Pasture Improvement Research in Eastern and Southern Africa

Proceedings of a workshop held in Harare, Zimbabwe, 17–21 September 1984
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Pasture Improvement Research in Eastern and Southern Africa

Proceedings of a workshop held in Harare, Zimbabwe, 17–21 September 1984

Editor: Jackson A. Kategile

Cosponsored by the Southern African Development Coordination Committee, Gaborone, Botswana, and the International Development Research Centre, Ottawa, Canada
Abstract: The proceedings contains reviews by national scientists on pasture research done primarily in Eastern and Southern Africa (Ethiopia, Kenya, Tanzania, Burundi, Zambia, Zimbabwe, Swaziland, Lesotho, Botswana, Mozambique, and Madagascar). The application of the results obtained and lessons learned are highlighted and used in setting of national priorities for research areas for the future. Critical reviews on current pasture research methodologies are included in the proceedings. The research methods discussed are germ-plasm collection, storage, and dissemination; and germ-plasm introduction and evaluation, nutritive evaluation of pastures, grazing experiments, and range monitoring. Specific guidelines on methodologies are outlined and these are useful to pasture agronomists, animal nutritionists, and range-management scientists.

Two case studies of pasture-research regional networks in Asia and Latin America were presented and discussed. A strategy for future pasture research coordinated through a regional Pastures Network for Eastern and Southern Africa (PANESA) was discussed and agreed upon.


Deux études de cas ont fait l’objet d’une présentation suivie d’une discussion : il s’agit des réseaux régionaux de recherche sur les pâturages en Asie et en Amérique latine. Après discussion, on a convenu d’une stratégie de la recherche sur les pâturages, dans les années à venir; la coordination de cette stratégie sera assurée par une section régionale du Pastures Network for Eastern and Southern Africa (PANESA).

Resumen: En las actas se recogen ponencias presentadas por científicos de diferentes países sobre las investigaciones en pastos que se han realizado principalmente en el Africa oriental y meridional (Etiopía, Kenia, Tanzania, Burundi, Zambie, Zimbabwe, Suazilandia, Lesotho, Botswana, Mozambique y Madagascar). Se destaca la aplicación de los resultados y experiencias obtenidos, muy útiles para determinar las prioridades de las investigaciones futuras en las diferentes naciones. En las actas se recogen también ponencias críticas sobre las metodologías empleadas actualmente en las investigaciones sobre pastos. Se analizan los siguientes métodos de investigación: recogida, almacenamiento, diseminación, introducción y evaluación de germoplasma; evaluación del valor nutritivo de los pastos; experimentos de pastoreo; y control de dehesas. Se resumen directrices y metodologías específicas de gran utilidad para agrónomos especializados en pastos, expertos en nutrición animal y científicos especializados en gestión de dehesas.

Se presentan y analizan dos estudios de casos de las redes regionales de investigación en Asia y Latinoamérica. Se discutió y aprobó una estrategia para realizar investigaciones sobre pastos en el futuro que serán coordinadas por la Red de Investigaciones sobre Pastos para Africa Oriental y Meridional (RIPADM).
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PAST AND CURRENT TRENDS OF PASTURE RESEARCH IN KENYA

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Abstract This paper looks at the trends of pasture research in Kenya over a span of some 80 years. A review of the agriculture production systems is given to enable the reader to appreciate the historical background of the earlier impetus of research, which was geared toward meeting the needs of the large-scale, mixed-farming enterprises. The change of farm sizes and land ownership, postindependence in 1963, brought about a reappraisal of the research and extension policy.

Research endeavours of the early 20s-70s produced tangible benefits to the needs of the era. The main thrust was on ley grasses as practiced under the mixed-farming system used during that period. Legume pastures and fodder were researched. The results were extended to the farmers through personal visits, field trips, agricultural shows, and through technical bulletins and local farmers' publications.

