [32, 46].

Ethiopian peasants use irrigation mainly to supplement rain-fed agriculture. They are faced with problems both of water surplus (during the rainy season) and water deficiency (during the dry season). Stream flow regimes in different parts of the country strongly reflect rainfall patterns. Whereas perennial streams and rivers with discharge sufficient for irrigation predominate in the high-rainfall one in the western, central and some eastern highlands, and along the escarpments of the Rift Valley (1,200 - 2,000 mm precipitation), the longest low flow periods are found in the water courses in Gondar, eastern Gojam, Wello, Tigray and Eritrea and the lowlands of Hararghe Administrative Regions, which also constitute the traditional famine areas. In the Rift Valley and other semi-arid lowland areas below 1,600 metres, more than 90 per cent of all run-off occurs during the main rainy season (June to September), leaving many water courses dry during much of the year [1]. Seasonal unavailability of stream water may prevent many farmers from irrigating their land. A survey of 14 peasant schemes in 5 administrative regions, for example, revealed that many farmers were interested in irrigating more land but were unable to do so because of water shortage [67].

At lower elevations, where the climatic constraints on crop production are most severe, the main concern of peasants is to produce a single crop with supplemental irrigation. In the cool highlands, by contrast, with their longer growing periods, a single main crop is usually assured, and there is scope for improving production by introducing double cropping [27, 46]. Traditionally, farmers have grown drought-resistant crops such as millet and sorghum in more arid areas to cope with the vagaries of the weather, thus minimizing the need for irrigation [11]. Similarly, the widely used soil bunds (and probably also stone terraces) for the purpose of soil and water conservation have been shown to give higher grain yields than slopes without these structures [85]. But these strategies cannot always avert crop failures, as in 1984, when the length of the growing period (based on soil moisture availability) was only 92 days in Wello Region, the area worst hit during that famine, rather than the average 241 days [20]. Tigray and Hararghe had rainfall deviations similar to those in Wello [45]. As part of progressive degradation in the highlands, numerous springs and streams have dried up in recent years [87], but the effect on irrigated peasant agriculture has not been studied. It is conceivable that more arid conditions will lead to increase in irrigated farming, as noted in much of East Africa during droughts [8].

IV. IRRIGATION DEVELOPMENT SINCE THE 1984/85 FAMINE

The 1984/85 famine provided a major stimulus for the development of a government-sponsored small-scale irrigation programme in areas effectively controlled by the Central Government, and especially in communities where producer cooperatives had been or were to be established. Peasant agriculture had hitherto been neglected by the Government, both before and after the revolution. The Ten-Year Plan, prepared during the famine, called for the development of 57,000 hectares for small-scale irrigation in private and cooperative farms by

1993/94 [70]. This expansion of small-scale irrigation is consistent with the trend in Africa, away from large commercial schemes. This has been caused by increasing concern over an impeding ecological crisis, decline in peasant food production, and the inability of large-scale irrigation farms to provide adequate and regular supplies of water to subsistence farmers [44, 58, 88].

The recently established Irrigation Development Department of the Ministry of Agriculture was charged with the development and implementation of the small-scale irrigation programme, and began to construct small earth dams, stream diversion weirs, ponds (for domestic use, irrigation and fish culture), shallow wells (mostly in Eritrea), and earth terraces. Small-scale irrigation was defined as farms of 200 hectare or less applying this method of production. Both ministerial and party offices nationwide had orders to encourage peasants to develop local water sources for food production, with government assistance. The criteria used for selecting localities for this programme specified that they receive between 300 - 1,200 mm of rainfall annually, are located in densely populated areas between 1,500 - 2,300 m and have slopes of 3 per cent or less [65]. Additional selection criteria were: The need for increasing local cropping intensity and thus carrying capacity; the extent of drought and food deficits within the 1,500 - 2,300 m altitudinal zone; farmers' willingness to consolidate their land for cooperative farming; availability of water and land resources; and the level and extent of traditional irrigated agriculture in the target zone [42]. The rationale for selecting the 1,500 - 2,300 m altitudinal zone was that the need for irrigation is less in the cooler, more humid areas above 2,300 m and in the predominantly pastoralist areas below 1,500 m.

The short-term objectives of the programme include increased production through double cropping and supplementary irrigation during the dry season, increase in domestic water supplies and peasant income, and rehabilitation or replacement of traditional irrigation schemes with

more modern systems. In the long term, Ethiopia's food problem i expected to be ameliorated, and rural development to facilitated throug hydro-electric development, small-scale industries, employmen generation and land rehabilitation [65]. Another objective, that o developing producer cooperatives, is unlikely to receive emphasis in the future, because of the recent changes in economic policy and the poor record of cooperatives, further discussed below. The programme is being implemented by regional and district (*awraja*) offices of the Ministry of Agriculture, mobile construction brigades, and labour provided by peasant associations and cooperatives. By 1985, a total of 213,000 farmers irrigated an estimated 53,000 - 62,000 hectare in peasant associations and 16,000 hectare in cooperative farms [95]. According to estimates by the Ministry of Agriculture, 30 per cent of the total peasant irrigated areas, including rehabilitated traditional systems, was developed by the Ministry after the 1984/85 famine [37].

More than two-thirds of the total irrigated area and nearly 90 per cent of the farmers using irrigation in 1986 were in Hararghe, Wello, Wellega and Shewa Regions. Twenty-three per cent of all farmers in Hararghe, 13 per cent in Wellega, 7 per cent in Illubabor, 5 per cent in Wello and 4 percent in Shewa used irrigation [32, Table 1). No data are available for Tigray and Eritrea, although it is known that 71 of the 114 earth dams constructed between 1981 and 1989 were in these two regions [68]. The low proportion of farmers irrigating in Wello, Sidamo and Gamo Gofa (3 per cent in each), all famine-prone areas, and the larger proportions in the humid regions of Wellega and Illubabor point to maldistribution. The high cost of earth dams (about US$ 500 per hectare) and their small net contribution to agricultural output (caused by their location in areas that were at least partially cropped earlier, and the high sedimentation rates due to excessive erosion in the denuded catchments) has put their usefulness into question. They are justified mostly in human and social terms, particularly in more arid, agriculturally marginal areas at lower elevations, where they may contribute significantly to

famine relief and rehabilitation efforts [32]. But in the long term, the importance of small-scale irrigation in the lowlands may be expected to increase, because of the accelerated down-slope movement of the Ethiopian population [55].

