

NATURAL RESOURCES SYSTEMS PROGRAMME
FINAL TECHNICAL REPORT

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Dryland applied research and extension project

Author

KARI

Organisation

Kenya Agriculture Research Institute
Regional Research Centre
P O Box 27
Embu
Kenya

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DFID Natural Resources Systems Programme

NRSP, HTSPE, Thamesfield House
Boundary Way, Hemel Hempstead, HP2 7SR
United Kingdom

t: +44 (0) 1442 202447
f: +44 (0) 1442 219886
e: nrsp@htspe.com
w: www.nrsp.org.uk

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**DRYLAND APPLIED RESEARCH AND EXTENSION
PROJECT (R5172)**

FINAL TECHNICAL REPORT

Kenya Agricultural Research Institute -
Regional Research Centre,
P.O. Box 27, Embu, Kenya

May 1997

ACKNOWLEDGEMENT

The Dryland Applied Research and Extension Project (DAREP) was implemented through inputs from a range of institutions which are acknowledged with gratitude. Funding for capital items, technical assistance and operating costs was provided through the Department for International Developments' (DFID - formerly ODA) Renewable Natural Resources Research Strategy, Natural Resources Systems Programme (Semi-arid Production Systems component). Kenya Agricultural Research Institute (KARI), through its Directors' office, provided technical inputs in agronomy, crop protection, livestock and economics and also administrative and logistical support. Kenya Forestry Research Institute (KEFRI) provided technical input in agro-forestry. Natural Resources Institute provided UK management and technical input in social anthropology and biometrics, an engineering input came through DFID's Associate Professional Officer Scheme (APOS). Technical inputs on animal draught power, animal health, forestry and post harvest processing came from the Ministry of Agriculture and Livestock Production which also gave front line extension support. Many other institutions provided technical support and collaboration including ICRISAT East Africa Programme, IITA, ICARDA, CIP, ICRAF, University of Nairobi Agricultural Engineering Dept., Katumani National Dryland Farming Research Centre, National Veterinary Laboratories and National Soil Laboratories at KARI-Muguga, Taita-Taveta Integrated Development Project and Kamarugu Project. Central to the projects' activities were the farmers and their local leaders from Mbeere, Tharaka and Central Isiolo who collaborated with enthusiasm.

FINAL TECHNICAL REPORT: DRYLAND APPLIED RESEARCH AND EXTENSION PROJECT (R5172) - May 1997

Executive Summary

1. The project was a collaborative project between the Kenya Agricultural Research Institute (KARI), the Kenya Forestry Research Institute (KEFRI) and NRI, and was funded as part of DfID's Renewable Natural Resource Research Strategy (RNRRS) through the Natural Resources Systems Programme (Semi-arid productions systems component). KARI nominated a project leader/agronomist, a livestock scientist and an economist; KEFRI an agro-forester, NRI a TC social anthropologist. DfID provided an agricultural engineering input through its APOS scheme.

2. The project purpose was initially broad, with an emphasis on strategic participatory research methodology development in parallel with technology development which responded to the needs of the local farming community. Due to re-structuring of the RNRRS, the project purpose was re-phrased in later stages to fit the "yellow brick" outputs. However, re-phrasing of the project purpose did not substantially alter the programme direction and activities which had been planned using the original objective (see Annex 2 containing logical frameworks from the two stages of the project).

3. Project outputs were both methodological and technical. A range of participatory methods for problem diagnosis, research design, trial implementation and evaluation, and demonstration and dissemination were tested and reported. Technology options and recommendations for producing new crops and varieties, crop utilisation, soil and water management, tools and tillage, animal health and agro-forestry were availed to government extension services, NGOs and farmer groups. Research results were made available to wider audiences within Kenya and in neighbouring countries through conference papers, posters and publications. (see annex 1). Project contributions were:-

- contribution to the strategic socio-economic research on participatory research options within NARS and RNRRS programmes,
- improved capacity of resource poor communities and national research institutions to conduct collaborative participatory agricultural research.
- a reduction of risks in dryland farming, and
- increased productivity and crop diversity enhancing household food security

Background

4. DAREP started in 1993, with the goal of improving the quality of life of small-holder farming families in semi-arid areas of Africa through inter-disciplinary development and dissemination of sustainable agricultural technologies and participatory research methodologies. DAREP took over an existing programme of dryland farming trials which had been initiated as part of a large ODA funded area based agricultural development project; the Embu, Meru Isiolo (EMI) Project. When

EMI was abruptly ended in 1990, these trials were continued through a bridging project known as the Dryland Applied Research Project which built up a network of trial sites and support staff in the local communities of the project area (Gibberd, 1994). The DAREP project was conceived within a five year time frame, with funding approved for the first three years. In 1995 however, nearly two years into the project, following re-structuring of the RNRRS, DAREP was reviewed and in early 1996 granted funding for a one year exit phase within the revised RNRSP framework - giving a total project lifespan of about three and a half years.

5. The project has tackled a range of agricultural development problems which were identified through diagnostic surveys in the project area, literature review and extensive consultations with national research and extension institutions during project formulation. These included:

- Limited local social organisation and infra-structure for developing and disseminating new technologies and for participating in the formal research process
- Low and erratic rainfall
- Declining soil fertility
- Food insecurity at household and community level
- Limited choice of adapted (short-season, drought tolerant and pest/disease resistant) crops and varieties
- High crop losses due to pests
- Low and risk-prone livestock productivity
- Limited knowledge on propagation and establishment of trees

Project Purpose

6. The project purpose was initially broad, with an emphasis on strategic participatory research methodology development in parallel with technology development which responded to the needs of the local farming community. Due to re-structuring of the RNRRS, the project purpose was re-phrased with emphasis on reducing risk in semi-arid farming systems of Kenya through the conclusion, documentation and dissemination of participatory adaptive research for improved conservation & use of water resources, the optimisation of land use and cropping patterns, the improved production of livestock and the establishment of on-farm trees. The project also purposed to document and disseminate important strategic experience gained in participatory methods for technology identification, evaluation and sharing. Specific focus was on conservation & use of water resources, and the optimisation of land use and cropping patterns (NRSP SAPS Purposes 1 and 2, and specifically to Outputs 1 and 2 of Purpose 1 and Output 2 of Purpose 2). During the exit phase (from March 1996 to March 1997) the focus was on completion of research activities initiated, documentation and dissemination of research findings.

Research Activities, Outputs and Contributions of Outputs

7. A modification of the recommended reporting format has been necessary due to the broad scope and multiple activities of the project. Reporting the activities, outputs and contributions under separate sections was tried, but resulted in repetition and poor flow. Instead each activity is described together with its resulting outputs and contribution. During the projects dissemination, activities were reported under thematic headings which cross-cut the main technical components (ref Conf abstracts). However for brevity and clarity of reporting here, and to retain consistency with the revised project proposal, six technical component based activity areas are used. Each activity group had one or more lead implementing researcher who took primary responsibility, supported by other members of the team as need arose. A reduction of time and operational funds limited inputs into some planned activities. At the same time, emerging opportunities resulted in some new activities being conducted using resources in place or resources available from other sources at no extra cost to the project. Modifications to planned activities are indicated under each activity heading. Due to the large numberwide range of activities, the technical details are not included but can be found in the attached list of project documents representing written dissemination outputs from the project.