Pasture research from the early 70s tended to continue on the lines of ley grasses and accumulation of germ plasm; the late 70s to the early 80s have seen a greater emphasis being paid to more relevant research on the needs of the smallholders in the high potential areas and in the marginal agrarian areas. A greater awareness of the role of arid pastoral areas in maintaining animal productivity led to accelerated research in those disciplines by both the Kenya government and through internationally aided research projects.
Scarcity of land and a severe competition with crops in the high potential areas due to high opportunity costs of crop production has led research to be concentrated on intensive fodder production, utilization of farm by-products, and on development of other feed resources.

It is concluded that the challenge to research and extension in Kenya is to meet demands for milk and meat production, both increasing at about 5.3%/year.

This paper gives an outline of past and current impetus in pasture research activities as dictated by the prevailing agricultural production systems, then and now. Published results appearing in scientific journals, theses, booklets, advisory leaflets, or as reports and working papers should be available from the various pasture research stations given in Appendix 1.

The total land mass of Kenya is 569,260 km². The land falls into six ecoclimatic zones; zone 1-6, as given by Griffiths (1962). Kenya has distinct wet and dry seasons with almost the whole country experiencing a bimodal distribution. Peak rains occur around April and November. About 72% of the land mass receives less than 500 mm annual rainfall, 13% receives from 500 to 750 mm, 12% receives from 750 to 1,250 mm, and about 4.3% receives more than 1,250 mm rainfall (Potter 1983).

Seasonal variation in temperatures is slight, but the highlands tend to be cooler. The mean air temperature at the coast is about 27 °C and the general rate of decrease with altitude is approximately 5.3 °C/1,000 m. A diurnal variation of 10 °C is typical, except at the coast where it is less and at elevations above 2,000 m where it is likely to be greater (Pratt and Gwynne 1978).

AGRICULTURAL PRODUCTION SYSTEMS

Pasture research in Kenya has tended to be influenced by the prevailing agricultural production systems. It is relevant, therefore, to give a fair coverage of the production systems prevailing before independence in 1963 and the changed pattern of the post independence era.

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More than 80% of the Kenya land mass, or $46 \times 10^6$ ha, is unsuitable for arable farming and intensive livestock production because there is too little rain or no access to sufficient water. Table 1 shows agricultural enterprises practiced in the six ecoclimatic zones.

Comprehensive reviews on Kenya's agricultural sector; agriculture development policy; African land tenure reform; and the development of the small farm areas, the large farms, and the range land areas are given by Senga, Smith, Okoth-Ogendo, Heyer and Waweru, Hinga and Heyer, and by Kaufmann, respectively, in a book edited by Heyer et al. (1976).

From the 1890s to the 1950s agricultural development policy in Kenya was almost entirely European settler oriented although scant attention was paid to African agriculture from the 1930s to the mid 1950s. At that time, before independence, it was possible to make a clear distinction between large- and small-scale farming in terms of land tenure and size; large-scale farming was non-African owned and the small-scale farming was African owned. The African farms were in the so-called nonscheduled areas whereas the large-scale non-African owned farms were designated "scheduled" areas. By 1960, the "scheduled" areas comprised about $3.0 \times 10^6$ ha of which $1.4 \times 10^6$ were in mixed farming areas and the remaining $1.6 \times 10^6$ ha were in plantations and ranching areas (Senga 1976).

As noted earlier from the mid 1950s some attention was given to developing African agriculture but it was not until the commissioning of the famous "Swynnerton Plan" in 1953 that a real intensification of African agriculture was considered seriously. The plan also outlined different strategies for different areas depending upon rainfall, population densities, and other climatic and production features.

This trend again gained momentum, on the eve of independence in 1961, when a "Million Acre Settlement Scheme" was started for purchasing $1.2 \times 10^6$ acres of largely mixed farming land from the former "scheduled" areas for distribution to Africans (Senga 1976). Post-independence, many other settlement schemes were undertaken by the Kenya government in collaboration with the British government. The change in land owner-
Table 1. Agricultural enterprises practiced in the six ecoclimatic zones of Kenya (adapted from Senga (1976)).