V. CROPPING PATTERNS

In 1986/87 the Ministry of Agriculture carried out a national survey of crops cultivated under small-scale irrigation. Reasonably comprehensive data could be obtained only for Hararghe, Shewa and Wello Regions, and the results on crop yields are unreliable and not included here. Nevertheless, some irrigation schemes are known to have resulted in dietary diversification, lower vegetable prices and increased food intake [74]. In the 1,020 peasant associations and producer cooperatives in Hararghe, Shewa, Wello and Gamo Gofa for which cropping data could be collected, vegetables were the most widely cultivated crops, followed by maize, potatoes, fruits and coffee (Table 2). Some crops were highly concentrated at the *awraja* or regional levels, reflecting the influence of culturally linked agricultural systems and associated food preference and use of stimulants. Coffee, *chat (Catha edulis)*, sweet potatoes and sorghum were cultivated mostly in Hararghe; the cereals wheat, barley and teff (*Eragrostis teff*), various pulses and *gesho (Rhamnus prinoides)* mostly in Shewa and Wello; and tobacco only in Yifatna Timuga *Awraja* in Shewa. Cultivation of thee stimulant *chat* in many peasant associations in Shewa, Wello and Gamo Gofa, which was not reported by Getahun and Krikorian [6] indicates its rapid spread in Ethiopia. Use of irrigation has been instrumental in extending the altitudinal range of *chat* from 1,900 - 2,100 m to 900 - 2,400 m [94]. *Chat* has become an attractive cash crop because of rising demand, and also it has a greater price stability than coffee has.

The relatively small number of localities irrigating *teff* in Shewa, where it is the predominant grain, and in Wello, where it is nearly as

important as barley and sorghum, appears to be largely caused by its short growing period. *Teff* is a short-cycle crop, which matures in 3-4 months during the big rains. Maize and sorghum, irrigated widely in all study areas, require 8-9 months for maturation. Normally planted during the unreliable small rains (February to March), maize and sorghum require supplementary irrigation.

Urban/rural differences in cropping patterns were associated with local diets and the role of domestic and foreign markets. Harar Zuria *Awraja*, with its large regional markets in Harar town, was the only area to cultivate lettuce, and was the largest producer of nearly all other vegetables, root crops, *chat*, sugar cane and fruits. The cultivation in and around Harar town of a wide variety of fruits and vegetables which are rarely grown in other parts of Ethiopia, and which includes *amboshek* (in Aderigna) *(Annona cherimoya), baharo (Allium porrum), fajula (Raphanus sativus), gesho (Annona reticulata), and kiyare (Cucumis sativus)* reflects the long Arab influence on Harar. *Chat*, also associated with the highlands around Harar, is widely consumed by the local Somali, Oromo and Harari populations, and is transported several times a week by aircraft to Djibouti and Yemen, and daily by car to Somalia. Coffee by contrast, is marketed by the Ethiopian Coffee Board rather than by peasant associations and producer cooperatives.

Although strictly comparable cropping data from the pre-revolution period are not available, the great variety of food crops found to be irrigated in Hararghe, and the predominance of vegetables, maize and potatoes (Table 2), indicate major changes since the 1950s, when coffee and fruits were apparently the major irrigated crops [13]. A greater emphasis on food staples in recent years may be due to greater population pressure and concomitant intensification of agriculture, although this point requires further study. These cropping patterns contrast with those in the commercial irrigation schemes, where maize

and vegetable production are declining and fruit production is increasing, because of the greater profitability of the latter [61].

Information on acreages devoted to different crops is limited to Hararghe Region. In general, individual peasant associations and producer cooperatives cultivated larger areas of *chat* (up to 26 hectares) than of sweet potatoes, sorghum, maize, potatoes and coffee (all between 0.5 - 25 hectares). Grain and root crop acreage were generally only slightly larger than those for fruits and vegetables, indicating the relatively large scale of the more commercial oriented vegetable enterprises. Management capability, peasant initiative, and the impact of the prevailing top-down approach used in small-scale irrigation development in Ethiopia (further discussed below) appear to be major factors in the size of irrigated areas, particularly in the government-sponsored schemes. In Siyanana Producer Cooperative near Robe in Bale Region, for example, 100 ha. were to be developed for irrigation with heavy government inputs, but the 40 cooperative members, all settlers from Wello Region, were unable to cultivate this large area because of lack of labour and working capital [89]. Meshna Seyama Producer Cooperative in Southern Shewa Region, by contrast, earned 208,000 Birr from the sale of vegetables grown by 170 members on only 17 ha. These local farmers gradually expanded the irrigated area from 20 ha in 1979 to 260 ha in 1989, mostly with their own inputs [24]. Surveys in 11 traditional and 3 government-sponsored irrigation schemes in central and eastern Ethiopia revealed great variations in organizational structures, agricultural and irrigation practices, and productivity levels. The study recommended (among others) that peasant associations themselves construct new schemes, that existing schemes be upgraded with the assistance of the Ministry of Agriculture, and that water users or irrigation societies be formed prior to the construction of new schemes [67].