Development, Analysis, documentation and dissemination of participatory methods

Planned Activities:-

8. Farming system characterisation,
Participatory diagnostic surveys
Adoption studies on selected technologies
Literature reviews
Stakeholder research planning workshops
Thematic research programme formulation
Socio-economic seasonal farm monitoring
Market studies
Activities strengthening farmer research capacity
Local research site management committees
Farmer open days and participatory extension
Training of research and field staff in participatory approaches and communication skills
Documentation and dissemination of participatory methodologies (including methodologies workshop)

Modifications:-

9. Due to both funding limitations and procedures recommending adoption studies be done 3-5 years post technology introduction, formal adoption studies were not conducted. Instead, analysis of on-farm seasonal monitoring data and follow of cowpea seed sales provided insights into seed systems and adoption of new varieties offered to farmers by the project.

10. Market study data not published as project economist was sent on six month training course,

11. Three more community level workshops were held at the site to:-

- a. review the dryland research agenda,
- b. review experiences with site committees and clusters, and
- c. initiate farmer input into location and variety specific dryland crop guidelines.

Outputs

12. Farming system characterisation through review of literature was conducted and presented in both poster and report format at the methodology workshop and end of DAREP conference.

13. Participatory broad-based diagnostic surveys were conducted in seven locations in collaboration with extension and local NGOs. In addition focused studies were conducted including a tool and tillage diagnostic survey, a livestock reconnaissance study, studies into indigenous knowledge and practices for worm control, mange control, fodder tree propagation and soil fertility management practices. All of these activities were reported and the findings used to inform experimental content and interpretation. Some experiences from these were presented as a report and poster during the end of project conference.

14. Ten literature reviews were conducted to inform research planning as follows; socio-economic overviews of Tharaka and Mbeere, dryland soil fertility management, cropping systems, soil and water management, rural mechanisation, indigenous soil and water conservation, livestock health and production, livestock nutrition and management of draft animals and use of multi-purpose trees in fodder production in semi-arid areas.

15. Six focused stakeholder research planning workshops were held in order to bring a breadth of technical expertise from research, extension, Universities and NGOs into the detailed research programme formulation and increase “ownership” of the research outputs. The outputs of the meetings (confirmed priorities for adaptive and strategic research and outline research protocols) were distributed to participants and disseminated at the end of project conference.

16. Thematic research programme formulation was undertaken using a small workshop format in order to integrate the various technical components within problem oriented themes and encourage cross-disciplinary reporting of research results. The experience and lessons were presented as a poster and paper at the end of project conference.

17. Instead of formal adoption studies, two studies provided indicative information on adoption. A follow up study of farmers buying seed of 32 new cowpea varieties sourced from IITA. Over half of the farmers were still planting the varieties after a second season and nearly half had given or sold seed of them to neighbours. A study of farmers' seed preferences and actual seed sources showed that 35% of new varieties in a particular season came from the DAREP sites, and a further 36% was saved from a previous season. Both studies were presented as posters and reports at the end of project conference.

18. Socio-economic farm monitoring data was analysed and written up in part due to time, data entry and data analysis constraints. Data on seasonal problem monitoring, seed source, seed selection and seed storage methods was presented in poster and report format at the end of project conference. Data on cropping choices and patterns, crop and soil management, tree planting history, tree management and livestock management was not analysed.

19. Market price study data was entered and analysed but not published as the economist responsible went on training.

20. Activities to build farmer research capacity included the following:-

-Establishment of two focused farmer research groups for tillage tools and water harvesting. These groups went through several cycles of research trials, starting with development of a research agenda, implementation, evaluation, re-formulation and through to development of recommendations for technologies being tested.

-Eight local research site management committees were elected by the local community during farmer open days. The site committees took a lead role in open days, seed bulking and distribution and resolution of local inter-personal conflicts. Research site committees were monitored, held self evaluation meetings and submitted reports on these. They were visited and encouraged to continue activities. Several have continued with seed bulking on a self-help basis.

-The formation of researcher farmer clusters in all ten on-farm sites improved on-farm trial monitoring and farmer to farmer communication. Farmer to farmer evaluation seasonal visits and competitions were established within the clusters as an effective means for hands-on training in formal research methods and stimulating farmer to farmer learning. Some of the clusters developed further into self-help groups for seed bulking and fund raising for agricultural activities.

-Three expert farmer panels for on-site screening of new sorghum, pearl millet and cowpea varieties were formed and operated for two seasons. This provided a forum for interaction between farmers and plant breeders. One of these panels also evolved into a self-help group.

-Two farmer study tours on water harvesting and soil and water technologies to other dryland districts were very effective for sourcing practical expertise in water harvesting and encouraging farmers to experiment with a wider range of water harvesting techniques.

-Community level workshops to review the dryland research agenda, and review experiences with site committees and clusters were held in eight communities, without any senior research or extension staff present. The results will be useful for informing future research activities and were documented in reports, papers and posters presented at the end of project conference.

-Seven farmer workshops, also without research or extension specialist input, were held to develop location and variety specific dryland crop guidelines. Reports and data from these workshops have been compiled, but not analysed and reported due to time and funding limitations. This activity may be picked up by the NARP II adaptive research programme.

21. The results of the activities to strengthen farmers research capacity were presented at the end of project conference as papers and posters and some were also presented at other conferences.

22 Farmer open days were held in all seven cropping seasons covered, including the final two drought seasons in which modest yields of many crops were achieved, demonstrating to farmers the value of new drought tolerant varieties and improved soil and water management methods. Average farmer attendance per season ranged from 1,500 to over 2,000 with roughly equal representation of male and female farmers and also school pupils. Farmers comments on trials were systematically recorded using participatory ranking and focused dialogue and used to evaluate and re-design treatments. A paper and poster on farmer open days was presented at the end of project conference.

23. Technicians and field staff received intensive training in facilitation and participatory approaches and methods, as documented in the trainers report. Research officers and technicians were trained in basic communication skills.

24. A workshop on researchers experiences with participatory methods was held. Papers presented at the workshop were made available at the end of project conference.

Contribution to output: Experiences in participatory methods for technology identification, evaluation and sharing

25. The formal research and dissemination capacity of resource poor farmers has been built up in the project area. Farmers are now in a stronger position to conduct their own research and also make demands on the national research and extension system. A community level research infrastructure is in place which is available for use by the KARI/ODA NARP II adaptive research and other programmes. Researchers and specialists in the national research and extension systems have improved capacity to use participatory approaches. Experience with using a range of participatory methods has been shared with other KARI researchers in a workshop and at the end of project conference. The experiences have been written up as a case study which was presented at an ODA regional review of experiences with participatory technology development. There is further scope for analysing and documenting experiences with participatory methods, depending on the level of demand and interest from other potential users.

Soil and water management, tools and tillage research

Planned activities:-

26. Diagnosis of constraints related to tillage and tools,
Testing of new tools,
Linkages with local artisans,
Trial on farmer adaptation of soil and water management (SWM) techniques
Verification of SWM techniques on experimental sites
Verification of SWM techniques on farmers fields
Publication and dissemination of soil and water management/rural mechanisation
literature review
Documentation and dissemination of research findings

Modifications:-

27. Three additional activities were conducted arising from demands from site committees, local artisans and extension:-

- . ox weeding demonstrations in four sites,
- . tools markets in collaboration with a local NGO,
- . farmer recommendation workshops for water harvesting

Research outputs

28. All proposed outputs were delivered. The results of the diagnostic survey were compiled and presented to farmers as a basis for planning the on-farm research programme in tools and tillage. Farmer groups were involved in tools testing. In order to address tool supply and design issues, linkages were formed with local artisans culminating in tools markets where farmers judged tools on display and explained their requirements to local artisans. The results of on-farm and on-station experimentation on rain water harvesting and conservation were documented. Tentative recommendations were developed at workshops with collaborating farmers and the results were shared with extension and researchers from other semi-arid areas at a dissemination workshop. Nine technical papers and posters reporting results were presented at four conferences and all technical reports displayed at the end of project dissemination conference. Ox weeding demonstrations for farmers were held at four sites.