<table>
<thead>
<tr>
<th>Zone</th>
<th>Area</th>
<th>Agricultural enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>800 km² - 1% of the land mass</td>
<td>High altitude above tree line. Mostly barren except for moorland or grassland here and there. Land use - water catchment and tourism.</td>
</tr>
<tr>
<td>2</td>
<td>53,000 km² - 9% of the land mass comprises bulk of Kenya's high potential agriculture area</td>
<td>Embraces the bulk of Kenya's forests, both indigenous and planned. Agricultural potential very high especially in the highlands. Coffee, tea, and pyrethrum are important cash crops. Cotton yields well at lower elevations. Intensive smallholders grow pulses, potatoes, some maize, vegetables, and a very high proportion of smallholder dairy production, poultry and some pigs at higher elevations.</td>
</tr>
<tr>
<td>3</td>
<td>53,000 km² - 9% of the land mass. Medium potential agricultural land</td>
<td>Most of the large-scale mixed farming areas growing hybrid maize, wheat, and barley. Small-scale holders grow maize, cotton, groundnuts, pulses, and oilseeds. At lower elevations at the coast cashew and coconuts are also grown. Livestock does well on both large farms and on smallholdings.</td>
</tr>
<tr>
<td>4</td>
<td>53,000 km² - 9% of the land mass. Marginal agricultural</td>
<td>Most of the earlier-established ranches are in this zone. Subsistence crop farming and livestock keep-</td>
</tr>
</tbody>
</table>

(continued)
Table 1. Concluded.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Area</th>
<th>Agricultural enterprises</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>300,000 km² - 52% of the land mass</td>
<td>Wildlife is important in many areas. Moderate rangeland development potential. The zone has been the focus of much of the present and proposed livestock development programs. Pastoralists occupy an important position.</td>
</tr>
<tr>
<td>6</td>
<td>112,000 km² - 20% of the land mass</td>
<td>Predominantly pastoralist country. Limited livestock development exists, but productivity depends on land use as well as on potential, population, infrastructure, access to markets, development resources, etc.</td>
</tr>
</tbody>
</table>

and postalists also continued through private individuals and cooperatives buying land while a few farms remained within the government parastatals to maintain their size and production enterprises. In most cases, farms bought by cooperatives were subdivided into small units to settle many families.

The picture that has emerged now is that of a very much diversified agricultural production. However, the majority of plantations and ranches remained in the hands of non-Africans because they were costly to buy and run. However, many of the large-scale mixed farms have ended up being divided into smaller units but some few remained as large units and have either
changed hands or are with the same owners. The result has been accelerated production in the former "non-scheduled" areas and in the settlement schemes as a result of the nonrestrictive nature in what the African farmer can grow and rear. Shares of small farms as a percentage of the value of gross marketed output increased from 18% in 1954 to 22.2% in 1962 and up to 52.5% in 1972 (Senga 1976). These percentages are exclusive of commodities used on the farm for subsistence.

The major animal production enterprise by the small-scale farmers in the former "scheduled" and "non-scheduled" areas is dairying. By 1970 an estimated 418,000 grade dairy cattle, or 60% of the dairy national herd, was in the hands of the smallholders and only 284,000 head remained on the large-scale farms (Chema 1983). Available statistics indicate that in 1978 out of the 901 x 10^6 L of milk available for consumption smallholders produced 69%, the large-scale farmers produced 17%, and the remaining 14% came from the pastoralists and commercial ranchers. Other minor ruminant livestock enterprises of the smallholders are sheep and goats used for ceremonial purposes and sometimes to provide extra cash income. However, the Ministry of Agriculture, in collaboration with Winrock International has been working on a project to introduce dairy goats to the smallholders in Western Kenya and the Nyanza Districts.