VI. CONSTRAINTS IN IRRIGATION DEVELOPMENT

Implementation of the small-scale irrigation programme has been uneven, and beset by numerous difficulties in all administrative regions. Almost all the irrigation farms developed by the Ministry of Agriculture after 1984 failed to reach organizational and production targets, largely because of the disenchantment of farmers with cooperative farming, and also insecurity of tenure [42]. Continuing land fragmentation and reduction in farm size since the 1975 land reform have been major factors in the reappearance of insecure land tenure [33, 41]. Rapid population growth, the resettlement and national villagization programmes, and the formation of producer cooperatives were instrumental in land distribution patterns. Individual farmers received, on average, 0.1 - 0.5 ha. of irrigable land; but in many peasant associations, few of the members had access to irrigation [42, 67]. Producer cooperatives, which represented only 3 per cent of all peasants in Ethiopia in 1986 [3], were favored over private farmers by the service cooperatives in regard to the allocation of land, fertilizer, improved seeds and credit. Only farmers organized in producer cooperatives and service cooperatives with legal status could obtain credit from the Agricultural and Industrial Development Bank, a major donor of small-scale irrigation development in Ethiopia [42].

In spite of the Government's drive towards cooperative farming since 1979, production of producer cooperatives declined; they have an unfavorable public image, and most peasants have tried to avoid becoming members. Practically all producer cooperatives disintegrated in 1990, after the Government's initiative for a new economic policy. Although membership was voluntary, producer cooperatives used irrigation, fertilizer, seeds, mechanization and training opportunities to entice peasants to join, only to increase their resistance, and thus also poor agricultural performance [73]. This and other forms of pressure, at

the local level reflect a curious lack of understanding of peasant mentality on the part of administrators, and run counter to the Government's stated policy of observing the principle of voluntariness and evolutionary transition to collective agriculture; thus the effects have contributed to jeopardizing the prospects for a realistic transition to socialism [5]. This situation may have promoted attitudes of using the land for immediate benefits only, mitigating against necessary investment of labour and material resources for each dams, terraces and other irrigation works [42, 83]. That long-term security of tenure may be a solution to this problem is indicated by the results of a recent study of environmental rehabilitation in the northern highlands, where only those farmers who enjoyed security of landholding or land use displayed both the skills and willingness to invest in renewal with little or no outside aid [81]. Another problem of the small-scale irrigation programme was the failure to consult peasants in the project planning phase, and designs were based on the perspective of the engineer, without enlisting active participation of the peasantry [42, 67].

The top-down approach, which has failed to generate necessary community participation, self-reliance and local decision making in Ethiopia and elsewhere in Africa, has increasingly been criticized during the past decade. Quests for a more promising participatory approach which may lead to citizen empowerment and sustained rural development culminated in the Arusha International Conference on Popular Participation in the Recovery and Development Process in Africa in March 1980, and in a follow-up workshop in Addis Ababa [22]. The extensive literature on the participatory approach was summarized by Gran [39]. Implementation of this approach in Ethiopia would be difficult, especially if the deeply entrenched top-down, corporate and paternalistic attitudes of rural developers and administrators persist. But the potential for local initiative and participation seem to be promising in view of the keen awareness of peasants of the benefits from irrigation, their willingness to contribute labour and funds for the construction and

maintenance of system, and their ability to manage irrigation schemes [67].

The national villagization programme, begun in 1985, also impaired the development of small-scale irrigation in many communities. Fifty-nine per cent of the rural population had been moved to villages by 1987/88. Comparison of the irrigated area reported by the 1983/84 agricultural survey (53,519 ha.) [64] with that of the 1985 survey (52,799 ha.) (Table 1) for the same 11 administrative regions suggests that the resettlement and villagization programme disrupted some peasant irrigation projects. This is in spite of the fact that the new villages tend to be located nearer to streams, rivers, roads and larger settlements than was the case with the old dispersed homesteads. The new villages in general have better access to suitable river bottom lands, irrigation water, transportation facilities and markets, and the congregation of farmers in larger, nucleated villages may facilitate the formation and employment of work brigades, the management and maintenance of irrigation schemes, and the availability of credit, all considered crucial for the success of such projects [12]. In addition, 533 streams and rivers were harnessed as part of the villagization programme, 12,650 springs developed, 4,560 ponds dug and 8,450 wells constructed. But in most communities, villagization resulted in smaller and fewer vegetable gardens, *chat* and fruit trees around houses [3], and in the abandonment of irrigated land in the old settlement areas [56].

Lack of market incentives were found to be due not only to low crop prices but also lack of coordination in production among farmers and their market information systems often resulted in oversupply and undersupply of perishable vegetables and fruit during the harvest and off-season, respectively, with corresponding price fluctuations. lack of storage and transport facilities exacerbated this situation [42, 67, 74].

The food-for-work programme in Ethiopia, dating back to the early 1960s, and involving more than 50 multinational, bilateral, international, national and non-governmental organizations in 1989, spearheaded by the World Food Programme, has contributed to the development of water resources and conservation programmes. The food-for-work programme constitutes an integral component of the Ethiopian Highlands Reclamation Project of the Ministry of Agriculture. The World Food Programme alone, which allocated US$40 million in 1985 and $76 million in 1989, supported the construction of 600,000 ha of soil and stone bunds, 470,000 km of hillside terraces in afforested areas, and thousands of check dams in eroded galleys and hundreds of stream diversions. Nevertheless, recent evaluation of the various programmes revealed that most of them had little impact on farmers, and that their sustainability is uncertain in view of planning, implementation and operational difficulties, confusion and ambiguities over user rights, and lack of land tenure security [10, 48]. Critics of the Highlands Reclamation Project point out that more drastic changes are needed in the agricultural system than the mere construction of conservation structures, namely community level changes that lead to agricultural intensification [26]

This is not to deny that shortages of building materials, especially cement and steel, impaired the development of small-scale irrigation systems. Only 38 per cent of the 31,470 quintals of cement and 21 per cent of the 21.1 million Birr requested by the Irrigation Development Department in 1989/90 were released by Ministry of Finance, and the proportion of the annually requested budget and materials that were released declined between 1987/88 and 1989/90. However, the view that "... the capacity to implement irrigation schemes in the future depends mainly on availability and flow of materials and funds" tends to exaggerate construction problems *vis a vis* organizational, tenure and operational problems, considering that the development of irrigation projects by peasant communities with only technical support from the