Contribution of outputs

29. Technologies (external water harvesting, pitting, basins, and tied furrows) tested and adapted by farmers have reduced their risks and increase production, particularly on smaller farms where land is limiting. Yield increases of 10-15% were achieved in good rainfall seasons and much higher relative yields in drier seasons. Extension were collaborators in the research process and the Soil Conservation Branch are currently working on a SIDA sponsored handbook for rainwater harvesting which includes the results and farmer

recommendations from the DAREP research. Further verification, extension and adoption monitoring within the focused research groups has been proposed as a component of the NARP II adaptive research programme. While initial uptake may be slow, in the longer term this technology will make crop production more sustainable, reduce risks and increase scope for crop diversification.

Selection and management of genetic resources for semi-arid conditions

Planned activities:-

30. Variety screening of popular drought resistant crops cowpeas, pearl millet, sorghum, chickpeas),
Testing, agronomy and utilisation of new crops (groundnuts, cassava, sweet potatoes, proso millet, dwarf pigeon peas, wheat, dryland beans),
Seed bulking,
Study of preservation of green vegetables
Trial on control of kiwi weevil in cowpeas
Documentation and dissemination of research

Modifications:-

31. A workshop to develop dryland recipes for utilisation of preserved vegetable leaves was conducted in order to prepare for rapid dissemination of the technology.

32. While all crop trials were planted in the two final seasons (April and November 1996 rains), failure of rains in both seasons seriously hampered trial completion and seed bulking, as well as delaying analysis and documentation activities. A further factor was less than anticipated agronomic input and not all trials conducted at the research sites were fully analysed.

Outputs

33. Farmers visiting research sites were able select from a very wide range of drought tolerant crops and varieties for adaptive testing on their own farmers. The results of on-farm variety evaluations by farmers were systematically recorded, analysed and reported in technical reports. Recipes and options for the utilisation of new crops were demonstrated to farmers using participatory demonstration methods. Outline results from all crops trials were presented in the projects technical reports. In addition more comprehensive results of research conducted on sorghum, cowpeas, millet, wheat and groundnuts was presented at four conferences in the form of ten papers and posters.

34. Following a successful recipe development workshop involving farmers and home

economists from extension, the cowpea leaf drying and utilisation methods were popularised to very many farmers through participatory field days. This activity was documented and presented in papers and posters presented at three regional conferences in Zimbabwe, Tanzania and Kenya. However, chemical analysis of preservation options tested were not completed, due to the high cost, which was beyond the scope of the project exit strategy budget

35. Preliminary results from the kiwi beetle control trials indicated limited effect of neem extract compared to conventional insecticides, and indicated scope for more strategic use of these as shorter term strategies. Results were documented and disseminated as papers presented at two conferences.

36. Seed bulking activities were very successful mid-way through the project, with large quantities of seed for a wide range of new crops and varieties being sold to farmers (for example half ton of more than 30 cowpea varieties in one season). However, seed bulking was seriously affected by the two consecutive droughts in the final year resulting in many collaborating farmers losing seed of new varieties.

Contribution of outputs

37. New drought escaping varieties and new drought tolerant crops have been adopted by collaborating farmers, spreading risk through crop diversification and contributing to household food security by providing earlier food and a wider choice of foods. ICMV 111, an early pearl millet variety has proved particularly popular, closing the hunger gap by up to two weeks. Many of the new cowpeas have been appreciated for their leaf and grain qualities for household food. A number of farmers have started planting small areas of the introduced varieties of cassava, dwarf pigeon peas, proso millet and groundnuts. Preliminary results in crop protection of legumes indicate potentially high returns to strategic pest control measures.

38. Pest control will require further adaptive research being proposed under NARP II. Proposals for continued work with sorghum, millets and cowpeas using farmer expert panels have been made under NARP II adaptive research. Preservation of germ-plasm which survived the last two droughts has been made a priority by the KARI regional centre director. The project staff have supported Kamarugu, a local NGO in an application to the ODA NGO support programme for further bulking and dissemination of new varieties and crops and establishment of community level seed banks. Seed has been distributed to NGOs in other semi-arid parts of Kenya.

4.4 Soil fertility studies

39. Given the complexity of the soil fertility problem, basic research leading to strategic

and adaptive interventions was planned to be implemented as part of a Ph D programme of a team member.

Planned:-

40. On farm soil researcher managed fertility trials
Soil fertility pot experiments at experimental sites
Laboratory analyses
Soil organic matter cycling experiments
Production of interim report.

Modifications

41. Due to high management requirements, the original 10 on-farm trial sites were reduced to 4 and replicated 3 times in each farm.
42. High temperatures and water problems forced abandonment of the pot experiment and instead on-farm micro-plots were used in an N5 labeled experiment to determine biological N₂ fixation by cowpeas.
43. A soil fertility management survey and site characterisation of on-farm trial farms were conducted in order to contextualise on-farm experimental results.
New millet and sorghum varieties were evaluated under high and low fertility on station,
44. ICMV221, a popular new pearl millet variety was evaluated on-farm under high and low fertility conditions

Outputs of Soil fertility studies

45. All proposed and additional outputs were delivered. A soil fertility management survey, site characterisation, replicated on-farm trials, pot experiments, laboratory analysis and soil organic matter experiments were all conducted and also the fertility observation trials and on-farm variety trials. An interim report was written and presented to the Soil Science Dept., University of Reading for Ph D. upgrading which was accepted. Three conference papers have been presented; one on soil fertility management practices on small-holder farms in semi-arid areas, one comparing laboratory results with farmers assessment of soil fertility and one reporting the methodology for on-farm testing of a new variety under high and low fertility.

Contribution of Outputs: Soil fertility limitations and research opportunities.

46. Phosphorous has been identified as one of the major limiting plant nutrients in small-holder farms, together with low soil organic matter levels. Addition of small amounts of P has been shown to boost crop production and proper use of organic matter through manure application boosts production and has high residual values. Application through further adaptive research will reduce risk and increase production, particularly in conjunction with use of the new soil and water conservation techniques and new crop varieties introduced by the project. The new millet variety ICMV 111 has proved to yield well under low fertility and respond well to fertility improvements. Farmers have been able to assess the potential of

a large number of new varieties under high and low fertility conditions without exposing themselves to risk.

4.5 Increasing productivity and reducing risk in livestock keeping in semi-arid areas

Planned:-

47. Study on epidemiology of worms in goats
Screening of local concoctions for indigenous mange control
Screening herbal de-wormers in goats
Documentation and dissemination

Modifications:

48. Time and funds limited completion of epidemiology and herbal de-wormer screening. Due to high demand from farmers in Gategi, a farmer study tour on indigenous mange control was conducted.

Outputs

49. Research on epidemiology of worms in goats included on-farm monitoring of selected animals for four seasons, two of which were not thought to be typical. The recommendation was for a more detailed climatological study for developing strategic economical worm control recommendations. Preliminary results were presented in paper and poster format at the KARI scientific conference and end of project conference.

50. Screening of the most popular herbal de-wormers in goats was completed, but some lesser known herbs were not included in the trials. Results have received positive evaluations from farmers, but laboratory analysis was not supportive at the scientifically accepted standards of efficacy, raising the issue of whose standards to use in on-farm evaluation. Results have been documented and disseminated as a paper and poster at the end of project conference.