Many of the large-scale unit ranches are still operational and some new ones, especially in the Coast Province, have come up. But the major livestock enterprises, in terms of cattle, sheep, and goats, are still in the hands of the pastoralists. Some cattle, sheep, and goats are also kept by the agrarian communities in the more marginal areas.

PASTURE RESEARCH UP TO THE 1970s

Until the recent past, Kenya relied on grass ley production in the high potential areas to raise dairy cattle, sheep, and high-quality beef. Leys played an important role in the mixed-farming systems. A few large farms were using improved pastures to raise dairy cattle, sheep, and beef. As noted earlier, the role of
the smallholder in these enterprises was almost nil. Naturally, therefore, pasture research was mainly geared to cater for the "needs of the day." The major thrust of pasture research was, therefore, on ley farming, legumes, and fodders.

In 1908, the first Government Experimental Farm was set up at Kabete to provide information and training for prospective European settlers. Among the activities was the evaluation of pasture species. Activities expanded when in 1922 the Scott Agricultural Laboratories (currently called National Agricultural Laboratories) were established. The first Pasture Specialist, called a Grassland Improvement Officer, was appointed in 1930. Planted grass, legumes, and fodders were evaluated at Kabete and at demonstration farms at Njoro, Molo, Kitale, and Rongai to cover the main ley farming areas, while grazing studies of the indigenous swards at Kabete, Naivasha, Ngong, and Machakos were laid down to cover the main ranching areas (Ministry of Agriculture 1980).

An attempt was made in 1935 to look into pastoral areas. Grazing blocks were established in Maasai to monitor vegetation, but the study was abandoned due to difficulties of controlling grazing patterns caused by lack of water supply points and traditional land tenure patterns.

A review of all grassland research activities was held in 1950 and it was decided to establish regional centres to serve the main ecological zones. Ol Joro Orok, which had been established 6 years earlier, Molo and Kitale were established as centres for the higher and wetter regions, whereas Katumani and Marigat were established for the drier medium-altitude areas. That was also the beginning of a research program to provide information suitable for the smallholder African farmer as it was becoming clear that the possibilities of famine might cause a drain on the central administration. Programs from the main stations were coordinated with the established substations such as at Embu, Kisii, Kakamega, and also on demonstration farms so that the full range of situations could be investigated. To increase geographical coverage, pasture research activities were extended to Coast Province in 1960.
From the early 1950s, an East African based program of agricultural and veterinary research at Muguga included an Animal Production Division, and among its activities was the determination of the nutritive value of various feedstuffs, pastures included.

The achievements of the thrust of pasture research, gauged by the requirements of the times, were quite substantial. Good ley grasses were produced from the local varieties based on the level of success of dry matter production, vigour, nutritive quality, and persistency. Seeding activities and resistance to diseases were also looked into. Among the notable species of ley grasses were the Chloris gayana and its cultivars and Setaria sphacelata (Setaria ancepts). In the higher altitude areas it was common to see exotic ley grasses such as fescues and perennial rye grasses with or without legumes. A number of other grass and legume species and their ecotypes were collected and described botanically. They were evaluated to assess their suitability for the different climatic zones.

For all the promising and cultivated grasses, fodders, and legumes cultural practices such as seed bed preparation, time of planting, spacing, and seed rate were established. Weed control, fertilizer application, time of harvesting/grazing, and cutting heights and frequency were also studied. Forage conservation methods as hay, standing hay, or silage were studied and established (Orodho 1983). The picture that emerged within the high-altitude, high-potential areas between the 50s and 60s was that of a highly complex mixed farming system using very productive ley and legumes pastures and some other fodder crops. The excellence of farming in those areas was comparable to any in the world.