Government is a viable option [42]. The view expressed by many engineers and administrators that mechanization of construction and operational activities is essential in small-scale irrigation development [38] ignores the extensive irrigation experience and knowledge held by many Ethiopian peasants, and the need for appropriate technology and community participation. The chronic shortages of funds, skilled manpower and mechanized equipment are unlikely to be alleviated in the near future, and would render the implementation and sustainability of irrigation projects more difficult. Various advanced agricultural inputs, particularly chemical fertilizer, have in fact been rejected by peasants in some communities, because of their high cost and scarcity [80]. While the need for simple construction designs, use of locally available materials and manpower, and operational activities that are both comprehensible to farmers and cost effective has been recognized by the Ministry of Agriculture [42], they still need to be developed and implemented within the context of community participation. It remains to be seen if the Government's revised economic policy, which emphasizes the need to raise productivity of the peasant sector through effective utilization of traditional technology familiar to the peasants [21], will lead to more viable and sustainable irrigation farms.

Non-government organizations have in general had a stimulating effect on small-scale irrigation development since the 1984 famine, when they began to transform themselves from relief organizations into development institutions, with most of them including water resources development in their programmes. They have at their disposal larger budgets than Ethiopian Government institutions, and they operate mostly independently of government bureaucracy [86]. However, the sustainability of irrigation systems is seldom possible after they are turned over to the Ministry of Agriculture and the Relief and Rehabilitation Commission, because of (among other drawbacks) lack of fuel, spare parts, budgets sufficient for operation and maintenance, and disinterest of farmers in cooperative farming.

The hastily planned, emergency type small-scale irrigation programme has promoted conflicts among water users in the absence of comprehensive water legislation, and has increased the risk of ecological upsets. The customary water legislation in force in the highlands dates back to the venerated *Fetha Nagast* (*The Law of Kings*) and is contained in the Civil Code of 1960, which does not cover the broad range of water usage, pollution and conservation problems arising out of agricultural, urban and industrial water use [29, 84]. Moreover, most provisions of the 1960 Civil Code which deal with ownership and use of water have become obsolete since the revolution [29]. The draft water legislation under discussion in 1990 is intended to regulate all forms of water use [52]. The uncontrolled small-scale irrigation development since 1984 has also drawn heavy criticism from officials of the major governmental water development agencies, who warned of increasing erosion due to the clearance of natural vegetation along water courses and to inadequate offtake structures; flooding, waterlogging and salinization due to poor water management; and decrease of water supplies for downstream and lowland users, including mechanized farms [95]. The tendency of peasants to divert as much water as possible with available technology without consideration of the needs of downstream users, and the greater efficiency and longevity of modern diversion structures now being installed point to the need for specific legislation and decisive enforcement [67]. The recent decline of the level of Lake Zway, a shallow, productive lake supporting a thriving tilapia industry run by local fishing cooperatives, has been linked with the development of 1,000 ha of land to irrigation by 12 peasant associations which obtain the water from the tributary Meki River and from new wells along the lake shore [23, 35].

In 1990 the Ministry of Agriculture recommended the establishment of water users' associations with a maximum of self-initiative and community participation, as part of an effort to develop community-based infrastructure that promotes, implements and regulates locally acceptable,

operationally efficient and ecologically sound peasant irrigation farms. Community based peasant institutions dealing with irrigation have existed traditionally in many parts of Ethiopia. they were responsible for the construction and maintenance of stream diversions, dams and canals, the equitable distribution of water among members, and the setting of disputes related to the allocation and use of water. Peasant associations have inherited or replaced most of these institutions. Four added functions of the proposed users' associations would be (a) to serve as a bridge between extension staff and individual farmers, (b) to develop irrigation farms independent of government assistance,[2] (c) to raise funds to finance on farm works and operating expenses, and (d) to disburse credit from donor agencies [43]. Their success would seem to depend largely on the Government's ability to provide the necessary incentives for irrigation development and other intensified agricultural activities, by encouraging local initiative, local effort and local savings for investment in irrigated agriculture and community development projects.

VII. CONCLUSION

Small-scale irrigation has a long history in Ethiopia, but has remained relatively unimportant in food production in most areas. Nevertheless, there is considerable peasant knowledge about and interest in irrigated agriculture that has not been considered by recent programmes. The emergency type irrigation programme implemented by the Government during the 1984/85 famine appears to have increased food production in some localities but has been beset with numerous administrative, social, technical and ecological problems. In many areas irrigated agriculture has been disrupted and irrigation works have deteriorated in the wake of the villagization and cooperative programmes, the famine and the secessionist war. This situation is unlikely to improve unless a peace agreement can be negotiated and the following conditions are in operation: that government-sponsored irrigation services are made available more equitably among farmers;

that greater security of land tenure is achieved; that greater use is made of existing peasant knowledge and other local resources; and that a comprehensive water law is promulgated. The wide range of problems impinging on small-scale irrigation development also requires that it be developed, with greater effort than in the past, through integrated rural development using the participatory approach. This should not only facilitate broadly based mobilization of rural resources but also greater sustainability of programmes than through top-heavy centrally planned or free enterprise type agricultural development that focuses merely on production and deals only with farm commodities. The Government's call in 1990 for the development[3] of a mixed economy with greater allocation of resources to the peasant sector rather than to state farms may be expected to foster more productive and sustainable irrigation agriculture only in the long term. During this transition period, the peasant associations and producer cooperatives are in a state of disarray.