51. Research on indigenous mange control was successfully completed. Several local concoctions were judged equivalent to the commercial drug using body condition score and weight gain parameters, but a mixture of castor oil and *tamarindus indica* pods was judged the best by farmers. The research generated considerable interest among farmers and also from researchers in other countries in the region. Results have been documented and disseminated through paper and poster presentations on six separate occasions; twice in Kenya, twice in Tanzania, once in Zambia and once in Zimbabwe. A farmer to farmer study tour proved a highly effective dissemination approach with farmers participating in turn training others in their local area.

Contribution to Outputs: Increasing livestock productivity and reducing risk

52. Risk has been reduced and livestock incomes more secure through introduction and popularisation of an effective low cost and locally available remedy for mange control. To further consolidate the benefits, the link with agro-forestry in the preservation and planting of more medicinal species should be followed up. The work on epidemiology also needs to be completed, with more efforts to access farmer knowledge and practice on climatic effects and their own strategic interventions in animal health. Work proposed on livestock nutrition, including the work initiated by ICRAF on use of indigenous fodder trees, would further reduce risks and increase returns to livestock production.

4.6 Addressing limitations of on-farm tree establishment in semi-arid areas

Planned activities:

53. Diagnostic fruit tree trials
Evaluation of water harvesting for tree establishment
Evaluation of termite control methods in tree establishment
Windbreak observation,
Planting niche monitoring
Documentation and dissemination

Modifications -

54. A propagation study was planned later, following an opportunity for post-graduate research which was designed to link in with and be funded through an ODA NRSP livestock feed systems work being extended to the semi-arid areas. In the event this project was not extended, but managed to fund the start of the propagation research while DAREP picked up the bulk of the costs.

Outputs

55. The diagnostic fruit tree trial was completed and results documented and disseminated as a paper at the end of project conference. Results confirmed the importance of termite and drought constraints to tree establishment and also the potential for using grafted mangos for high value fruit production in dry areas.

56. Water harvesting options for tree establishment have been evaluated technically and through farmer assessment, and results disseminated as papers in conferences in Tanzania and Kenya. Based on farmer modifications to on-farm trials, stone mulching is a more popular option, followed by v shaped catchment which however carries risks of water-logging during heavy rains.

57. Termite control methods in tree establishment have been evaluated on-farm and at the research sites and the results documented in a paper presented at the end of project conference. The results suggest a complex interaction between termite attack and drought stress - one which may over-ride many of the single effects of different concoctions applied at establishment.

58. The windbreak trial was established at Isiolo, but its long-term nature made full technical evaluation within the time-span of the project unfeasible. A poster based on tree survival was resented at end of project conference.

59. Planting niche monitoring was completed, documented and the results presented in a paper at the end of project workshop. Boundary and homestead planting of multi-purpose species was the main outcome.

60. Controlled propagation trials were conducted on two popular indigenous fodder species, following a key informant survey. On-farm propagation verification trials followed a more detailed formal survey and farmer training workshop. Data is being analysed for M. Phil. Thesis at Centre for Arid Zone Studies, Bangor.

61. A paper on methodology and challenges in dryland agro-forestry research was presented at two conferences.

Contributions to Outputs: Limitations to on-farm tree establishment and propagation

62. A contribution was made to expanding income opportunities and improving diet through the introduction of a variety of fruit trees (grafted mango, guava and papaya) to the project area. Continued monitoring of farmer management and mortality may be worthwhile. To build on the initial research, a trial on mango variety on-farm screening has been proposed under NARP II adaptive research programme.

63. Options for reducing risk of tree mortality through a range of termite control and water harvesting options were evaluated with farmers and encouraged environmental conservation through tree planting. Farmers continue to experiment with these methods as trees present an alternative to livestock as a longer investment.

64. Easier propagation methods, particularly for *melia volkensii*, promise to boost the commercialisation of dryland timber production, particularly with the depletion of forest resources in higher rainfall areas of Kenya.

DOCUMENTS LIST

for Dryland Applied Research and Extension Project (DAREP), KARI Regional Research Centre, Embu

Introduction

The documents listed below contains most of the documents produced by the DAREP project between July 1993 and January 1997 reporting project activities. As these are all working documents, and not finished publications, we would request that the contents are not quoted or reproduced in any form without the prior consent of the author/s.

ANNUAL REPORTS

- AR.1 Annual Report 1993
- AR.2 Annual Report 1994
- AR.3 NRI Annual Report 1995

TECHNICAL REPORTS

- TR.1 First six monthly (August, 1993 - March, 1994) technical report
- TR.2 Second six monthly ((April, 1994-September, 1994) technical report
- TR.3 Third one year (October ,1994 - September, 1995) technical report

WORKING PAPERS

- WP.1 Participatory Approach to Variety Selection, Dissemination and Seed Production in Semi-Arid Kenya: SAARSR-E Symposium, Harare, October, 1995 2nd-4th
By: A. Sutherland, J. Muthamia & A.N. Micheni 10 pages
- WP.2 Overview of Participatory Methods used in Dryland Applied Research and Extension Project (DAREP/RRC Embu Workshop 22-23 October 1996)
By: A. Sutherland 17 pages
- WP.3 Progress Report on Socio-Economic Studies and Participatory Research Activities (DAREP Project Completion Meeting 3-6 February, 1996)
By: A. Sutherland & J. Ouma 27 pages

- WP.4 Notes on Diagnosing Soil Management Issues and Related Socio-Economic Issues, Using a Farming Systems Approach: Workshop on Diagnosis of Farming Systems Constraints Related to Soil Management, Manor House Agricultural Centre, Kitale : September 1994 26-30
By: A. Sutherland 14 pages
- WP.5 Experiences with "Handing Over the Stick" : Research Agenda Review by Farmer Research Panels in Semi-Arid Eastern Kenya"
By: A. Sutherland, J. Ouma & P. Mutwiri 18 pages
- WP.6 The Participatory Research Process of the DAREP Soil and Water Component (DAREP Soil & Water Harvesting/Conservation Tillage Workshop" : 4-6 June 1996
By: A. Sutherland & D. Mellis 35 pages
- WP.7 Dryland Applied Research and Extension Project On-farm agronomy, Livestock and Agroforestry Trials: February, 1994
By: Irungu J. Sutherland A. Kang'ara J.& Kidundo M. 10 pages
- WP.8 The Use of Indigenous Knowledge in Increasing Productivity: September, 1994
By: Kidundo M. 7 pages
- WP.9 Fallow System in Semi-Arid Zones of Africa: September, 1994
By: Kidundo M. 5 pages
- WP.10 Participatory Technology Development by Jua Kali Metal Workers for Farmers in Semi-Arid Embu and Tharaka: Paper for FIT National Forum "New Approaches to Development" March, 1995 Jua Kali
By: D. Mellis, H. Skinner & B. Mwaniki 9 pages
- WP.11 Challenges to Draught Animal Technology in Semi-Arid Areas: Experiences from Lower Embu and Tharaka: Paper Presented at Second Kenya Network for Drought Technology (KENDAT) National Workshop on Meeting the Challenges to Draught Animal Technologies and Use in Kenya: March 27-31, 1995 Animal
By: D. Mellis & B. Mwaniki 9 pages
- WP.12 Challenges to Draught Animal Health and Husbandry, March, 1995
By: J.N. Kang'ara 9 pages
- WP.13 Utilization of Calliandra and Other Multi-purpose Trees as a Protein Supplement in the Smallholder Dairy Farms: April, 1995
By: Kang'ara J. 7 pages
- WP.14 The Agro-ecological Zones and the Agroforestry Potential: April, 1995
By: Kidundo M. 8 pages
- WP.15 Challenges for Agroforestry Research: April, 1995
By: Kidundo M. 5 pages
- WP.16 Dryland Farming Systems Development in Embu and Tharaka Nithi Districts of Kenya: An Update Analysis :September, 1994