Through extension, the research results were passed to the settler community and it was easy for it to be propagated through pamphlets produced at the research stations and distributed on field days and at show grounds; as well as through field visits to the farms. Printed literature reached the farmers through the papers "The Kenya Farmer," the "Royal Agricultural Society journal," and the "Kenya Weekly News." Scientific papers have been published in various international journals (Appendix 2).
PASTURE RESEARCH FROM THE 1970s TO THE PRESENT

With the changes in land ownership and farm size, the earlier objectives of pasture research were slightly modified to direct attention to the small-scale farmers in heavily populated areas. However, in some of the major research stations, some work was still mainly based on areas that had no bearing on the requirements of the smallholders. Some major criticism on these lines were voiced by the Ad hoc Committee set up to review maize and pasture research in Kenya (Ministry of Agriculture 1980).

The establishment of the Range Management Division within the Ministry of Agriculture signaled the determination of the Kenya government to develop the range areas. The drier areas program, which had been based at Marigat and Katumani research stations, was separated from its parent station at Kitale. Work on drier areas continued to be carried out at Katumani and on a newly established Kiboko Range Research Station in 1967.

The Kitale-based programs, inclusive of those carried out on its affiliated out stations, were strengthened by a number of technical-assistance projects. In 1966, the Dutch-aided grass-breeding project was established with a major emphasis on ley grass production. From 1971-77 the British government funded a research project based at Kitale. The terms of reference of this project as spelt out by Goldson (1977) were:

(a) To provide scientific assistance that would enable the accumulated knowledge on pasture and forage species to be measured in terms of animal production and to be integrated into farming systems.

(b) To provide assistance for the extension of the results of pasture and forage work from the Kitale and Molo environments to other ecological areas important for intensive livestock production.

A detailed report of the activities of the program is given in the report mentioned and a list of technical reports that were compiled is also given.

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In 1974, the Food and Agriculture Organization of the United Nations (FAO) Norad-assisted project for grass collection and evaluation was initiated to provide a nationwide evaluation of plant species of potential usefulness for increased animal production. Work on this project was carried out in all the research stations given in Appendix 1 to cover the wide ecological zones of Kenya. In 1980, a United Nations Development Programme (UNDP)/FAO project on forage development and seed multiplication was started. Its terms of reference have been to develop some of the promising forage materials identified by the previous projects by producing seed or vegetative materials and by carrying out preextension trials on selected farmers' fields.

Apart from the reorganization at Kitale station, which has resulted in more relevant and wider objectives as spelt out by Orodho (1983), other pasture research stations have placed more emphasis on research based on zonal needs. Embu Agricultural Research Station has redirected its emphasis on the production of high-yielding fodder crops with appropriate technology to cater to the needs of the smallholder who produces milk under zero and semizero grazing.

From about the mid 1960s to the end of the 1970s the Kenya Agricultural Research Institute (KARI), formerly the East African Agricultural and Forestry Research Organization, concentrated in research on increasing beef production in the semi-arid areas. Currently, a limited program on range research has been maintained and the emphasis has recently changed to research oriented toward smallholder dairy production using Bana grass, deep litter from poultry, and other smallholder feed resources such as the role of systematic maize defoliation. Over the next few months there are plans to produce technical bulletins on their work to be used by farmers and extension workers.

Most of the research on rangelands is carried out at Kiboko Range Research Station. Katumani Research Station concentrates on research relevant to smallholder farming conditions prevailing in the Katumani and its environs. The current objectives of Katumani Research Station as spelt out by Orodho (1983) are
(a) To select and improve the nutritious forage and fodder crops that can supplement naturally grazed pastures in part or in whole with particular attention to the needs to sustain animal productivity during the dry season.

(b) To investigate the possible ways of maintaining dry-season fodder reserves such as the use of drought-tolerant fodder trees and shrubs and experimental development of small-scale technologies for preserving fodders.

(c) To maximize production and utilization of methodologies for farm by-products and crop residues.

(d) To increase output per animal through the use of better feeding management.