This literature review indicates that the success of any small-scale irrigation programme in Ethiopia, in regard to contributing to food security on a sustained basis, will depend to a large degree on (a) the ability of the Government's economic policy to create motivated farmers and facilitate their participation, and (b) the appropriate mix of farmer initiatives and government support structures. We concur with Seavoy [78] that political action must precede the use of infrastructure and technology to assure self-sustained operational and technical inputs. Whether administrated by the Government or non-governmental organizations, the manner in which system imposed from outside during development programmes interact with local social and ecological systems is instrumental in their acceptance and per capita production. Studies of these interactions may provide valuable insights not only into peasants' coping behaviour during periods of food shortage and famine, as noted elsewhere [49], but also into the real needs of the peasants, and their opportunities in and requirements for small-scale irrigation development. In terms of suitability of the local environment and socio-

Table 1
Number of Farmers Using Small-scale Irrigation and Acreages Irrigated in 1985, by Administrative Region

Administrative Region	Farmers Using Irrigation		Irrigated Area (h)
	Number	Percent of all farmers in the Region	
Hararghe	84,291	23	14,910
Bale	8,623	8	4,606
Sidamo	2,105	3	1,322
Gamo Gofa	5,658	3	3,711
Shewa	42,609	4	7,913
Arsi	1,376	6	819
Wello	26,218	5	6,593
Gojam		no data	
Wellega	33,175	13	6,977
Gondar	6,711	2	1,223
Illubabor	10,700	7	1,813
Keffa	9,823	3	2,912
Tigray		no data	
Eritrea		no data	
Total	213,289		52,799

Source: FAO [32].

economic situations for irrigation development and returns to public investment and expenditures, the greatest benefits may be obtained by giving top priority to increasing irrigation efficiency and food production in existing schemes or new peasant-initiated schemes [67]. The common unsatisfactory results from government-initiated peasant irrigation projects around the world, suggests the following approach to irrigation development, as quoted from Underhill [91]:

> Development is seen as learning process, with the pace of development dictated by the farmers themselves. This may initially be slow, though in fact probably no slower than in many large schemes where cost and time overruns are common. An advantage is greater robustness due to a large dose of independence.

Table 2

Table 2

Crops Grown Under Irrigation by 1020 Peasant Associations and Producer Cooperatives in Hararghe, Sidamo, Wello and Gamo Gofa Administrative Regions in 1986/87 (1980 Ethiopian Calendar)

	Hararghe (394 Peasant Associations)	Shewa (20 Peasant Associations)	Wello (357 Peasant Associations)	Gamo Gofa (9 Peasant Associations)	Total (n = 1020)
	+ #				
Vegetables	238 (8)	182 (8)	179 (9)	10 (2)	609 (27)
Maize	110 (7)	85 (8)	96 (9)	9 (2)	300 (27)
Potatoes	129 (4)	68 (7)	25 (6)	2 (1)	220 (18)
Fruit	90 (8)	34 (6)	44 (7)	6 (2)	174 (23)
Sweet potatoes	82 (8)	4 (3)	37 (8)	6 (1)	139 (20)
Coffee	82 (7)	1 (5)	29 (6)	1 (1)	123 (19)
Barley	7 (1)	54 (2)	30 (4)	0 (1)	91 (7)
Sugar cane	60 (6)	21 (7)	4 (2)	0	85 (15)
Chat	70 (5)	7 (2)	7 (3)	1 (1)	85 (11)
Wheat	8 (2)	34 (4)	18 (3)	0	60 (9)
Sorghum	34 (6)	10 (2)	11 (4)	2 (2)	57 (16)
Pulses	21 (6)	18 (4)	10 (4)	0	54 (14)
Teff	4 (1)	19 (3)	14 (4)	0	37 (8)
Gesho	0	9 (2)	11 (3)	0	20 (5)
Tobacco	0	14 (1)	0	0	14 (1)
Cotton	1 (1)	1 (1)	2 (1)	7 (2)	11 (2)
Fenugreek	0 (1)	3 (2)	6 (3)	0	9 (5)
Sesame	5 (1)	1 (1)	0	0	6 (2)
Groundnuts	1 (1)	1 (1)	3 (1)	0	5 (7)
Oats	2 (2)	0	3 (2)	0	5 (4)
Tree seedlings	0	0	0	1 (1)	1 (1)
Fishing	0	1 (1)	0	0	1 (1)
Irrigated pasture	0	1 (1)	0	0	1 (1)

\+ No. of peasant associations growing this crop.
\# No. of *awrajas*; 8 awrajas were studied in Hararghe, 8 in Shewa, 9 in Wello and 2 in Gamo Gofa.

Source: Unpublished data of the Irrigation Development Department, Ministry of Agriculture, Addis Ababa.

NOTES

1. The writer is thankful to Ato Habtamu Gessesse of the Irrigation Development Department, Ministry of Agriculture, for making available the small-scale irrigation statistics, to Ato Akalu Meshesha of the Water Resources Development Authority, Mr. Paavo Farm of the Lutheran World Federation and Mr. Gregory D. Bellas of Africare for useful discussions, and to the Department of Geography of Addis Ababa University for technical support. I am also grateful to Dr. Abdurahman Abdulahi of the Ministry of Agriculture's Crop Protection Department and Dr. Hashim Tewfik for their assistance in identifying the Adere plant names.

2. The administrative regions mentioned in this article do not conform with the new ones, since the data on which paper is based were compiled by using the old administrative classification.

3. Except for technical assistance.

4. For a detailed discussion of the concept of integrated rural development in the context of Ethiopian agriculture see Cohen [17].

REFERENCES

[1] Admasu Gebeyehu. Regional Analysis of Some Aspects of Stream Flow Characteristics of Ethiopia. Ph.D. Thesis, Faculty of Technology, Addis Ababa University, 1988.

[2] Akalu Negewo. Towards a Strategy for the Development of State Farms in Ethiopia: Executive Summary. Report prepared for the Ministry of State Farms Development. Addis Ababa, 1987.

[3] Alemayehu Lirenso. Villagization and Agricultural Production in Ethiopia: A Case Study of Two Regions. Institute of Development Research, Addis Ababa University, 1989.