- WP.17 Water Harvesting and Conservation Tillage in Semi-Arid Kenya: Conclusion of DAREP S&W Component Proceedings of a Workshop : 4-6 June, Embu
By: David Mellis 116 pages
- WP.18 Experiences with Using Broad-Based Diagonosis (BBD) as An Inter-disciplinary Entry Point DAREP/RRC Embu Workshop on Experiences with Participatory Methodologies - EAST College, Embu, 22-23 October, 1996
By: A.J. Sutherland and J. Ouma 14 pages
- WP.19 Experiences with Farmer Research Clusters & Farmer to Farmer Evaluation Tours DAREP/RRC Embu Workshop on Experiences with Participatory Technology Development, EAST College, Embu, 22-23 October, 1996
By: A.J. Sutherland 14 pages
- WP.20 Experiences with Developing Research Themes for Integrating Technical Components in Planning and Reporting Dryland Adaptive Research
By: A. Sutherland 9 pages
- WP.21 Experiences with Farmer Research Agenda Review Workshops: DAREP/RRC Embu Workshop on Experiences with Participatory Technology Development, EAST Embu 22-23, October, 1996 College,
By: A. Sutherland 7 pages
- WP.22 Experiences with Involving Other Stakeholders Through Participatory Research Planning Meetings
By: A. J. Sutherland 10 pages
- WP.23 Background Paper Prepared for DAREP/RRC Embu Workshop on Experiences with Participatory Methodologies, EAST College, Embu, 22-23 October, 1996
By A. J. Sutherland
- WP.24 Dryland Applied Research and Extension Project (DAREP): On-Farm Trials Feb.22 - March 2nd 1994 By:J.W. Irungu, J. Kang'ara, M. Kidundo and A. Sutherland 9 pages
- WP.25 DAREP On-Farm Trials: Tools and Tillage Experiences Paper Presented at the Regional Workshop on On-Farm Trials held in Embu, Kenya Feb.22 - March 2nd 1994
By: H.Skinner & B. Mwaniki 6 pages
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By: J.O. Ouma and D. Mellis 11 pages
- WP.27 "What is the Problem? - Challenges in Diagnosing Animal Draught Constraints and Opportunities in Tharaka and Lower Embu, Kenya"
By: A. Sutherland 23 pages
- WP.28 Participatory Evaluation of Sorghum Varieties in Eastern Kenya
By: J.G.N. Muthamia, J.W. Irungu, A. Sutherland, J.Ouma and A. Micheni 10 pages
- WP.29 Maintenance of Soil Fertility and Organic Matter in Dryland Areas

By: J.W. Irungu, Geoff Warren and A.N. Micheni

- WP.30 Notes on Socio-Economic Issues in Crop Management: Implications for Agronomic Research : Paper presented at (MIAC) Crop Management Forum, Wida Nairobi, 17-18 March, 1994 By: A. Sutherland Hotel,
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- WP.32 "Meeting the challenges of animal traction through participatory technology development: Experiences from a semi-arid area of Kenya. By: M. Harriet and D. Mellis

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- LT.2 Soil and Water Management, February, 1995
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By: David Mellis. 12 pages
- LT.4 Literature Collection in Isiolo District, November, 1994
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- LT.5 Relevant Socio-Economic Literature in Lower Embu, February, 1995
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By: Skinner H. and Micheni. A. 25 pages
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- SR.3 Livestock Reconnaissance Report. An Overview of Livestock Production in Semi-Arid Areas of Embu and Tharaka/Nithi Districts : September, 1993

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- SR.4 Tharaka Diagnostic Survey : December, 1993
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By: Sutherland A.
Vol.I Farming in Mbere, Overview Report - 73 pages
Vol.II:
Part One : Farming in Kilia - 56 pages
Part Two : Farming in Mbita - 39 pages
Part Three : Farming in Machanga - 71 pages
Part Four : Farming in Kerie - 30 pages
- SR.6 Cowpea Follow-up Study
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- SR.7 A Report on an Informal Survey with Key Informants from Mbeere, Kitui and Kibwezi Districts in Kenya
By Kidundo, M.

STUDY TOUR REPORTS

- STR.1 Tour of ASAL Programmes in Eastern & Coastal Provinces (Machakos, Taita Taveta, Kwale and Kilifi Districts)
By: David Mellis March 21-25, 1994 10 pages
- STR.2 Tour of Indigenous Water Harvesting Methods in Ukambani 3-6 Jan. 1996
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- STR.9 Tropical Agroforestry Course, University of Edinburgh : September 94

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- STR.11 A Study Tour of Farmer Participatory Research Projects in East Africa :
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- 16-17 April 1996 By: A. Sutherland 4 pages

TECHNICAL DOCUMENTS

- TD.1 DAREP Tools and Tillage On-farm Research Methodological Report :
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By: The Field Staff 22 pages
- TD.15 Report for KARI/NARP I 2 pages
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- TD.17 Report on DAREP In-house Technical Review : 22-25 May 1995
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- TD.18 Report on Tools and Tillage meeting - farmers and Jua Kali tool producers,
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By: Skinner H. June 1994 10 pages
- TD.19 Report on DAREP Experiences with Farming Systems and Characterisation and
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- TD.23 DAREP Highlights 1995/96 20 pages
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- TD.29 DAREP Progress Report to June 1995 and Future Plans 19 pages
- TD.31 Report on Evaluation of DAREP Farmer Research Clusters
By: A Sutherland
- TD.32 Minutes of the DAREP Cropping Systems Research Planning Workshop:
21st February, 1995 15 pages
- TD.33 Minutes of the DAREP Soil and Water Management Research Planning Workshop:
22nd February, 1995 19 pages
- TD.34 Minutes of the DAREP Socio-Economic Research Planning Workshop: 23rd
February, 1995 8 pages
- TD.35 Minutes of the DAREP Animal Nutrition and Draft Power Research Planning
Workshop: 24th February, 1995 10 pages
- TD.36 DAREP: Summaries of the 1995 Research Protocol March, 1995
By: M. Kidundo 16 pages
- TD.37 Progress Report on Socio-Economic Studies and Participatory Research Activities :
Prepared for DAREP Project Completion Meeting 6th February, 1996
By: A. Sutherland & J. Ouma 27 pages
- TD.38 DAREP Frontline Staff Sites Report on Farmer Participation Experiences for:
Machang'a
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Mutuambare
Isiolo
Kaanyaga
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- TD.39 Report of the Training Workshop for Frontline Extension Staff in Participatory
Approaches: Kiritiri, Embu 19th Nov. - 1st December 1995
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- TD.40 Proposed Programme for Completion of Dryland Applied Research and Extension
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- TD.40 Report on DAREP Field Days - September 1995
- TD.41 DAREP Research Highlights for 1994 4 pages
- TD.42 Agronomic research in arid and semi-arid areas of Eastern Kenya.
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- TD.43 Meeting challenges of nutrition and health of draught animals in ASAL DAREP
experiences. By: J.N. Kang'ara