The Coast Agriculture Research Station, consisting of Mariakani and Mtwapa, cater to the humid coastal belt and the less-wet hinterland, respectively. Research work has an emphasis on identification and testing of pastures suitable in both areas.

The early 1970s saw a productive UNDP/FAO beef research project at Lanet on maize silage. From the mid 1970s to the present, research has changed to forage sorghum as an alternative to maize silage. From about 1979 a Small Ruminant Collaborative Research Support Programme (SR-CRSP) was started with the collaboration of the Kenya government and a consortium of U.S. universities under the leadership of Winrock International. The SR-CRSP in Kenya is on dairy goats. One of its activities is to look into feed resources for small ruminants in smallholder areas and also to study the nutritional and metabolic aspects of these feed resources (Sid Ahmed and Onim, personal communication).

In 1976, an Integrated Project in Arid Lands (IPAL) was started. Among its activities have been the study on fodder biomass, stocking rates, grazing/browsing characteristics of the small stock and camels, and a nutritional profile of the available feeds in the arid and semi-arid study areas.

At Egerton College, some work is being done on stall feeding of dairy cattle. At the Department of
Animal Production, University of Nairobi, a substantial amount of work has been done on digestibilities and utilization of pastures, fodders, and arable farm by-products such as sweet potato vines, wheat and barley straws, and on maize stover. (Those publications preceded by an asterisk in Appendix 2 refer to published work on arable farm by-products.)

Academic staff in the Department of Animal Production are also doing collaborative research with SR-CRSP and some Ministry of Agriculture research stations were at some stage involved in the IPAL programs.

ACHIEVEMENTS AND EXTENSION OF RESULTS

The achievements of almost 80 years of research are reflected in various published works. Orodho (1983) gives a comprehensive list of the publications stemming from the research. But the greatest tangible achievements were the thriving large-scale animal production enterprises of the 40s-60s in the "scheduled" areas. Currently, achievements are noticeable in the smallholder areas within the ecoclimatic zones 2 and 3.

But as late as 1980 concern was voiced on the relevancy of pasture research from the postindependence period. It was noted that emphasis was being made on extensive forage plant collections, which resulted in a large gene bank being established at Kitale. Efforts were first being made on evaluation of the species collected in terms of agronomic practices and animal productivity potential. It was also noted that pasture agronomic research had not been adequately supported by evaluation of animal productivity and that research on developing drought-resistant fodders in marginal areas was wanting. These unhappy observations are beginning to change now, and it is hoped that with increased impetus on smallholder-oriented research in both the high potential and marginal arable areas the situation will improve even more. Together with these changes in research accent there is a need for increased manpower training in the areas of pasture research and extension. Extension of the available relevant research is being undertaken at various levels through tours, field days, demonstrations, public media,
seminars, agricultural shows, and publications. The recently introduced "teach and visit" program by the Ministry of Agriculture under the sponsorship of the World Bank has had a positive impact on crops but without parallel achievements in animal production.

The challenges for pasture research and extension is to meet the expected demands for milk and meat production, both increasing at about 5.3/year. Increased milk production from the high-potential areas must come from the smallholders but they are now producing milk from land that is facing a very severe competition with crops owing to the high opportunity costs of the crops enterprise. Increased meat production will continue to be expected to come from the marginal and submarginal areas but there must be a better and safer understanding of the whole range of complex production factors coupled with adequate provision of the necessary infrastructure. These are difficult challenges.

Acknowledgments

I would like to thank D.B. Thomas of the Faculty of Agriculture, University of Nairobi for his time and useful discussion of the early work on pasture research in Kenya and also for permitting me to refer to his personal collection of printed material. I also wish to express my thanks to H.L. Potter, KARI, Kenya for allowing me access to his collection of references on pasture research in Kenya.

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National Agricultural Research Station, P.O. Box 450 Kitale.

Western Agricultural Research Station, P.O. Box 169, Kakamega.

Nyanza Agricultural Research Station, P.O. Box 523, Kisii.

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