[4] Almeida, M. de. *Some Records of Ethiopia 1593-1646.* Translated and edited by C.F. Beckingham and G.W.B. Huntingford. London, The Hakluyt Society, 1954.

[5] Alula Abate. Peasant Associations and Collective Agriculture in Ethiopia. *Erdkunde 37,* 118-128, 1983.

[6] Amare Getahun and Krikorian, A.D. *Chat:* Coffee's Rival from Harar, Ethiopia. *Economic Botany 27,* 353-389, 1973.

[7] Anderson, D. Cultivating Pastoralists: Ecology and Economy Among the Il Chamus of Baringo, 1840-1980. In *The Ecology of Survival: Case Studies from Northeast African History* (Edited by Johnson, D.H.), pp. 241-260. London: Lester Crook Academic Publishing, 1988.

[8] Anderson, D. and Johnson, D.H. Introduction: Ecology and Society in Northeast African History. In *The Ecology of Survival: Case Studies from Northeast African History* (Edited by Johnson, D.H.) pp. 1-24. London: Lester Crook Academic Publishing, 1988.

[9] Asmerom Kidane. Demographic Consequences of the 1984-1985 Ethiopian Famine. *Demography 26,* 515-522, 1989.

[10] Beckett-Brown, J. Soil Conservation/Forestry and Food Aid in Ethiopia: Some Experiences and Some Problems. Paper presented at the 6th International Soil Conservation Organization, 6-18 November, 1989, Addis Ababa and Nairobi.

[11] Bekure Wolde Semait. Some Spatial Characteristics of Peasant Farming in Ethiopia. *Ethiopian Journal of Development Research* 5-7 (2), 17-48, 1983.

[12] Berry, L., Ford, R. and Hosier, R. *The Impact of Irrigation on Development: Issues for a Comprehensive Evaluation Study,* A.I.D. Program Evaluation Discussion Paper No. 9. Worchester: Clark University, 1980.

[13] Brooke, C.H. Settlement of the Eastern Galla, Hararghe Province, Ethiopia. Ph.D. Dissertation, University of Nebraska, 1956.

[14] Brown, L.H. *Conservation for Survival: Ethiopia's Choice.* Addis Ababa: Addis Ababa University Press, 1973.

[15] Buxton, D.R. the Shoan Plateau and Its People: An Essay in Local Geography. *The Geographical Journal 14,* 157-172, 1949.

[16] Carr, C. *Pastoralism in Crisis: The Dassanech and their Ethiopian Lands.* Chicago: University of Chicago Press, 1977.

[17] Cohen, J.M. *Integrated Rural Development: The Ethiopian Experience and Debate.* Uppsala: The Scandinavian Institute of African Studies, 1987.

[18] Cohen, J.M. and Weintraub, D. *Land and Peasants in Imperial Ethiopia.* Assen: Van Gorcum, 1975.

[19] Cohen, J.M. and Isaksson, I.M. Food Production Strategy Debates in Revolutionary Ethiopia. *World Development 16,* 323-348, 1988.

[20] Daniel Gamachu. Food Production, Landuse and Drought in Wello Region of Ethiopia. *Proceedings of the AAU-DAAD Conference on Problems of Man and His Biosphere,* pp. 34-40. Addis Ababa: Addis Ababa University, 1988.

[21] Documents of the 9th Plenum of the COPWE. *Report by Mengistu Hailemariam: Resolution Adopted from the Plenum.* Addis Ababa, 1988.

[22] ECA and FAO. Workshop on Planning and Implementation Technologies for Participatory Rural Development in Africa. Sponsored by the United Nations Economic Commission for Africa and the Food and Agriculture Organization, 19-24 November, 1990.

[23] Editorial. Lake Zuwai Irrigation Project Launched. *The Ethiopian Herald,* 25 September, 1985, pp. 1, 5.

[24] Editorial. Cooperative Earns Over 200,000 Birr from Sales of Vegetables. *The Ethiopian Herald,* 15 June, 1989, p. 1.

Editorial. President Announces Series of new Policies with Far-Reaching Impact on Nation's Political and Socio-Economic Development. *The Ethiopian Herald,* 6 March, 1990, pp. 1, 3.

Ege, S. Changing Patterns of Land Tenure in Ayne, Mafud Woreda. Paper presented at the Conference on Peasant Production and Development in Ethiopia. Sponsored by the University of Bergen, 28-29 August, 1989.

Ethiopian Red Cross. *Ethiopia: Upper Mille and Chelelaka Catchment Disaster Prevention Programme UMCC-DPP,* Vol. 2. *Landuse and Water Development.* Addis Ababa: Ethiopian Red Cross, 1986.

Ethiopian Valley Development Studies Authority. Master Plan for the Development Authority. Master Plan for the Development of Surface Water Resources in the Awash Basin. Draft Final Report, Vol. 2. Main Report. Prepared by Sir William Halcrow and Partners, Addis Ababa, 1989.

Ewneta Akama. Water Law of Ethiopia. Senior Essay, Faculty of Law, Addis Ababa University, 1987.

FAO. *Food Production Yearbook*, Vol. 34. Rome: Food and Agriculture Organization, 1980.

FAO. *Food Production Yearbook,* Vol. 39. Rome: Food and Agriculture Organization, 1985.

FAO. Ethiopian Highlands Reclamation Study. Final Report AG; UTI/ETH/037. Rome: Food and Agriculture Organization, 1986.

Fassil Gebre-Kiros. Agricultural Land Fragmentation: A Problem of Land Distribution Observed in Some Ethiopian Peasant Associations. *Ethiopian Journal of Development Research 4,* 1-12, 1980.

Fattovich, R. Remarks on the Late Prehistory and Early History of Northern Ethiopia. *Proceedings of the Eighth International Conference of Ethiopian Studies,* (Edited by Tadesse Beyene), Vol. 1, pp. 85-104. Addis Ababa: Institute of Ethiopian Studies, 1988.