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- CP.1 Soil fertility status in smallholder farms in the semi-arid areas of Tharaka Nithi district: Farmers' assessment compared to laboratory analysis: Paper presented at the KARI Scientific Conference, 30th October - 1st November, 1996 By: J.W. Irungu, G.P. Warren & A. Sutherland 13 pages
- CP.2 Evaluation of vegetable preservation methods and dissemination by J.N. Kang'ara 15 pages
- CP.3 Accelerated technology development: The case of millet and Dryland Embu and Tharaka Nithi Districts: Paper presented at 5th KARI Scientific Conference, 30th October - 1st November, 1996 - By J. Ouma, A. Sutherland, J. Muthamia, C.R. Mugo, J.W. Irungu and S. King 22 pages
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- CP.5 Setting research priorities with farmers: Experience of DAREP paper presented at the KARI Scientific Conference, 30th October - 1 November, 1996- By A.J. Sutherland, S. Mellis, C.R. Mugo 34 pages J. Ouma,
- CP.6 Methodology innovations in Dryland Adaptive Research: The use of farmer expert panels in technology screening paper presented at the KARI Scientific Conference, 30th October,- 1 November, 1996 -By: J.O. Ouma, A. sutherland, D. Mellis, B. Kanyenji, S. Mukuru and P. Mutwiri 18 pages
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- CP.9 The need of epidemiological studies on worms in ASAL Areas for sustainable livestock production: Paper presented at the KARI Scientific Conference, 30th October- 1st November, 1996. By: J.N. Kang'ara, J.N. Kamau, J.N.Njiru and W. Wakhusama 4 pages
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CP.13 The participatory research: Process of the DAREP soil and water component: Paper presented for presentation to the SAAFR-E fifth regional conference, Arusha, Tanzania 23rd - 25th September, 1996 By: D. Mellis

End of Project Conference Papers

Theme One: Development and evaluation of participatory methodologies and institutions for adaptive research, extension and dissemination

****Linking Research And Sustainable Technology Supply Through Participatory Technology Development In Dryland Farming Areas** *Sutherland, A.J., D. Mellis, J. Kang'ara, J. Muthamia*

Site Management Committees: A Local Institution To Support Technology Demonstration And Dissemination In Marginal Areas *Kang'ara, J.N.N. And J. O. Ouma*

Focused Farmer Research Groups: A Method For More Effective Technology Development And Dissemination. *Mellis, D.*

****Participatory Varietal Screening: The Case Of Millet In Dryland Embu And Tharaka/Nithi Districts, Kenya** *Ouma, J.O., A.J. Sutherland; J.Muthamia, C.R.Mugo, J.W.Irungu And S.King*

Theme Two: Risk Reduction and increased productivity in Mixed Dryland Farming

Participatory Cultural Control Of Termite Damage On Tree Seedlings In The Semi-Arid Areas *Ochieng, D., M. Kidundo And M. Karichu*

Control Of Kiwi Beetle (*Piezotrachelus Varium* Wagner) On Cowpea In Semi-Arid Eastern Kenya: Search For Cost Effective Approach *Gethi, M., J. Muthamia, Sutherland A.J. And Karichu M.*

Development And Evaluation Of Water Harvesting / Conservation Techniques For Trees In Semi-Arid Eastern Kenya. *Ochieng, D., M.Kidundo And M.Karichu*

Rainwater Harvesting For Crops In Semi-Arid Areas *Mellis, D., H. Matsaert And A. Micheni*

****Screening The Herbal Dewormers For Efficacy In Worm Control.** *Kangara, J.N.N., J.N.Kamau, J.N. Njiru, W.W.Wakhusama, R. W. Gathambiri And J.M. Karanja*

Theme Three: Improving Household Food Security and Nutrition

****The Household Food Security Challenge In Semi-Arid Areas: Diagnosis And Planning Of Research Interventions** *Sutherland, A.J., J.W. Irungu, J. Kang'ara, J. Muthamia And J. Ouma*

Cowpea Varietal Evaluation In Semi Arid Areas Of Eastern Kenya *Muthamia J.G.N., J. W. Irungu, And E.N. Njiru*

****Participatory Evaluation And Utilisation Of Dryland Food Crop Recipes And Vegetable Preservation Methods** *Kang'ara, J.N.N., A.J. Sutherland And I. Gachoki*

Theme Four: Improving the sustainability of Mixed Farming Systems

****Soil Fertility Management Practices In Smallholder Farms In Semi-Arid Mbeere In Eastern Kenya: An Analysis Of The Farming Systems.** *Irungu, J.W., M. Wood, G. Warren And J.R. Okalebo*

****Use Of Indigenous Knowledge For Sustainable And Effective Mange Control In Goats.** *Kang'ara, J.N.N., J. N. Kamau, J.N. Njiru, R.W Gathambiri And J.M. Karanja*

Key Informants Survey As A Diagnosis Tool For Propagation Of *Melia Volkensii* - A Potential Agroforestry Tree In Semi-Arid Kenya¹ *Kidundo, M.*

An Appraisal Of Soil Fertility In Smallholder Farms In The Semi-Arid Areas Of Tharaka Nithi District: Farmers' Assessment Compared To Laboratory Analysis¹. *Irungu, J. W., A.N. Micheni, G.P. Warren And A. Sutherland*

Theme Five: Introduction of low input Cash crops

Groundnut And Proso Millet As Alternative Low Input Cash Crops *Muthamia, J.G.N., J.W.Irungu, A.J. Sutherland, E.N. Njiru And C.N. Mugo*

On-Farm Fruit Tree Planting As A Diagnostic Tool: Experiences From Semi-Arid Eastern Kenya *Kidundo, M.*

Theme Six: Reducing the (Female) Labour Burden

Development And Introduction Of Affordable Planting And Weeding Tools For Dryland Areas *Mellis D., H. Matsuert And B. Mwaniki*

****** These papers were also presented as posters

Poster Presentations

Theme One

Using broad-based diagnostic surveys (BBDS) for research priority setting and team building

Experiences with research agenda review by researcher farmer panels in semi-arid Eastern Kenya

Farmer to farmer evaluation - an approach to motivating and training farmer researchers

Dryland Applied Research and Extension Project's experiences with farming systems characterisation and targeting

Involving other stakeholders through participatory research planning workshops

Seasonal monitoring of on-farm farmer's problems - is it a cost effective tool for problem verification and household characterisation?

Seed practices and preferences in semi-arid areas

Experiences with developing research themes for integrating technical components in planning and reporting dryland adaptive research

Experiences with farmer open days for technology evaluation and dissemination

Tools/technology market as an approach to linking agricultural technology manufacturers and consumers

Experiences with farmer research clusters

Theme Two:

Climatic Data Monitoring (Showing Summaries Of Rainfall, Temperature And Other Data As Part Of Background Information To The Project Area)

The Importance Of Epidemiological Studies On Formulation Of Strategic Worm Control Programme In ASAL Areas.