[35] Foerch, G. Water Resources Development: Some Impacts on Environment. *Proceedings of the AAU-DAAD Conference on Problems of Man and His Biosphere,* pp. 41-48. Addis Ababa: Addis Ababa University, 1988.

[36] Franzel, S., Legesse Dadi, Colburn F. and Getachew Degu. *Grain Marketing and Peasant Production in Ethiopia.* Occasional Paper Series No. 14, Rural Development Committee. Ithaca, New York: Cornell University, 1989.

[37] Gedion Asfaw. The Need for an Irrigation Policy and Strategy. Paper presented at the National Irrigation Policy and Strategy Workshop. Sponsored by the Office of the National Committee for Central Planning, 30-31 Oct. 1989.

[38] Girma Mengistu. Monitoring and Evaluation the Construction of Small-scale Irrigation Projects -- Development of a Procedure for South Eastern Agricultural Development Zone, Ethiopia. M.Sc. Thesis, Dept. of Civil Engineering, Institute of Irrigation Studies, University of Southampton, 1987.

[39] Gran, G. Policy Strategy Issues in participatory Rural Development in Africa. Paper presented at the Workshop on Planning and Implementation of Techniques for Participatory Rural Development in Africa. sponsored by the United Nations Economic Commission for Africa and the Food and Agriculture Organization, Addis Ababa, 19-24 November, 1990.

[40] Grant, J.P. The State of the World's Children. New York: UNICEF, 1987.

[41] Grova, M.E. Experience with Implementation Integrated Community Development Projects with an Environmental Bias in Ethiopia. Paper Presented at the Workshop on Rural Development in Northern Shewa. Sponsored by the University of Bergen, 28-29 August, 1989.

[42] Habtamu Gessesse. Problem and Constraints in the Study, Construction and Management of Small-scale Irrigation Projects. Paper Presented at the National Irrigation Policy and Strategy Workshop. sponsored by the National Committee for Central Planning, Addis Ababa, 30-31 October, 1990.

[43] Hallpike, C.R. *The Konso*. Cambridge: Cambridge University Press, 1972.

[44] Harrison, P. *The Greening of Africa*. London: Paladin Croft Books, 1982.

[45] Hellden, U. and Eklundh, L. *National Drought Impact Monitoring: A NOAA NDVI and Precipitation Data Study of Ethiopia*. Lund: University of Lund, 1988.

[46] Hewett, R. Assessment of Irrigation Potential in the Ethiopian Highlands. *Proceedings of the National Workshop on Food Strategies in Ethiopia*. Addis Ababa: Office of the Committee for Central Planning, 1989.

[47] Huffnagel, H.P. *Agriculture in Ethiopia*. Rome: Food and Agriculture Organization, 1961.

[48] Hurni, H. Degradation and Conservation in the Ethiopian Highlands. Paper Presented by the African Mountains Workshop Ethiopia. Sponsored by the International Geographical Union and Addis Ababa University, 18-27 October, 1986.

[49] Huss-Ashmore, R. and Katz, S.H. (eds.) *African Food Systems in Crisis*. 2 Vols. London: Gordon and Breach, 1989.

[50] Janssen, K., Harrison, M. and Penrose, A. *The Ethiopiaan Famine*. London: Zed Books, 1987.

[51] Jutzi, S. Deep Black Clay Soils (Vertisols) -- Management Options for the Ethiopian Highlands. Paper Presented at the African Mountains Workshop Ethiopia. Sponsored by the International Geographical Union and Addis Ababa University, 18-27 October, 1986.

[52] Kifle Lemma. The Proposed Ethiopian Water Resources Code and Its Implications on the Irrigation Subsector. Paper Presented at the National Irrigation Policy and Strategy Workshop. Sponsored by the Office of the National Committee for Central Planning, Addis Ababa, 30-31 October, 1990.

[53] Kloos, H. *Irrigation and Schistosomiasis in the Awash Valley of Ethiopia.* Ph.D. Dissertation, University of California, Davis. Published upon demand by University Microfilms International, Ann Arbor, 1977.

[54] Kloos, H. Development, Drought and Famine in the Awash Valley of Ethiopia. *African Studies Review 25,* 21-48, 1982.

[55] Kloos, H. and Aynalem Adugna. The Ethiopian Population: Growth and Distribution. *Geographical Journal* 155, Part 1, 33-51, 1989.

[56] Kloos, G., Tuffa Abate, Asrat Hailu and Teklemariam Ayele. Social and Ecological Aspects of Resettlement and Villagization Among the Konso of Southwest Ethiopia. *Disasters 14,* 309-321, 1990.

[57] Koehn, P. Ethiopia: Famine, Food Production and the Legal Order. *African Studies Review 22,* 51-71, 1979.

[58] Lambert, J.H.D. Traditional Agriculture: Its Role in Sustainable Food Production and Resource Management in Africa. *Man-Environment Systems 16,* 119-132, 1986.

[59] McCann, J. Toward a History of Modern Highland Agriculture in Ethiopia: The Sources. Proceedings of the Ninth International Congress of Ethiopian Studies, Vol. 1. Moscow: USSR Academy of Sciences, Africa Institute, 1988.

[60] McCann, J. Historical Trend of Agriculture in Ankober District, 1840-1989. Paper Presented at the Conference on Peasant Production and Development in Ethiopia. Sponsored by the University of Bergen, 28-29 August, 1989.

[61] Melesse Endalamaw. The Economics, Financing and Cost Recovery Mechanisms in Irrigation Projeects. Paper Presented at the National Irrigation Policy and Strategy Workshop. Sponsored by the National Committee for Central Planning. Addis Ababa, 30-31 October, 1990.

[62] Merid Wolde Aregay. Land Tenure and Agricultural Productivity, 1500-1850. *Proceedings of the Third Annual Seminar of the Department of History.* pp. 115-124. Addis Ababa: Addis Ababa University, 1986.

[63] Mesfin Wolde Mariam. Dimension of Vulnerability for Famine. Paper Presented at the National Conference on a Disaster Prevention and Preparedness Strategy. Sponsored by the Office of the National Committee for Central Planning, 5-8 December, 1988, Addis Ababa.

[64] Ministry of Agriculture. General Agricultural Survey 1983/84 (1976 E.C.): Preliminary Report, Vol. 1. Planning and Programming Department, Addis Ababa, 1984.

[65] Ministry of Agriculture. Small-scale Irrigation Report (in Amharic). Irrigation Development Department, Rural Development Branch, Addis Ababa, 1985.

[66] Ministry of Agriculture. Unpublished Data of the Irrigation Development Department, Rural Development Branch, Addis Ababa, 1986.

[67] Ministry of Agriculture. Traditional Organizational Forms in Small-scale Irrigation Schemes. Report by Tahal Consulting Engineers Ltd., in Association with Shawel Consult International. Addis Ababa, 1988.

[68] Ministry of Agriculture. Annual Report on Small-scale Irrigation (in Amharic). Irrigation Development Department, Rural Development Branch, Addis Ababa, 1989.

[69] Murdock, G.P. *Africa: Its People and Their Culture History.* New York: McGraw-Hill, 1959.

[70] ONCCP. *The Ten-Year Perspective Plan 1983/84-1993/94.* Office of the National Committee for Central Planning, Addis Ababa, 1984.

[71] ONCCP. National Irrigation Policy and Strategy Workshop, Discussion Papers. 30-31 October, 1990, Addis Ababa.

[72] Pankhurst, R. Notes for a History of Ethiopian Agriculture. *Ethiopian Observer 7,* 210-240, 1964.

[73] Pausewang, S. Peasant Organizations and Markets Ten Years After the Land Reform. *Proceedings of the Ninth International Congress of Ethiopian Studies.* Vol. 2, Moscow: USSR Academy of Sciences, Africa Institute, 1988.

[74] RRC and UNICEF. *Quick Assessment: Cash for Food in Ethiopia: UNICEF Emergency Intervention.* Addis Ababa, 1988.

[75] Richards, P. Ecological Change and the Politics of African Land Use. *African Studies Review 26,* 1-72, 1983.

[76] Robinson, W.C. and Yamazaki, F. Agriculture, Population and Economic Planning in Ethiopia, 1953-1980. *Journal of Developing Areas 20,* 327-338, 1986.

[77] Scudder, T. River Basin Development and Local Initiative in African Savanna Environments. In *Human Ecology and Savanna Environments* (Edited by Harris, D.R.), pp. 385-405. London: Academic Press, 1980.

[78] Seavoy, R.E. *Famine in East Africa: Food Production and Food Policies.* New York: Greenwood Press, 1989.

[79] Simoons, F.J. *Northwest Ethiopia: People and Economy.* Madison: University of Wisconsin Press, 1960.

[80] Solomon Mulugeta. Some Aspects of the Major Constraints to Fertilizer Use in Northern Shewa. Paper Presented at the Workshop on Problems and Prospects of Rural Development in Ethiopia. Sponsored by the Institute of Development Research, Addis Ababa University, Nazareth, 1-2 December, 1989.

[81] Staal, M. *Constraints to Environmental Rehabilitation Through People's Participation in the Northern Ethiopian Highlands.* Geneva: UNRISD Discussion Paper No. 3.

[82] Stitz, V. Studien zur Kulturgeographie Zentralathiopiens. *Bonner Geographische Abhandlungen 51,* 1-395, 1974.

[83] Storck, H. Development and Agriculture in the Hararghe Highlands: Constraints and Prospects. *Proceedings of the AAU-DAAD Conference on Problems of Man in Biosphere.* pp. 41-48. Addis Ababa University, 1988.

[84] Strauss, P.L. *The Fetha Negast (The Law of Kings).* Engl. transl. by Abba Paulos Tzadua. Addis Ababa University, Faculty of Law, 1968.

[85] Tamiro Hawando. Increasing Agricultural Production in Ethiopia Through Improved Soil, Water and Crop Management Practices. *Proceedings of the National Workshop on Food Strategies in Ethiopia.* pp. 243-275: Addis Ababa: Office of the National Committee for Central Planning, 1986.

[86] Tegegne Teka. A Brief Survey of Development Activities in Northern Shewa. Paper Presented at the Workshop on Rural Development in Northern Shewa. Sponsored by the University of Bergen, 28-29 August, 1989.

[87] Tewolde-Berhan Gebre-Egziabher. Vegetation and Environment of the Mountains of Ethiopia and Their Implications for Utilization and Conservation. Paper Presented at the African Mountains Workshop Ethiopia. Sponsored by the International Geographical Union and Addis Ababa University, 18-27 October, 1986.

[88] Timberlake, L. *Africa in Crisis.* London: Earthscan, 1985.

[89] Tsegaye Kassa. Personal Communication, 1990.

[90] Turton, D. Mursi Response to Drought: Some Lessons for Relief and Rehabilitation. *African Affairs 8,* 333-346, 1985.

[91] Underhill, H.W. *Small-scale Irrigation in Africa in the Context of Rural Development.* Rome: FAO, 1984.

[92] Vogel, W. Human Ecology and Agricultural Terraces in North Yemen. Paper Presented at the African Mountain Workshop Ethiopia. Sponsored by the International Geographical Union and Addis Ababa University, 18-27 October 1986, Addis Ababa.

[93] Webb, P. and von Braun, H. Drought and Food Shortages in Ethiopia: A Preliminary Review of Effects and Policy Implications. Paper Prepared for the International Food Policy Research Institute and the Office of the National Committee for Central Planning, Addis Ababa, 1989.

[94] Westphal, E. *Agricultural Systems in Ethiopia.* Wageningen: Centre for Agricultural Publishing, 1975.

[95] WRDA. General Information on Irrigated Lands in Ethiopian River Basins. Water Resoucres Development Authority, 1985.