Theme Three:

Participatory Evaluation Of Sorghum Varieties In The Arid And Semi-Arid Areas

Theme Four:

Windbreak Demonstration Trial At Isiolo

Soil Fertility Improvements Under Manuring In Semi-Arid Lower Embu And Tharaka-Nithi

Residual Value Of Manure In Dryland Arable Cropping

Sustainability Of Dryland Arable Cropping And Soil Fertility Improvement Using Manure

On-Farm Performance Of New Pearl Millet Variety, ICMV221 Under Various Soil Conditions

Theme Five:

Grams Varieties For The Semi - Arid Lands: Performance And Utilization

Performance Of Wheat In Non-Traditional Wheat Growing Areas Of Semi-Arid Eastern Kenya

Theme Six:

Gender Participation In Agriculture And Agricultural Research: Experiences From Dryland Areas Of Eastern Kenya

Demonstrations On Plough Weeding Using Expert Farmers As Agricultural Demonstrators

PROJECT TITLE: DRYLAND APPLIED RESEARCH AND EXTENSION PROJECT

PERIOD OF FUNDING: 1 OCTOBER 1992 - 30 JUNE 1995

BRIEF DESCRIPTION: ADAPTIVE RESEARCH PROJECT FOR SMALL HOLDER FARMERS IN SEMI-ARID OF EMBU, MERU AND CENTRAL ISIOLO DISTRICTS OF KENYA, FEATURING CLOSE COLLABORATION BETWEEN KENYAN RESEARCH INSTITUTES, EXTENSION SERVICES, LOCAL INSTITUTIONS AND FARMERS

FUNDING SUMMARY: NRI CONTRIBUTION: E224,000 PER YEAR

GOK CONTRIBUTION: E14,000 PER YEAR

PROJECT STRUCTURE

ACHIEVEMENT INDICATORS

HOW QUANTIFIED/ASSESSED

ASSUMPTIONS/RISKS

WIDER OBJECTIVE

To improve the quality of life of small-holder farming families in semi-arid areas of Africa through development and dissemination of sustainable agricultural technologies and participatory research methodologies.

Long term increase in income and yields.

Population sustained without environmental degradation.

Central Statistics office reports on long term trends of provides, area and yield

Sample surveys & agricultural officers' yield & crop area data..

Soil & Water conservation dept reports.

Political conditions remain stable and no radical changes in government policy occur which disrupt economy.

IMMEDIATE OBJECTIVES

To identify with farmers, the constraints to improved production, income and sustainable productivity.

Constraints are elaborated and ranked.

Annual reports

Half yearly technical reports.

site committee reports.

Researchers and farmers are able to identify constraints accurately

To identify solutions to those constraints through applied research on sites & with farmers on their farms, which are appropriate for a range of social groups.

Research process develops sustainable strategies which are adopted by farmers and which lead to increased productivity and income or reduced risk under adverse conditions.

Research reports 1/2 yearly over project life.

monitoring reports on adoption rates and characteristics of adapters.

Severe climatic variation may preclude conclusive verification of hypotheses.

To develop or identify relevant technologies in the field of crop varieties, crop protection, new crops,

Increased number of extension recommendations. Improved adoption of

DAREP six-monthly reports.

Identification of farmer constraints in Lower Embu, Meru and central Isiolo.	Analysis of physical and social data to establish groups with similar environmental characteristics, opportunities and needs.	Survey reports.	Full team assembled and able to function effectively as an interdisciplinary team.
Description of farmers technical knowledge, methods and rationale.			
The establishment of an adaptive research infrastructure that can respond effectively to the needs of farmers and priorities of local development committees.	Sites selected and research agenda determined by Dec 1992. Number of meetings of site committee. Institutional framework specifying linkages to local communities in place.	Review report end year 2. Evaluation by site committees. Field site records of attendance, sales.	Agricultural priorities of local farmers and committees can be addressed by adaptive research.
On-farm research methodologies identified and tested and appropriate analytical tools developed.	A range of methodologies tested with different levels of farmer participation	6 month and annual reports. Publications in journals.	
On-farm research programme established.	Programme of on-farm trials established by end of year 1, addressing priority problems of men and women farmers.	Field workers reports. Evaluation of on-farm trials by participation.	
End of season trial analysis and farmers and researchers evaluations determine research plan for subsequent season.	Number of farmers implementing OFTs of different types.		
Technologies identified and adapted to overcome farmers constraints.	Technologies identified, appropriate for a range of socio-economic status and physical environment.	Analysis of on-site trials in 1/2 yearly reports.	Viable technologies for adaptive research exist in research station
Project staff trained on the job in survey and PRA methods, data handling.	50 staff (research officers, field workers, support personnel etc) trained over three years.	1/2 yearly reports. Training course evaluation.	Personnel released for training Appropriate training source identified.
The implementation of a methodology for monitoring the progress and output of participatory research in arid and semi arid areas.	Monitoring system and farmers evaluation mechanisms established. Comparisons with participatory adaptive research elsewhere.	1/2 yearly reports.	Continuity of staff.

tillage methods, soil fertility, soil and water management, animal health and production, agro-forestry and other topics that are identified by the Project as priorities.

recommendations.

MoA/reports.

To work towards sustainable and replicable institutions for effective multidisciplinary adaptive research which link with local planning institutions.

Improved linkages between farmers extensionists, researchers.

DDC evaluation and workshop reports.

GoK agricultural RESEARCH policy continues to support linkages.

Site committees established and increasingly active.

Attendance by TA's DAO, LPO at sites open days and site committee meetings.

Improved project relations with the DDCs LDCs and the Centre Advisory committee.

Attendance of field assistants at extension meetings.

Strengthened experience of KARI researchers.

Active participation of KARI researchers at workshops and production of papers on adaptive research.

To identify, develop, evaluate and disseminate appropriate methodologies which promote farmer participation in research identification, design conduct and interpretation.

Methodologies developed, tested, adopted and disseminated.

OFFA and field assistants records.

Participating staff and institutions can implement their commitment to participatory approaches.

Numbers of men and women farmers from a range of socio-economic groups participating in on-farm research, open days and site visits.

Publications on participatory research methodologies.

No obstacles raised to farmer participation by local leaders.

Numbers of farmers adopting new technologies.

DAREP 1/2 yearly reports.

Research institutions accept the validity of innovative methodologies.

OUTPUTS

In Year 1, information base prepared for project planning;
 - collection of secondary data and reports.
 - review of site and on-farm trials data and experience from DARP.
 - interdisciplinary baseline survey describing existing technology and current farming and income systems.

Secondary information collected and interim workplan elaborated by Sept 92.

Review report.

Data is accessible.

Review completed by March 93.

Statistical results and qualitative survey of farmers.

Survey completed and written up by November 92.

Annex 2

NRSP SEMI-ARID PURPOSES 1 & 2: LOGICAL FRAMEWORK FOR THE "DRYLAND APPLIED RESEARCH AND EXTENSION PROJECT"

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Goal (prescribed)			
Productivity and productive potential in semi-arid production systems increased through the application of systems-based approaches.	Productivity of semi-arid production system increased by 10% between 2005 and 2010 in targeted NRD core and niche countries.	National RNR surveys and statistics Evaluation of RNRRS FAO Annual Reports Reports of commodity organisations National environmental data reports	GoK and donor funding for agricultural research and systems based approaches in research and extension is available at an adequate level for impact.
Purpose			
Production of farming systems increased and risk reduction strategies enhanced through improved conservation & use of water resources, and the optimisation of land use and cropping patterns.	In mixed farming systems in semi-arid Kenya and similar environments: Conservation and management of water resources/water use efficiency improved by 10% by 2005 Crop yield increased by 20% by 2005 Livestock output increased by 10% by 2005 Annual and seasonal variability of production decreased Land use and cropping pattern strategies implemented by local communities by 2005 Biomass production increased by 10%; soil fertility maintained; soil erosion reduced Risk reduction techniques/strategies adopted in target areas by 2005	KARI/KEFRI/MoALD reports National production statistics Evaluation of NRSP Research programme reports Monitoring against baseline data	Enabling environment (policies, institutions, markets, incentives) for widespread adoption of new strategies and technologies exists. Climatic conditions are favourable.
Outputs			
Output 1. Research on improved techniques for rain water harvesting and water conservation tillage documented and disseminated	1.1 Water retention techniques demonstrate 20% increase in field trials by 2002 1.2 Extension services and NGOs knowledge of soil and water management improved by end of project	1.1 Research programme reports 1.2 Project documents available in extension and NGO offices; attendance records of end of project workshops and training	KARI, KEFRI, GoK extension services and NGOs invest in the uptake and application of research results.
Output 2. Research into improved methods for selection and management of appropriate genetic resources (e.g. drought tolerant varieties, pest/disease resistant varieties, short-season varieties) documented and disseminated.	2.1 New or improved protocols/procedures for genetic resource use adapted to target area by 2000 2.2 At least one new variety or new crop adopted by 20% of farmers neighbouring research sites, and by 1% of all farmers in the project area by 1998	2.1 Research programme reports 2.2 Adoption studies	Breeder seed is available for testing and foundation seed is available to farmers. Farmers value trees above other land uses.
Output 3. Soil fertility limitations identified and researchable opportunities documented.	3.1 Packages of new or improved technology and management strategies successfully field tested and adapted by 2000. 3.2 Research recommendations for addressing N and P deficiencies in place by end of project	3.1 Adoption studies 3.2 Research recommendations	KARI, ODA, NGO or IARC programmes want to take up ongoing research activities and infrastructure (physical and social)

Output 4. Strategies for increasing productivity and reducing risk for livestock keeping in semi-arid crop/livestock systems documented and promoted	4.1 5% of farmers in the project area are aware of herbal mange control methods by 1998	4.1 Adoption studies and baseline monitoring	
Output 5. Limitations to on-farm tree establishment and propagation diagnosed, and initial research to address these documented.	5.1 Strategy for addressing research and extension needs for on-farm tree establishment problems in place by end of project	5.1 Technical project reports	
Output 6. Experiences in participatory methods for technology identification, evaluation and sharing documented and disseminated.	6.1 Increased awareness of, and expertise in using, participatory approaches of KARI, KEFRI and extension staff	6.1 Proposals to the Adaptive Research Project Survey reports	
Activities			
1.1 Publish and disseminate soil and water management/rural mechanisation literature review 1.2 Trial on farmer adaptation of soil and water management (SWM) techniques 1.3 Verification of SWM techniques on experimental sites 1.4 Verification of SWM techniques on farmers fields 1.5 Documentation and dissemination of research findings	1.1 Literature reviews completed by May 1996 1.2 Trials completed by June 1996 1.3 Trial completed by June 1996 1.4 Trial completed by June 1996 1.5 Workshop held in May/June 1996 and documents with key stakeholders	1.1 Literature reviews 1.2 Technical reports 1.3 Recommendation leaflets and technical reports 1.4 Ditto 1.5 Workshop proceedings and document distribution lists	Funds flow in a timely manner Vehicles remain serviceable Staff remain in good health Farmers continue to cooperate with research and extension staff Communication skills are improved to an acceptable level
2.1 Completion of research on variety selection and testing and introduction of new crops 2.2 Seed bulking 2.3 Completion of studies of preservation of green vegetables 2.4 Trial on control of kiwi weevil in cowpeas 2.5 Documentation and dissemination	2.1 Recommendations available for 40 new varieties and 11 new crops by end of project 2.2 1000kg of seed available to farmers 2.3 Research completed by September 1996 2.4 Research completed by August 1996 2.5 Documents with key stakeholders; end of project workshop	2.1 Technical reports; recommendation leaflets 2.2 Technical reports 2.3 Technical reports 2.4 Technical reports 2.5 Document distribution list; workshop proceedings	TC Social Anthropologist remains to end of project Extension staff are willing to collaborate in content and editing of documents and extension materials Kenyan research and technician staff are not unduly diverted to other duties
3.1 On farm soil fertility trials 3.2 Soil fertility pot experiments at experimental sites 3.3 Laboratory analyses 3.4 Soil organic matter cycling experiments 3.5 Production of interim report	3.1-3.5 Researcher understanding of limitations to cropping caused by N, P and organic C deficiencies increased	3.1-3.5 Interim reports of PhD thesis and Reading University organic matter cycling project	Computers function well, and vital work is not lost or corrupted Professional DTP assistance is available within budget
4.1 Completion of research on epidemiology of worms in goats 4.2 Completion of research on indigenous mange control 4.3 Completion of research on screening herbal de-wormers in goats 4.4 Documentation and dissemination	4.1-4.3 Research completed by September 1996 4.4 End of project workshop; farmer and extensionist trainings and documents with key institutions and individuals	4.1-4.3 Technical reports 4.4 Workshop proceedings; technical reports and extension materials	Climatic conditions allow meaningful demonstrations during end-of-activity workshops and trainings for extension staff and farmers Technologies (including methodologies) are sufficiently well advanced to be able to promote recommendations with confidence.

<p>5.1 Diagnostic fruit tree trials 5.2 Evaluation of water harvesting for tree establishment 5.3 Evaluation of termite control methods in tree establishment 5.4 Windbreak trials 5.5 Planting niche monitoring 5.6 Propagation studies 5.7 Documentation and dissemination</p>	<p>5.1-5.5 Research evaluated by September 1996</p> <p>5.7 End of project workshop; farmer and extensionist trainings and documents with key institutions and individuals</p>	<p>5.1-5.5 Technical reports</p> <p>5.7 Workshop proceedings; technical reports and extension materials</p>
<p>6.1 Farming system characterisation progress report 6.2 Production and publication of unpublished survey reports 6.3 Adoption studies on selected technologies 6.4 Editing and publication of literature reviews 6.5 Completion and documentation of socio-economic farm monitoring 6.6 Analysis and publication of market study data 6.7 Documentation of activities to build farmer research capacity 6.8 Monitoring and documentation of research site committees 6.9 Hold last farmer open days and evaluate and document participatory extension 6.10 Training of research and field staff in communication skills 6.11 Documentation and dissemination of participatory methodologies (to include a methodologies workshop)</p>	<p>6.1-6.8 Reporting completed by October 1996</p> <p>6.9 Farmer open days completed by August 1996</p> <p>6.10 Staff ability to write and present information improved</p> <p>6.11 Workshop held and documentation completed by end of project</p>	<p>6.1-6.8 Reports, reviews, adoption studies.</p> <p>6.9 Open day reports; technical reports</p> <p>6.10 Technical reports; workshop proceedings</p> <p>6.11 Workshop proceedings; technical reports and materials for extension staff</p>

Inputs by activity group	£stg	Ksh	
A. Operating costs			
1. Soil and Water Management	2000	170,000	
2. Crop Varieties	2000	170,000	
Vegetables	1000	85,000	
Crop protection	1000	85,000	
3. Soil fertility	3000	255,000	
Organic matter	442	37,500	
4. Livestock	3500	297,500	
5. Agroforestry	3000	255,000	
6. Socio-economics	4000	340,000	
7. Experimental site maintenance and Embu Regional Research Centre Maintenance	7000	595,000	
		KSh 2,090,000	
Sub-total	£26942		
8. Carry-over from 1995/96	36626	****	
9. Equip. carry-over 1995/96	1654		
10. Equip for 96/97	200	****	
A. Total operating costs	£65422	*****	
B. TC Costs	£72437		
C. UK coordination costs	£5022		
Sub-Total	£142881		
D. VAT @ 17.5%	£25004		
TOTAL PROJECT COST	£167885		
NB: Currency conversion rate taken as: KSh 85 = £1.00 Stg.			